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IN EXPLOITATION OF GENETIC DIVERSITY IN POTATO BREEDING

ISTRAŽIVANJE GENETSKE RAZNOLIKOSTI U UZGOJU KRUMPIRA

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ABSTRACT

With a view to select divergent parents genetic diversity was estimated among twenty genotypes. Thirty F_1 progenies developed by line-tester mating were studied from seedling generation to first clonal generation for five important agronomic traits. Cluster analysis reveals that the parents could be grouped into seven different clusters. Cluster means showed wide range of variation for several traits among singles as well as multi genotypic clusters. Considering diversity pattern, parents should select from cluster I, III, IV and V for the improvement of potato. Analysis of variance revealed that all most all the sources of variation were highly significant for all the studied traits in both generations. Parents Challisha, Lalpakri, Patnai, Chamak, Sadagoti, TPS-67 and TPS-364 were found to be good general combiners for tuber yield and yield contribution traits due to their gca effects. The sca effects showed that out of 30 hybrids 12 were found to have specific combining ability for tuber yield and those hybrids also exhibited considerable heterosis for tuber yield and yield contributing traits.

Key words**:** Combining ability, first clonal generation, genetic diversity, heterosis, seedling generation, *Solanum tuberosum*

SAŽETAK

U svrhu selekcije različitih roditelja procijenjena je genetska raznolikost među dvadeset genotipova. Trideset potomaka F1 razvijenih spajanjem linija - ispitivača istraživano je od generacije sadnica do prve generacije klona za pet važnih agronomskih osobina. Analizom klastera otkriveno je da se roditelji mogu svrstati u sedam različitih klastera. Prosjeci klustera pokazali su veliki raspon variranja kod nekoliko osobina među pojedinačnim kao i više-genotipskim klasterima. S obzirom na raznolikost uzorka roditelje treba selekcionirati iz klastera I, III, IV i V za oplemenjivanje krumpira. Analizom varijance otkriveno je da su gotovo svi izvori variranja bili veoma značajni za sve istraživane osobine u obje generacije. Roditelji Challisha, Lalpakri, Patnai, Chamak, Sadagoti, TPS-67 i TPS-364 bili su dobri spajatelji za prinos gomolja i osobine prinosa zbog svog gca djelovanja. Djelovanje gca je pokazalo da je od 30 hibrida 12 imalo određene sposobnosti spajanja za prinos gomolja, a ti su hibridi također ispoljili znatnu heterozu za osobine prinosa gomolja i osobine što doprinose prinosu.

Ključne riječi: sposobnost spajanja, prva generacija klona, genetska raznolikost, heteroza, generacija sadnica, *Solanum tuberosum*

INTRODUCTION

Potato is an herbaceous tuber-bearing plant. Traditionally it is propagated by planting seed tubers. Depending upon the cultivar, flower may or may not be produced. Flowering is always accompanied by tuber initiation. Flower color varied from white to purple and flowers may lead to berries or be aborted, which is either due to varietal differences or to strong self incompatibility of the flower (Mondal 2003).

Parent selection is most important to achieve desirable hybrids in a breeding program. Maximum achievement will be achieved if the parents have a high probability of producing desirable clones able to survive many rounds of selection in the scheme. The estimate of genetic divergence in the available germplasm is important for the selection of desirable donors for breeding programme (Lotan and Pradhan 2005). The modern genetic breeding requires crosses between productive and genetic divergent parents, in order to have better heterotic effect and variability in the segregant generations (Cruz 2001). Simmonds (1979, 1996) and Mendoza and Haynes (1974) emphasized the need to screen parents and cross before their use in the breeding program and suggested that combining ability analysis based on progeny test data is useful method for evaluating parents and crosses for a wide range of quantitative traits.

Combining ability is one of the powerful tools in identifying the best combiner that may be used in crosses either to exploit heterosis or to accumulate fixable genes.

Potato is highly heterozygous crop. The knowledge of genetic divergence and its nature and degree serves a useful purpose to identify desirable parents for potato breeding programme. Combining ability and heterosis is perquisite for developing a good hybrid variety of potato. There is no report about utilization of genetic divergence for the selection of parents in potato breeding Bangladesh. Present work was conducted to assess the genetic diversity among the parents with the view of selection of desirable parents. After that according to D^2 results we design potato breeding program using line-tester crossing model. Combining ability and heterosis were used to find out best combiner and hybrid vigor form F_1 seedling generation and first clonal generation.

MATERIALS AND METHODS

To asses genetic diversity 20 diverse potato genotypes were evaluated. According to the D^2 results ten female and three male parents were selected for cross breeding programme. For flower induction artificial lighting was performed to extend photoperiod up to 17 hours with the help of high pressure sodium bulb. Emasculation and bagging was done properly. Pollens from male parents were collected from 10 am to 12 noon and again from 3 pm to 4 pm. On the following day pollination on desirable female parents were done. After 50 days of pollination the berries were collected and dryed in shade. After that TPS seeds were extracted from dry berry and stored in desicator. The F_1 TPS were sown in seedling trays filled with 1:1 mixture of sand and farmyard manure. After one month seedlings were transferred in to the field. Crops were harvested at 90 days after planting. After that seed tubers were stored in clod storage. The first clonal generation's seed tubers were sown in field. All trails were laid in a randomized complete block design with plot size of 6 m^2 comprising three rows of 20 hills per row planted at intra and inter row spacing of 20 and 60 cm, respectively. The recommended agronomic practices were followed to raise good crops. Observations were recorded and calculated on nine randomly selected plants from each plot on plant height, branch number, tuber number, tuber yield and average tuber weight. The divergence among 20 potato genotypes was estimated through the use of Mahalonobis (1936) Generalized

Distance as a measure of genetic dissimilarity, combined with Tocher Method and Principle Components. Combining ability analysis was done according to Kempthorne (1957). Heterosis was calculated from following formula.

$$\text{Mid parent heterosis \%} = \{(F_1 - \text{Mid parent}) \div \text{Mid parent}\} \times 100$$

$$\text{Better parent heterosis \%} = \{(F_1 - \text{Batter parent}) \div \text{Batter parent}\} \times 100$$

$$\text{Standard parent heterosis \%} = \{(F_1 - \text{Standered parent}) \div \text{Standard parent}\} \times 100$$

All the statistical analysis was performed by using MS Excel 2002, NTSYSpc 2.10 and GENSTAT 9.2

RESULTS

A cluster analysis was performed based on five morphological traits and results are illustrated in Figure 1. Cluster analysis based on morphological measured distances provided fairly good divisions of the parental genotypes into their heterotic groups (Figure 1). By applying of non-herierarchical clustering using co-variance matrix, twenty genotypes of potato were grouped into seven different clusters. Cluster I, V and VI consisted of maximum number of genotypes and cluster VII consisted or minimum number of genotypes. The dendrogram also shows comparatively low similarity among the populations. Genotypes were displayed in clustering ranging from 0.19 to 1.83. A clear separation among the genotypes was not found.

The intra and inter cluster distance in terms of average D^2 values are presented in Table 1. The highest inter cluster distance was between IV and V and the lowest between cluster II and VII. The minimum and maximum intra cluster divergence was found in cluster IV and V, respectively. The cluster mean for the five important agronomic traits are presented in Table 2. The highest plant height, branch number, tuber number, tuber yield and average tuber weight were recorded from cluster III, VII, VI, IV and IV, respectively.

Analysis of variance for combining ability of both seedling and clonal generations are presented in Table 3. The results reveal that treatment, parents, crosses, lines, testers and lines × testers were highly significant for all the studied traits in both generations. Where as parents *vc* crosses was highly significant all most all the traits except tuber number in both generations.

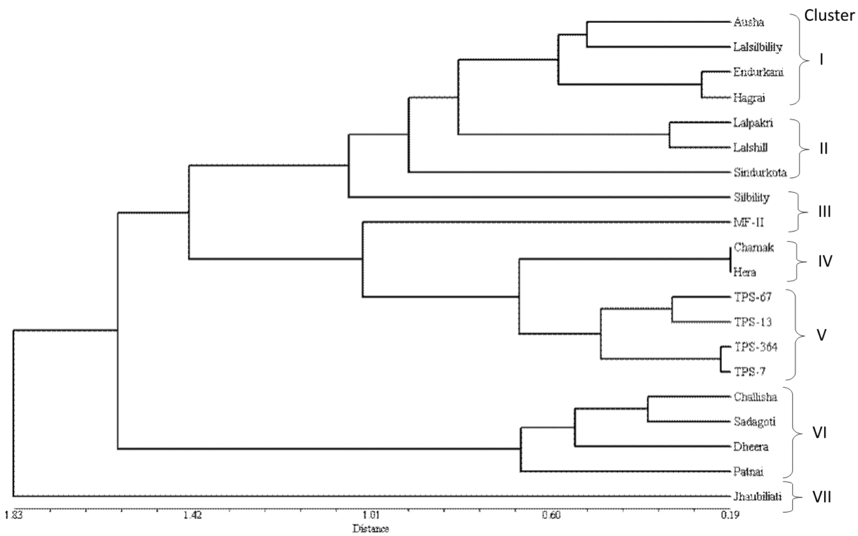

Figure 1: Dendrogram of the twenty genotypes clustered on the basis of morphological data based genetic distance estimates.

Figure 1 Dendogram dvadeset genotipova okupljenih na osnovi morfoloških podataka što se temelje na procjeni genetske udaljenosti

Replication exhibited non-significant result for all the traits except branch number.

The mean square of specific combining ability (sca) was higher than general combining ability (gca) for all the studied traits in both generations. In addition, the ratio of the mean square components associated with variance of gca and sca was much less than the theoretical maximum of unity for all traits studied. These results tend to suggest that genetic variation among crosses was primarily of the non-additive type. The results of the analysis of variance for combining ability were also confirmed from the additive (σ^2A) and dominance (σ^2D) components of variance.

Table 1. Intra and inter cluster average D^2 in twenty potato genotypes. Bold diagonals denotes intra cluster D^2 values where as off diagonals are inter cluster values.

Tablica 1. Prosjek D^2 unutar (intra) i među (inter) klastera u 20 genotipova krumpira. Debele dijagonale označuju D^2 vrijednosti unutar klastera a vrijednosti među klasterima su izvan dijagonala

	I	II	III	IV	V	VI	VII
I	**9.924**	6.48	6.989	6.852	8.977	6.219	6.504
II		**5.409**	6.884	5.711	7.717	6.421	4.024
III			**5.769**	7.357	8.868	7.009	6.122
IV				**4.415**	9.648	7.092	5.588
V					**14.577**	7.536	7.859
VI						**12.66**	6.168
VII							**0**

Table 2. Cluster mean of five important agronomic traits in D^2 analysis.

Tablica 2 Prosjek klastera pet važnih agronomskih osobina u analizi D^2

Cluster	Plant height (cm)	Branch number	Tuber number	Tuber yield (g)	Average tuber weight (g)
I	36.61	3.04	8.72	60.69	7.67
II	48.72	3.91	15.86	81.91	5.19
III	56.65	3.39	7.83	259.89	36.79
IV	31.22	3.33	9.78	386.56	41.8
V	25.64	3.28	11.17	316.68	31.4
VI	53.64	5.11	27.92	251.92	9.78
VII	35.15	9.96	15.44	48.29	3.18

Estimation of general combining ability effects of both generations are presented in Table 4. The gca effects showed that a wide range of variability existed among the parents in both generations. None of the thirteen parents however, showed significant gca effect for all the traits. Among the parents Challisha and TPS-364 are the most desirable female and male parents,

Table 3. Analysis of variance for combining ability in two generations.
Tablica 3. Analiza varijance sposobnosti spajanja u dvije generacije

Source	Df	Plant height (Cm)		Branch number		Tuber number		Tuber yield (g)		Average tuber yield (g)	
		SG	FCG	SG	FCG	SG	FCG	SG	FCG	SG	FCG
Replication	3	3.402	16.652	1.793*	1.651*	1.934	5.354	840.358	2250.431	1.068	20.132
Treatment	42	376.823***	386.693***	2.114***	8.397***	89.138***	221.825***	22226.416***	34233.781***	754.124***	778.313***
Parents	9	832.551***	899.183***	1.945***	8.931***	149.883***	447.499***	37989.759***	67753.787***	1117.978***	1536.662***
Parents vc Crosses	1	427.171***	199.007**	6.141***	5.164**	4.695	4.750	59552.276***	96363.339***	910.978***	1837.429***
Crosses	29	272.636***	280.326***	2.247***	9.211***	82.419***	182.221***	18346.529***	25230.047***	713.807***	586.957***
Lines	9	402.986***	505.743***	4.845***	14.919***	128.463***	351.730***	20751.819***	33161.809***	650.336***	496.382***
Testers	2	854.742***	373.487***	2.677***	34.472***	281.507***	350.072***	37300.338***	53885.943***	2425.426***	2229.296***
Lines × Testers	18	142.782***	157.267***	0.900***	3.550***	37.276***	78.816***	15037.906***	18080.178***	555.363***	449.762***
Error	126	8.298	14.005	0.516	0.566	3.257	9.402	461.660	974.031	21.108	16.856
Variance components											
δ^2 gca (line)		21.684	29.040	0.329	0.947	7.599	22.743	476.159	1256.803	7.914	3.885
δ^2 gca (tester)		17.799	5.406	0.044	0.773	6.106	6.781	556.561	895.144	46.752	44.488
δ^2 gca (average)		1.821	1.726	0.019	0.079	0.633	1.450	46.398	100.264	2.222	1.924
δ^2 sca		33.621	35.816	0.096	0.746	8.505	17.354	3644.062	4276.537	133.564	108.226
δ^2 sca / δ^2 gca		18.463	20.754	5.087	9.399	13.435	11.967	78.540	42.653	60.113	56.253
Additive components of variance (δ^2A)		29.135	27.611	0.302	1.270	10.129	23.201	742.360	1604.226	35.550	30.783
Dominant components of variance (δ^2 D)		134.484	143.262	0.384	2.984	34.020	69.414	14576.246	17106.147	534.255	432.905
Proportional contribution to total variances											
Lines		45.872	55.990	66.913	50.266	48.372	59.904	35.103	40.791	28.275	26.245
Testers		21.621	9.188	8.215	25.810	23.556	13.249	14.021	14.730	23.434	26.194
Lines × Testers		32.506	34.822	24.872	23.924	28.072	26.847	50.875	44.479	48.292	47.561

*,** and *** significant at P=0.05, P=0.01 and P=0.001, respectively; SG, Seedling generation; FCG, First clonal generation.

Table 4. Estimation of General combining ability (gca) effects of parents from the lines- testers crossing model for yield components in two generations.

Tablica 4. Procjena opće sposobnosti spajanja (gca) djelovanja roditelja modela križanja linije-ispitivača za komponente prinosa u dvije generacije

Parents	Seedling Generation					First Clonal Generation				
	Plant height (cm)	Branch number	Tuber number	Tuber yield (g)	Average tuber weight (g)	Plant height (cm)	Branch number	Tuber number	Tuber yield (g)	Average tuber weight (g)
Ausha	-2.342**	-0.129	-4.349***	-0.354	6.572***	-2.765*	0.021	-6.751***	-9.178	6.085***
Challisha	1.075	1.301***	-2.293***	19.924**	15.981***	0.066	2.181***	-3.418***	21.781*	14.256***
Chamak	-4.092***	-0.629**	5.124***	-19.701**	-8.311***	-4.594***	-1.347***	5.568***	-8.039	-5.569***
Hera	-8.022***	-0.643**	3.138***	50.604***	-0.092	-8.873***	-1.236***	6.596***	64.156***	-1.249
Lalpakri	0.506	0.065	-1.446**	-43.535***	-5.146***	2.517*	0.395	-1.251	-62.761***	-5.769***
Lal shil	11.492***	-0.074	-2.654***	-46.549***	-4.107**	9.990***	-0.139	-5.238***	-63.706***	-2.523*
MF II	-6.342***	-0.421*	4.207***	79.590***	1.478	-9.295***	-0.875***	8.776***	99.364***	-1.651
Patnai	-0.536	-0.379	-2.529***	10.215	4.247**	1.031	-0.583**	-3.946***	8.447	4.727***
Silbility	2.186**	0.024	-0.724	-40.215***	-5.079***	4.170***	0.264	-2.446**	-46.678***	-3.831**
Sadagoti	6.075***	0.885***	1.526**	-9.979	-5.543***	7.823***	1.320***	2.110*	-3.386	-4.477***
TPS-13	4.417***	-0.156	-0.828	-30.078***	-4.137**	2.839*	-0.664 **	-0.008	-33.951**	-4.614**
TPS-67	-4.804***	-0.143	2.968***	-0.899	-4.846**	-3.234**	-0.397*	2.963**	-4.993	-3.999**
Tps364	0.388	0.299	-2.140***	30.976***	8.982***	0.395	1.061***	-2.954**	38.944***	8.613***

*,** and *** significant at P=0.05, P=0.01 and P=0.001, respectively; GCA, general combining ability

Table 5. Estimation of specific combining ability (sca) effects of the 30 crosses in two generations
Tablica 5. Procjena određenih osobina spajanja (gca) učinaka 30 križanaca u dvije generacije

	Plant height (cm)			Branch number			Tuber number			Tuber yield (g)			Average tuber weight (g)		
	TPS-13	TPS-67	Tps364	TPS-13	TPS-67	Tps364	TPS-13	TPS-67	Tps364	TPS-13	TPS-67	Tps364	TPS-13	TPS-67	Tps364
Seedling generation															
Ausha	-3.000*	3.429**	-0.429	-0.233	-0.038	0.271	-0.047	-3.010***	3.057***	-37.075***	-46.588***	83.663***	-3.480	-1.982	5.462**
Challisha	-0.083	2.138	-2.054	0.461	0.324	-0.785*	0.606	2.393**	-2.999***	-60.019***	38.593***	21.426*	-19.115***	-12.525***	31.640***
Chamak	6.875***	3.221**	-10.096***	0.225	-0.163	-0.063	0.772	3.643***	-4.415***	25.897**	43.301***	-69.199***	3.631	3.946*	-7.577***
Hera	1.264	-5.349***	4.085**	0.114	-0.190	0.076	-0.742	2.338**	-1.596*	-16.075	-29.546**	45.621***	0.805	-3.123	2.319
Lalpakri	-2.347	-4.460***	6.807***	0.031	-0.190	0.160	0.383	-3.746***	3.363***	67.897***	-21.532*	-46.365***	9.085***	3.020	-12.105***
Lal shil	-4.667***	2.971*	1.696	-0.164	-0.426	0.590	2.092**	-2.246**	0.154	55.453***	1.940	-57.393***	4.924*	3.796	-8.721***
MF II	5.958***	-7.363***	1.404	0.267	-0.204	-0.063	-3.728***	4.851***	-1.124	-19.686*	-52.907***	72.593***	4.111*	-5.861**	1.750
Patnai	0.111	-3.460**	3.349**	-0.067	-0.079	0.146	1.967*	-2.663***	0.696	-49.978***	-4.699	54.676***	-8.417***	2.085	6.332**
Silbility	-5.444***	1.318	4.126**	-0.303	-0.107	0.410	-0.047	-1.051	1.099	31.953***	-4.060	-27.893**	4.661*	2.363	-7.023***
Sadagoti	1.333	7.554***	-8.888***	-0.331	1.074***	-0.743*	-1.256	-0.510	1.765*	1.633	75.496***	-77.129***	3.795	8.283***	-12.078***
First Clonal Generation															
Ausha	-0.464	1.651	-1.187	-0.538	-0.346	0.884**	-0.353	-3.157*	3.510**	-49.410***	-48.743***	98.153***	-4.732**	-1.925	6.656***
Challisha	0.106	2.595	-2.701	-0.239	1.578***	-1.339***	-1.228	5.385***	-4.157**	-80.160***	66.299***	31.861*	-15.783***	-11.817***	27.601***
Chamak	7.592***	4.415**	-12.006***	0.705*	-0.270	-0.436	0.328	6.565***	-6.893***	27.535*	46.701***	-74.236***	3.279	1.554	-4.833**
Hera	0.786	-3.683*	2.897	-0.114	-0.422	0.536	3.508**	2.121	-5.629***	4.090	-40.701**	36.611**	-0.643	-2.109	2.752
Lalpakri	-6.061***	-0.863	6.924***	-0.245	-0.761*	1.006**	-0.936	-5.115***	6.051***	71.424***	-22.368	-49.056***	8.198***	2.998	-11.196***
Lal shil	-4.700**	-1.585	6.285***	0.080	-0.520	0.439	1.383	-2.296	0.913	57.785***	9.660	-67.444***	5.173**	3.944*	-9.117***
MF II	4.731**	-6.259***	1.528	1.067**	-0.492	-0.575	-2.214	3.524**	-1.310	-0.701	-72.576***	73.278***	3.595*	-2.642	-0.953
Patnai	-3.200*	0.456	2.744	-0.308	0.217	0.092	2.008	-1.754	-0.254	-49.951***	-7.285	57.236***	-6.753***	-1.417	8.170***
Silbility	-4.547**	-1.224	5.772***	-0.281	-0.506	0.786*	-1.117	-2.879*	3.996**	26.965*	-8.076	-18.889	4.799**	3.455	-8.254***
Sadagoti	5.758***	4.498**	-10.256***	-0.128	1.522***	-1.394***	-1.381	-2.393	3.774**	-7.576	77.090***	-69.514***	2.869	7.958***	-10.827***

*,** and *** significant at P=0.05, P=0.01 and P=0.001, respectively; sca, specific combining ability

Table 6. Mean and range of performance and heterosis in the 30 F_1 of potato two generations
Tablica 6. Prosjek i niz djelovanja (performanca) i heteroza u 30 F1 dvije generacije krumpira

Traits	Generation	Performance		Mid parent heterosis %		Better parent heterosis %		Standard parent heterosis %	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Plant height (cm)	Seedling	37.9	15.0-57.0	27.1	-43.7-120.8	3.9	-44.5-100.5	32.2	-31.8-80.2
	First clonal	43.5	19.0-65.0	19.9	-39.6-76.4	-1.2	-50.3-75.4	26.3	-26.8-74.8
Branch number	Seedling	2.1	1.0-6.0	-16.5	-53.5-42.1	-24.5	-55.6-28.6	-14.8	-54.5-54.5
	First clonal	3.3	1.0-8.0	-9.4	-66.7-78.6	-19.1	-68.6-72.7	-5.0	-64.5-93.5
Tuber number	Seedling	10.8	2.0-31.0	21.7	-73.2-283.2	4.9	-73.2-283.2	19.2	-62.2-150.0
	First clonal	15.3	2.0-48.0	25.6	-75.4-261.0	6.1	-75.4-261.0	33.2	-59.6-167.3
Tuber yield (g)	Seedling	152.3	45.0-385.0	-25.0	-63.5-61.7	-39.3	-68.6-21.4	-47.4	-72.4-13.9
	First clonal	188.2	63.0-480.0	-22.9	-65.0-64.4	-38.5	-68.0-13.0	-50.7	-75.5-3.0
Average tuber weight	Seedling	15.1	3.6-120.5	-24.4	-81.1-232.1	-46.6	-82.7-149.5	-47.9	-75.4-120.7
	First clonal	17.2	3.4-132.0	-21.6	-82.2-234.9	-46.3	-86.7-134.8	-54.6	-79.3-96.4

respectively, which contributed positive significant gca effect for plant height, branch number, tuber yield and average tuber weight in both generations. Ausha and Patnai exhibited significant positive gca effect for average tuber weight in both generation.

Specific combining ability effects were estimated from both seedling and clonal generations of thirty hybrids (Table 5). Among the 30 hybrids significant positive sca effects were noted in both generations from 6 hybrids for plant height, 1 hybrid for branch number, 3 hybrids for tuber number, 12 hybrids for tuber yield and 7 hybrids for average tuber weight. None of the hybrids possessed significant positive sca effect for all the traits together.

The means and range of performance, mid-, better- and standard- parent heterosis of seedling and clonal generations of 30 F_1 hybrids are presented in Table 6. The mean performances for all the studied traits were higher in first clonal generation than seedling generation. The degree of heterosis varied from trait to trait in both generations. From seedling generation highest mid-, better- and standard- parent heterosis were observed in traits plant height, tuber number and plant height, respectively. On the other hand from clonal generation highest mid-, better- and standard- parent heterosis observed in tuber number. Among the 30 hybrids over 50% mid parent heterosis were found in crosses Patnai/TPS-13, Lalpakri/TPS-13, Lalpakri/TPS-67 and Chamak/TPS-67 for tuber yield; Patnai/TPS-13, Lalpakri/TPS-67, Lalpakri/TPS-364, Lalsill/TPS-364, Chamak/TPS-67, Sadagoti/TPS-67, Silbility/TPS-364 and Ausha/TPS-364 for tuber number and Patnai/TPS-67, Chamak/TPS-67, Hera/TPS-67 and MF-II/TPS-13 for average tuber weight (data are not shown).

DISCUSSION

Results of D^2 analysis revealed that twenty genotypes were distributed in seven groups/clusters but there is no clear separation found among the genotypes, this indicates that considerable variation existed among the studied genotypes. Observation from cluster mean suggested that none of the clusters contained genotypes with all the desirable traits which could be directly selected and utilized. Also almost all the minimum and maximum cluster mean values were distributed in relatively distant clusters. To develop desirable hybrids, hybridization between the genotypes of diverse clusters is necessary. According to Sinha et al. (1991) and Singh et al. (1996) recombination breeding between genotypes of different clusters is important to develop superior hybrid. In the present investigation, it is suggested that hybridization programme within the divergent cluster IV between V, I between V and III between V, are expected to give promising and desirable recombinants in the segregating generations.

The results analysis of variance indicated that source of variance viz. genotypes, parents, crosses, lines, testers and lines × testers for all the studied traits in both generations were highly significant. The magnitudes of mean square suggested that there were high heterotic responses for the studied traits.

The higher sca mean square than the gca indicated that the predominance of non-additive gene action in the expression of these traits and in agreement with the findings of the Sharma et al. (1998), Thompson and Mendoza (1984), Thompson (1980), Veilleux and Lauer (1981), Brown and Caligari (1986), Maris (1989), Neele et al. (1991), Bradshaw et al. (2000), Ortiz and Golmirzaie (2004), Biswas et al. (2005).

Among the thirteen parents challisha and TPS-364 exhibited positive significant gca effects in most of the studied yield contributing traits. So these parents should be utilized to produce highly productive hybrids. The gca effect for yield and average tuber weight appeared to be positively correlated which confirmed the observations of Mondal and Hossain (2006), Biswas et al. (2005) and Gaur et al. (1993).

According to Gilbert (1967) the additive parental effect as measured by gca effect are of more practical use to the breeder than non-allelic interaction, if these are exploited through conventional selection method. Rojas and Sprague (1952) also pointed out that gca effects would be more stable as compared to sca effect. In general, additive effects are mainly due to polygenes producing fixable effects and indicate the capacity of a variety in relation to all other varieties, it was crossed with.

The results of sca effects reveal that none of the crosses possessed significant positive sca effects for all the studied traits. It was also observed that those hybrids exhibiting positive significant sca effect were induced from crossing parent with good × good and good × poor general combiner. Generally good × good, poor × poor, poor × good and good × poor general combiner parents produced good specific combination. In these crosses additive ×

additive, dominance × dominance, dominance × additive, additive × dominance type of gene action was found. In many cases good × good general combiner produced inferior cross combination indicating epistasis type of gene action for these traits.

According to our present investigation, it is clear that hybridization between the members of diverse cluster produced superior hybrid and it was conformed by combining ability and heterosis analysis. From our studies we found that Challisha, Lalpakri, Patnai, Chamak, Sadagoti, TPS-67 and TPS-364 can be used as parent for potato breeding to produce desirable yield producing hybrids. Those parents exhibited expected results from gca analysis and they were distributed in comparatively distance clusters and their hybrids also exhibited high heterosis. So it is concluded that genetic diversity among the parental genotypes is important for improvement of potato through breeding programme.

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