COMBINING ABILITY AND GENETIC VARIABILITY STUDIES IN POTATO

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ABSTRACT

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Seventeen potato genotypes comprising seven parents and their ten crosses were evaluated during to November 2005 to March 2006 to study their combining ability and genetic variability. Mean squares due to GCA and SCA were highly significant for all the characters except number of branches/plant and dry matter content for which SCA mean square was non-significant. The mean squares due to GCA were found to be lower than SCA indicated pre-dominance of non-additive gene action for all the characters studied. The parents TPS-7, TPS-364, Hera and Chamak were found best general combiners for tuber yield and other important characters. The crosses TPS-7 × TPS-13, TPS-364 × TPS-13, TPS-13 × MF-11, Hera × TPS-19 and Chamak × TPS-13 were observed to be the most promising hybrid combinations for yield and other yielding components. High estimates of co-efficient of variability, heritability and genetic gain for plant height, number of branches, tubers number and yield indicated that these traits are largely controlled by additive gene action and that strength selection for them would be effective.

Keywords: Potato, combining ability, GCA, SCA and tuber yield

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a part of the diet of half a billion consumers in the developing countries (Mondal, 2003). Its area and production are increasing day by day in declaring in 2008, the International Year of Potato, the UN general assembly seeks to focus world attention on the role of potato in defeating hunger and poverty (Hossain, 2008). To feed this ever growing human of people there is a need to increase productivity. For a successful breeding program, combining ability and variability play a vital role. In the recent past, exploitation of hybrid vigor and selection of parents on the basis of combining ability and gene action have been important breeding approaches in crop improvement. The breeding methodology to be adopted for the improvement of a crop mainly depends upon the amount of genetic variability present in the crop. It is of immense important that the hybrids are obtained only from desirable parental combinations. Therefore, it is very important to select the desirable parents which could transmit high yield and other economic trait to their progeny. Combining ability analysis would help in the selection of parents and crosses for improvement of the crop. It also indicates the relation between additive and non-additive gene action (Arora, 1993). Hence, an attempt was made to study and genetic information about combining ability and variability in potato.

MATERIALS AND METHODS

The experiment was conducted at Botanical Research Garden at Department of Botany of Rajshahi University, Rajshahi-6205, Bangladesh during rabi season of November 2005 to March 2006. The materials used for the present study including seven parents and their ten crosses, which were planted on 20 November 2005. The experiment was carried out following randomized block design with three replications. Each genotype (tuber) was grown in a single row plot of 1 m long in each replication. The spacing was maintained 25 cm between rows and 5 cm between plants. Fertilizers were applied @150,120 and 30 kg/plot of N, K and P, respectively (Hayder, 2007).

Standard agronomic practices were followed and plant protection measures were taken when required. Observations were recorded on five randomly selected plants for plant height (cm) , number of leaves/plant, number of tillers/plant, number of tubers/plant, dry matter content and tuber yield (g/plant). General (GCA) and specific (SCA) combining ability were estimated according to Griffing's (1956) method-II and method-I. Genetic variability, heritability and genetic advance as percentage of mean (genetic gain) were computed as per the methods described by Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) revealed that both GCA and SCA variances were significant for plant height and tuber weight/plant which indicated that the expression of these characters were controlled by non-additive type gene action in controlling the characters. However lower magnitude of GCA variances than the corresponding SCA variances indicated predominance of non additive gene action. These findings are in close agreement with Hannan *et al*. (2007) and Geleta *et al*. (2006) in tomato. Non significant GCA variance for plant height leaves number/plant, branches number/plant, tubers number and tuber weight/plant suggested non additive gene action in their expression. Dod *et al*. (1992) also reported predominance of additive genetic variation for these characters in tomato.

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Table 1. Analysis of Variance for combining ability for tuber yield and its component characters in Potato

Source	df	PH	NLP	NBP	NT	DM%	TYP
gca	6	6.000**	0.067	0.043	0.205	0.133	91.945**
sca	21	6.600**	2.234**	0.268	7.700**	1.600	40.510**
Error	46	4.293	7.160	0.140	6.218	1.372	2.718
gca/sca		0.909	0.028	0.160	0.026	0.083	2.267

*PH=plant height, NLP=number of leaves/plant, NBP=number of branches /plant, NT=number of tubers, DM%=dry matter content and TYP=tuber yield /plant; **p=0.01*

General combining ability (GCA) effects

The GCA effects of the parents are shown in Table 2. Among the parents only TPS-13 and Hera were the best general combiner exhibited positive and significant GCA effects for plant height, number of tubers/plant including tuber yield (Table 2). Of two parents, TPS-67 and TPS-367 were good combiners for tuber yield exhibited significant and positive GCA effect for this trait. The parents TPS-67, TPS-7 and Chamak showed significant negative GCA effect for plant height, numbers and tuber yield were poor combiners for the respective traits.

Table 2. Estimates of GCA effects and mean performance of the parents for different characters in potato

Parents	PH		NLP		NBP		NT		DM%		TYP	
	mean	gca	mean	gca	mean	gca	mean	gca	mean	gca	mean	gca
TPS-67	37.614	3.456*	22.887	0.203	3.207	0.052	6.776	0.592	22.01	-1.043*	379.55	34.489**
TPS-13	33.785	1.083*	33.492	0.692	2.552	[0.390	7.841	-0.214	21.256	-0.302	437.063	13.794**
TPS-7	18.083	0.805*	32.458	-0.352	3.011	-0.065	9.141	-0.436	19.70	2.193**	422.166	-60.65**
TPS-364	25.433	0.472	27.528	-0.53	2.925	-0.204	15.051	0.342	22.186	-1.658**	419.767	13.52**
MF-11	24.800	1.097*	27.033	-0.013	2.818	-0.173	6.785	-0.283	19.88	0.810	369.142	-1.15
Hera	36.066	1.355*	38.709	-0.537	3.255	-0.106	11.475	2.469**	18.13	-0.135	484.44	4.739**
Chamak	22.125	1.358*	27.391	0.538	2.688	-0.108	8.447	-2.470**	21.01	0.139	477.388	-4.741**
SE	2.226		2.845		0.332		-1.373		0.564		52.079	

*PH=plant height, NLP=number of leaves/plant, NBP=number of branches /plant, NT=number of tubers, DM%=dry matter content and TYP=tuber yield /plant; *P=0.05, **P=0.01*

The association between GCA effects and mean performance of the parents revealed that parents having high performance also showed good GCA for most of the traits like plant height, dry matter content and tuber yield. The high performance of such parents for these traits may be mainly due to the performance of additive type gene action. The high GCA effects observed for different traits could be helpful in identifying outstanding parents with favorable alleles for different components of yield. In this affect, parents TPS-67, TPS-13, TPS-364 and Hera could be all possible matting for obtaining higher yield. The relation between mean performance with GCA effects for different yield contributing characters and yield in tomato were reported by Hannan *et al*. (2007). TPS-67 was a good general combiner for tuber yield, TPS-13 and Chamak was good general combiner for plant height TPS-7 and TPS-364 for dry matter as they contributed maximum number of favorable genes for these characters. These results suggested that the parents can be used for development of synthesis having higher tuber yield with rightly maturity.

Specific combining ability (SCA) effects

Results of ten best crosses on the basis of tuber yield/plant, their SCA effects for tuber yield/plant and significant SCA effects for their component characters are presented in Table 3. Among the crosses, the cross MF-11×TPS-13 exhibited maximum *per se* performance for tuber yield and showed significant SCA effects for all the six characters under study. Out of 10 crosses, significant positive SCA effects were observed in 4 crosses for tuber yield. The best cross for tuber yield was TPS-364 × TPS-67 which was followed by Chamak × TPS-67 and MF-11 × TPS-13. The *per se* performance of these crosses for yield was also very high. These crosses involved medium × medium, medium × high and high × high general combining parents. Parents with good positive GCA for yield (TPS-67), negative GCA for yield (TPS-7) and tuber number (Chamak) may be extensively used in hybridization program as a donor. The better performing three crosses (TPS-364 × TPS-67, Chamak × TPS-67 and MF-11 × TPS-13) can be utilized for developing high yielding hybrids parents as well as for exploiting hybrid vigor. Other crosses TPS-364 × TPS-67, chamak ×TPS-67 and MF-11 × TPS-13 ranked 2nd, 3rd and 4th in *per se* performance in yield, respectively. They showed significant SCA effects for all the sip characters in order. These crosses can be considered as promising hybrids. In general it was observed that the parents TPS-364, chamak, TPS-13, MF-11 and TPS-67 which are categorized as good general combiners have given better hybrids with other parents. Therefore, it appears that for getting good cross combinations GCA of parents is very important. These results support the findings of Hannan *et al*. (2007) and Geleta *et al*. (2006) in tomato.

Table 3. Hybrids with better performance for yield with SCA values and significant values of SCA for associated characters

Crosses	Per se performance for tuber yield/plant	SCA effect for yield/plant	Significant desirable SCA effects for other component characters
TPS7×TPS-67	236.11	-29.6*	PH
TPS-364×TPS-67	159.44	13.872*	NBP
MF-11×TPS-67	213.33	11.65*	NBP
Hera×TPS-67	205.55	-16.41*	-
Chamak×TPS-67	227.78	20.483*	-
TPS-7×TPS-13	198.88	-125.9**	PH, NLP, NBP, TN, TYP, DM%
TPS-364×TPS-13	126.67	-181.8**	PH, NLP, NBP, NT, DM%, TYP
MF-11×TPS-13	263.06	224.27**	PH, NLP, NBP, NT, DM%, TYP
Hera×TPS-13	228.89	-151.71**	PH, NLP, NBP, NT, DM%, TYP
Chamak×TPS-13	177.33	-197.4**	PH, NLP, NBL, NT, DM%, TYP

PH=plant height, NLP=number of leaves/plant, NBP=number of branches /plant, NT=number of tubers, DM%=dry matter content and TYP=tuber yield /plant

The high degree of genotypic variance indicated preponderance of additive gene effects. The range of variation was much pronounced for all the characters studied (Table 4).

Table 4. Estimates of genetic parameters for six characters in potato

Characters	MS	δ^2g	δ^2 p	GCV	PCV	h^2b	GA%
PH	19.219	63.524	67.817	45.88	47.41	93.7	91.48
NLP	0.215	12.696	19.86	12.955	16.20	63.9	21.34
NBP	0.216	0.437	0.567	31.075	35.39	77.1	56.20
NT	29.530	81.703	87.921	46.739	48.48	92.9	92.81
DM%	6.174	2.044	3.416	6.94	9.042	59.8	11.15
TYP	2.840	13.568	16.286	39.393	43.16	83.3	74.07

PH=plant height, NLP=number of leaves/plant, NBP=number of branches /plant, NT=number of tubers, DM%=dry matter content and TYP=tuber yield /plant

Maximum genotypic variance and phenotypic variance were found plant height and tuber number indicating greater scope of selection for the improvement of the two characters. The differences between genotypic coefficient of variability and phenotypic coefficient of variability were higher for leaves numbers, branches numbers and tuber number indicating vulnerability of the three characters to the environmental effects. High heritability (in a broad sense) as well as high genetic advance as percentage of mean were observed for plant height, branches number, tubers number and tuber yield indicated that these traits could be improved through selection and were governed to a great extent by additive gene. Haydar (2007) obtained that fresh weight and tuber weight/plant recorded comparatively high estimates of phenotypic coefficient of variability and genotypic coefficient of variability and heritability and heritability in potato.

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