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# COMBINING ABILITY IN POTATO (*SOLANUM TUBEROSUM* L.)

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**Abstract**

An investigation was conducted with ten potato genotypes following line × tester mating design to study the combining ability of yield and yield component characters *viz.*, days to emergence, plant height, number of stems/plant, number of tubers/plant, tuber weight/plant, tuber dry matter content and tuber weight loss due to respiration were studied. Highly significant genotypic difference was observed for almost all the characters. The contribution of testers was observed to be higher than that of the line × tester intersection for NS, NT and TW revealed the higher estimates of additive gene action among the testers. The sca variance was higher in magnitude than the gca variance for all the characters indicated the predominance of non-additive type of gene action for the expression of these characters. Estimation of gca effects of the parent revealed that among the male parents TPS-67 was found to be the most desirable parent, and among the female parents Lal Pakri, Patnai, Shill Bilati and Ausha were found to be good general combiner for tuber yield and its component characters. The estimation of sca effect reveled that out of 21 crosses, eight were found to be good specific combiner for tuber yield.

## Introduction

Potato is a highly heterozygous crop where non-additive gene action is known to be important for most of the economic characters. The aim in potato improvement program is to facilitate the recombination of a number of agronomic, disease and quality traits from the parents. Simmonds (1979, 1996) and Mendoza and Haynes (1974) emphasized the need to screen parents and crosses before their use in the breeding program and suggested that combining ability analysis based on progeny test data is a useful method for evaluating parents and crosses for a wide range of quantitative traits. An advantage of hybridization in potato is that once a hybrid with desired characters is identified, it can be multiplied vegetatively for a long time without any risk of segregation. Heterosis and combining ability is prerequisite for developing a good hybrid variety of potato. 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. So, the study was undertaken to determine the nature and magnitude of gene action of potato on yield and its component, agronomic characters and to exploit heterotic hybrid combination.

## Materials and Methods

Ten genotypes of potato were used in line × tester mating design. Seven genotypes (Lal Shill, Shill Bilaty, Lal Pakri, Sad a Gutti, Ausha, Patnai and Challisha) were used as female parents (line) and the remaining three (TPS-67, TPS-13 and Dheera) were used as male parents (tester). 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 a.m. to 12 noon and again from 3 p.m. to 4 p.m. On the following day pollination on desirable female plants were done. After 50 days of pollination the berries were collected and the seeds were extracted from the berries after another 15 days. All the lines were crossed to each of the testers to produce $F_1$ true seeds at Breeders Seed Production Centre, Bangladesh Agricultural Research Institute (BARI), Debigonj, Panchagarh during rabi

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season of 1999-2000. The $F_1$ true seeds of the ten crosses were stored in a desicator for the next cropping season. In 2000-2001 rabi season the $F_1$ seeds were sown in well prepared seed bed for tuberlet production. The seed tubers of parents were also multiplied separately. Seeds tubers of both $F_1$ and parents were stored for next year observation. The seed tubers of ten parents and their 21 hybrid progenies were evaluated during rabi season of 2001-2002 in the research field of Institute of Biological Sciences, Rajshahi University, Rajshahi. The tubers of all of the parents and their 21 crosses were planted on 15th November, 2001. The experimental design was Randomized Block Design with four replications consisting of 31 plots per replication. Each plot had two rows of 40 plants. Row to row and tuber to tuber distances were 60 and 20 cm, respectively. For raising good crops recommended dose of fertilizers and standard management practices were performed. The crops were harvested at 90 days after planting. Observation were recorded and calculated on ten randomly selected plants from each plot on days to emergence (DE), plant height (PH), number of stems/plant (NS), number of tubers/plant (NT), individual tuber weight/plant (ITW), tuber weight/plant (TW), tuber dry matter content (DM %) and tuber weight loss due to respiration (WL %). The ITW was calculated by dividing tuber yield/plant by number of tubers/plant and WL % was recorded after 150 days of harvest. The data were analyzed according to line × tester method suggested by Kempthorne (1957).

**Results and Discussion**

The analysis of variance of results (Table 1) revealed that the parents, crosses and parents vs. crosses show significant variation for almost all the characters. These findings indicated that there was wide range of variability among the parents/crosses/parents vs. crosses for the characters. The magnitude of mean squares suggested that testers were more diverse than the lines for DE, PH, NS, TN, DM and WL%, while the latter were more diverse than the former for the remaining traits. The higher magnitude of specific combining ability (sca) variance for all the characters indicating the predominance of non-additive gene action in the expression of these characters. Additive and non-additive types of gene action in potato were studied and reported by many (Sharma *et al.* 1998, Thompson and Mendoza 1984 and Thompson 1980). The present findings were in agreement with the finding of the above workers. The estimate of gca effects showed a wide range of variability among the parents (Table 2). None of the ten parents, however, showed significant gca effect for all traits together. The estimation of gca effect revealed that the TPS-67 is the most desirable male parent, which contribute significant positive gca effect for DE, PH, NS, TN, TW and DM%. It should be utilized in evolving highly productive hybrids. Among the female parents Lal Pakri and Patnai were found to the good combiner for PH. NS and TW. Beside these the female parent *viz.* Shill Bilati and Ausha were found to be good combiner for TW also. However, Shill Bilati, Lal Pakri, Ausha, Patnai and TPS-67 contribute nonsignificant and positive gca effect for ITW. The gca effects for TW and ITW appeared to be positively correlated which confirm the observation of 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 effect 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 estimation of specific combining ability effect (Table 3) reflect that out of 21 crosses none of the them possess significant positive sca effect for all the characters together. However, the crosses Lal Pakri × TPS 67, Sada Gutti × TPS-67, Lal Pakri × TPS-13, Ausha × TPS-13, Patnai × TPS-13, Challisha × TPS-13, Lal shill × Dheera and Shill Bilati × Dheera showed significant

positive sca effect for TW. It was also observed that all these crosses involved in crossing parent with good × good and good × poor general combiner. The above crosses show positive sca effect for most of the other characters suggested that there is scope for improvement of these characters. For DM% the crosses Shill Bilati × TPS-67, Patnai × TPS-67, Lal Shill × Dheera and Ausha × Dheera showed significant positive sca effect. On the other hand the crosses Lal Shill × TPS-67, Sada Gutti × TPS-67, Ausha × TPS-67, Lal Shill × TPS-13, Shill Bilati × Dheera, Lal Pakri × Dheera, Patnai × Dheera and Challisha × Dheera showed significant sca effect for WL %, therefore, these crosses can be exploited for improving DM and WL %. The crosses with positive sca effect for yield in general involved either only the good combining parent or at least one good combiner and an average or poor combiner. This result conforms the finding of Gaur *et al.* (1993). 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 were found. In many cases good × good general combiner produced inferior cross combination indicating epistasis type of gene action for these traits.

For processing purpose, tuber dry matter content is an important character as it determines the quality and quantity of the processed product. An increase in tuber dry matter, however, should not be accompanied with a decrease in yield, as will be expected due to negative correlation in between these two characters. A negative correlation between ITW and DM% was also reported by Gaur *et al.* (1978). A combination of all these three characters *viz.* TW, ITW and DM% in the crosses, though difficult, is desirable for selecting a recombinant genotype suitable for processing. In the present study the cross Lal shill × Dheera showed significant positive sca effect for the above characters indicating possibilities of selecting such a desirable recombinant.

From the over all observation, male parent TPS-67 was found to be the best combiner for yield and its component characters. On the other hand, female parents Shill Bilati, Lal Pakri, Auaha and Patnai may also be used as a good combiner for yield and yield component breeding. TPS-67 possess high yielding attributes as well as. high yield. On the contrary Shill Bilati, Lal Pakri, Ausha and Patnai possess desired quality but associate with low yield. Therefore, for the improvement of potato both yield and quality traits crosses can be made by using TPS-67 as male parent either with Shill Bilati or Lal Pakri or Ausha or Patnai as female parent.

## References

Gaur, P.C., P.K. Gupta and H. Kishore. 1978. Studies on genetic disvergence of potato. Euphytica. **27**:361-368.

Gaur, P.C., S.K. Pandey and S.V. Singh. 1993. Combining ability study in the development of potato hybrids suitable for processing. J. Indian Potato Assoc. **20**(2):144-149.

Gilbert, N. 1967. Additvie combining abilities fitted to plant breeding data. Biometric.**23**: 45-50.

Kampthorne, O. 1957. An Introduction to Genetical Statistics. John Wiley and Sons. Inc. New York.

Mendoza, H.A., and F.L. Haynes. 1974. Genetic basis of heterosis for yield in autotetraploid potato. Theor. Appl. Genet. **45**: 21-25.

Sharma, Y.K., P.C. Katochi, S.K. Sharma and S.K. Chaudhary. 1998. Genetic analysis for combining ability in true potato seed population. J. Indian Potato Assoc. **25**(1&2): 33-38.

Simmonds, N.W. 1979. Principles of crop improvement. Longman Group Ltd. London.

Simmonds. N.W. 1996. Family selection in plant breeding. Euphytica. **90**: 201-208.

Thompson, P.G. 1980. Variance components and heritability estimates for several traits in potatoes grown form true seed. Amer. Potato J. **57**: 496.

Thompson, P.G., H.A Mendoza and R.L. Plaisted. 1983. Estimation of genetic parameteres for characters related to potato propagation by true seed (TPS) in an andigena population. Amer. potato J. **60**: 393-401.

Thompson, P.G. and H.A Mendoza. 1984. Genetic variance estimates in heterogeneous potato populations propagated form true seed (TPS). Amer. Potato J. **61**: 697-702.

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