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**Research Article**

# Repeatabilty of general and specific combining ability effects of seedling and clonal generations in potato

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**Abstract**

The relative magnitude of general combining ability (gca) and specific combining ability (sca) effects in three generations (years), viz. Seedling (SG), first clonal generation (FCG) and second clonal generation (SCG) for tuber yield, tuber number, average tuber weight and tuber dry matter of potato in a line x tester mating design (10 × 4) was studied. There were marked differences in the gca effects of 14 parents. GCA and SCA for various characters varied from generation to generation. In general the correlation between various generations was varied and general conclusion could be arrived except in case of gca effects of males for dry matter. Considering the consistent performance over various generations for general combining ability, genotypes viz., MP/92-136, MP/91-65 and MP/90-95 for tuber yield and MP/92-136 for tuber number, Kufri Jyoti, for average tuber weight and MP/91-65 and QB/A-9-120 for dry matter were good general combiners, both in seedling and clonal generation. Similarly the crosses with consistent performance of specific combining ability over generations are cross MP/92-136 x Kufri Chipsona-1 for tuber yield and average tuber weight and QB/A-9-120 x MP/90-94 for tuber number and dry matter, were consistently good specific combiners in all generations. The variation in general combining ability effects over generation observed in the present study for tuber dry matter can be attributed to genotype × environment interaction. Hence, combining ability to select suitable parents for potato breeding has to be done based over years/generations. Parents and crosses with consistent performance over generations and those specifically suitable for breeding for processing quality were identified.

**Keyword:** Potato, combining ability, clone, yield.

## Introduction

Potato (*solanum tuberosum* L.) is the one of the world's most important food crop. Indeed, in most developed and developing countries including India, an increasing proportion of the crop is now processed prior to consumption. The potato processing industry needs cultivars with high tuber dry matter and acceptable colour of processed products. Combining ability is used for selection of parents for hybridization and to get information on genetics of different traits. The literature on these aspects are limited. In most of the studies results were based on a single clonal generation. Performance of clones and progenies is known to vary in early generations of potato breeding programme (Anderson and Howard, 1981; Brown *et al.*, 1987a, b, Maris, 1988; Gopal *et al.,* 1992, Gopal, 1997; Gopal, 1998). The knowledge on how general and specific combining ability effects vary from seedling to clonal generation and between clonal generations for dry matter is very limited. The aim of the present study is to get information on these aspects, based on the performance of 40 crosses involving 14 parents in line x tester design for three successive generations for tuber dry matter, tuber yield and its related traits.

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## Materials and Methods

Fourteen potato genotypes belongs to *Solanum tuberosum* susbsp. t*uberosum* were selected for the present study. They were Kufri Jyoti, Kufri Chipsona-1, Kufri Chipsona-2, MP/90-94, MP/91-35, MP/91-51, MP/91-65, MO/91-76, MP91-86, MP/92-30, MP/92-136, MP/92-154 and QB/A-120. Two genotypes Kufri Chipsona-1 and Kufri Chipsona-2 are two potato cultivars recently released in India exclusively for processing purposes. The Kufri Jyoti is a well-adapted cultivar released in 1976 and being cultivated in wide range of agro-climatic zones ranging form plains to high hills in India. Remaining 11 genotypes were selected in advanced generation's clones. The 14 selected genotypes were grown in field and crossing was done during summer (May – August, 1997) at the Central Potato Research Stations, Kufri (32□ N, 77□ E, 2500 m above see level) where the optimum climatic conditions are available. Based on high pollen fertility MP/91-35, MP/90-94, Chipsona-1 and Chipsona-2 were used as male parents and Kufri Jyoti, MP/92-30, MP/91-51, MP/91-65, MP/91-76, MP/91-86, MP/92-136, MP/92-139, MP/92-154 and QB/a-9-120 as female parents. The crosses were made in 10 x 4 line x tester mating design. True hybrid seeds from 40 crosses sown in nursery bed at the Central Potato Research Institute Campus, Modipuram (29o N, 76o E, 222 m above sea level) during autumn (October-February) 1999. The seedlings were transplanted in the main filed at 4-5 leave stage (35 days after sowing). At harvest 30 seedlings per replication per cross were retained. These were used to form three replications (one tuber per genotype per replication) of the first clonal generation (FCG). Twenty genotypes from each replication formed the material for second clonal generation (SCG). Parents were also included in all the generations. All the generations were raised in randomised complete block design with three replications. The crop was harvested at maturity (110 days after sowing). Data were recorded on single plant basis in three generations for four characters, viz. tuber yield (g), tuber number per plant, average tuber weight (g) and tuber dry matter (%). Percent tuber dry matter was estimated from freshly harvested tubers i.e. each one tuber per plant was sampled; equal portion of tuber was mixed, oven dried and % dry matter was estimated. Combining ability analysis was done and general and specific combining ability variances and effects were estimated using the computer software SPAR1. A fixed effect model was used for the test of significance at P □ 0.05. Phenotypic correlation coefficients between generations for combining ability effects were computed using computer software MSTAT-C.

**Results and Discussion**

Analysis of variance for combining ability showed that the mean squares for female, males and females x males were significant for all the characters. In the pooled analysis, mean square due to generations and various interactions with generation were significant. The ratio of components of variance due to general combining ability (pooled over females and males) versus total genetic variance showed a preponderance of additive gene action in seedling generation (SG) and second clonal generation (SCG)and non additive gene action for tuber yield in first clonal generation (FCG) (Table 1). In case of tuber number, additive gene action was observed in SG and SCG and non additive in FCG. For average tuber weight, additive in SG, non-additive in SCG and both additive and non additive in FCG. In case of dry matter, additive gene action was observed in FCG and SCG and non additive gene action in SG. The estimates of variance due to SCAs were found to be more important than GCAs variance for tuber yield and reverse for tuber number. Plaisted *et al.* (1962) and Gopal (1998) reported larger estimate of SCA variance than the corresponding GCA . But Maris (1989 found that GCA was more important than SCA. These results clearly indicated that GCA and SCA for various characters varied from generation to generation.

The correlation coefficient between generations for GCAs and SCAs were presented in Table 2. In general the correlation between various generations was varied and general conclusion could be arrived except in case of gca effects of males for dry matter. This estimation also may not be taken in to consideration since the number of males is only four parents. Considering the consistent performance over various generations for general combining ability, genotypes viz., MP/92-136, MP/91-65 and MP/90-95 for tuber yield and MP/92-136 for tuber number, Kufri Jyoti, for average tuber weight and MP/91-65 and QB/A-9-120 for dry matter were good general combiners, both in seedling and clonal generation. Kufri Jyoti was poor combiner for tuber yield and tuber number and MP/91-35 for dry matter. Similarly the crosses with consistent performance of specific combining ability over generations are cross MP/92-136 x Kufri Chipsona-1 for tuber yield and average tuber weight and QB/A-9-120 x MP/90-94 for tuber number and dry matter, were consistently good specific combiners in all generations. The cross MP/91-76 x MP/90-94 and MP/92-154 X Kufri Chipsoan-1 were poor specific combiners for more than one character, both in seedling and clonal generations.

The variation in general combining ability effects over generation observed in the present study for tuber dry matter can be attributed to genotype □ environment interaction. Killick (1997) alos observed a substantial environmental effect on expression of tuber dry matter content and suggested to study this trait over wide range of environments. Hence, selection of good combining parents based on single generation (year) study fir tuber dry matter may lead to a biased selection. Hence selection must be based on study of two or more generations. The parent MP/91-35 was such parent showed consistent GCA at different generations and could be used as parent for developing high dry matter genotypes for processing. Similarly, the cross QB/A-9-120 x MP/90-94 was the best specific combiner for dry matter and tuber yield. Hence this cross may be used in quality breeding programme.

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Table 1 Estimates of variance components and their relative importance in potato

| Character | $\sigma^2$ gca (females) | $\sigma^2$ gca (males) | $\sigma^2$ gca (pooled over female and male) | $\sigma^2$ sca | $\sigma^2$ gca/ ($\sigma^2$ gca + $\sigma^2$ sca) * |
|---|---|---|---|---|---|
| A. Seedling generation | | | | | |
| Tuber yield | 301.57 | 32.90 | 1148.02 | 1367.41 | 0.46 |
| Tuber number | 0.56 | 2.15 | 3.16 | 1.66 | 0.66 |
| Average tuber weight | 0.36 | 2.74 | 1.99 | 0.61 | 0.76 |
| Dry matter | 0.22 | 0.19 | 0.67 | 1.06 | 0.39 |
| B. First clonal generation | | | | | |
| Tuber yield | -59.19 | -170.5 | 1143.7 | 956.34 | 0.54 |
| Tuber number | 0.07 | 0.11 | 0.28 | 0.48 | 0.39 |
| Average tuber weight | 0.67 | -0.17 | 13.97 | 13.90 | 0.50 |
| Dry matter | -0.15 | 0.01 | 0.13 | 0.05 | 0.72 |
| C. Second clonal generation | | | | | |
| Tuber yield | 297.76 | 119.67 | 64.66 | 405.77 | 0.14 |
| Tuber number | -0.09 | -0.10 | 0.60 | 0.41 | 0.59 |
| Average tuber weight | 0.97 | 1.53 | 2.24 | 4.98 | 0.31 |
| Dry matter | 0.02 | -0.02 | 0.85 | 0.83 | 0.51 |

* The ratio is for σ2GCA (pooled). When the ratio >0.50, GCA is more important than SCA in the inheritance of the character concerned, while the reverse is for when the ratio is <0.50

Table-2: Between generations correlations coefficients for combining ability effects in potato

| Generation | Tuber yield | Tuber number | Average tuber weight | Dry matter |
|---|---|---|---|---|
| A. Based on gca of females | | | | |
| SG Vs FCG | 0.36 | 0.03 | 0.40 | 0.12 |
| SG Vs SCG | 0.70* | 0.70* | 0.67* | -0.17 |
| FCG Vs SCG | 0.49 | 0.39 | 0.46 | -0.60* |
| B. Based on gca of males | | | | |
| SG Vs FCG | -0.36 | -0.73 | -0.28 | 0.93** |
| SG Vs SCG | 0.98** | -0.10 | 0.38 | 0.96** |
| FCG Vs SCG | -0.39 | -0.38 | 0.17 | 0.88* |
| C. Based on pooled gca of female & males | | | | |
| SG Vs FCG | 0.30 | -0.15 | 0.22 | 0.28 |
| SG Vs SCG | 0.72** | 0.27 | 0.56* | -0.02 |
| FCG Vs SCG | 0.40 | 0.29 | 0.42 | -0.36 |
| D. Based on sca effects | | | | |
| SG Vs FCG | -0.08 | 0.29 | 0.32 | -0.04 |
| SG Vs SCG | 0.40* | 0.04 | 0.27 | -0.03 |
| FCG x SCG | 0.10 | 0.45* | 0.33 | 0.20 |