Usefulness of Andigena (Solanum tuberosum ssp. andigena) genotypes as parents in breeding early bulking potato cultivars

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Summary
Seven Solanum tuberosum ssp. tuberosum and three Solanum tuberosum ssp. andigena accessions were crossed to produce 12 Tuberosum × Tuberosum (T × T) and 9 Tuberosum × Andigena (T × A) progenies. These families were evaluated for five important traits for two successive clonal generations under short day sub-tropical plains. The differences in yield, average tuber weight and tuber number between T × T and T × A families in an early (75 days) crop were not significant. Compared to conventional intra-Tuberosum families, T × A families had significantly higher % tuber dry matter and specific gravity. In contrast to intra-Tuberosum crosses, T × A crosses exhibited a positive heterosis for tuber yield. Compared to T × T families, T × A families showed significantly higher heterosis for yield and tuber number. Comparison of T × T and T × A families and parents using canonical analysis led to the identification of superior hybrid families and superior parents. Some T × A progenies were close to breeding goal and thus can be used for selecting high-yielding cultivars. This revealed the usefulness of Andigena genotypes as parents in developing early bulking potato cultivars with broad genetic base for short day sub-tropical plains.

Introduction
Potato breeding programmes based on Solanum tuberosum L. have a narrow genetic base (Simmonds, 1962). Most breeders agree that it is increasingly difficult to obtain improvement in yield and other traits from among recombinants produced by crossing presently available parental clones. Primitive cultivated potatoes of Solanum tuberosum group Andigena are being used to broaden the genetic base of group Tuberosum material. Andigena is a rich source of genetic diversity. However, Andigena selections are known to exert a strong influence in crosses with clones of Solanum tuberosum group Tuberosum (Tai & Tarn, 1980) and high frequency of late maturity, small tubers occurring in some better crosses remains a problem for the breeder. Simmonds (1976) has emphasized the need to learn how to utilize Tuberosum × Andigena (T × A) hybrids. The immediate usefulness of Andigena material is in the form of T × A hybrids. The potential of Andigena accessions in increasing yield in T × A crosses due to heterosis, is well-established (Glendenning, 1969, 1975; Cubillos & Plaisted, 1976; Tarn & Tai, 1977, 1983). Short day adapted Andigena accessions can be useful parents in breeding programmes for short day sub-tropical environment. Multivariate statistical methods are very useful in summarizing and describing the variability found in natural or breeding populations. An approach that is very useful for determining breeding methods to obtain hybrids close to a chosen ideal is the multivariate technique of canonical analysis (Whitehouse, 1971). In potatoes, canonical analysis has been used for discriminating different type of families and to study their relationship to their parents (Tai & Tarn, 1980; Tai & De Jong, 1980; Tarn & Tai, 1983). The potato crop in sub-tropical Indian plains is normally harvested 90–110 days after planting. Early bulking genotypes giving high yield at...
early (75 days) harvest are highly desirable for their multiple advantages (Shekhawat, 1994). The present study was conducted with the objective to know the usefulness of late maturing Andigena genotypes in developing early (75 days) bulking potato cultivars for sub-tropical Indian plains. For this \( T \times A \) families were compared to conventional Tuberosum \( \times \) Tuberosum \( (T \times T) \) families and breeding goals using canonical analysis.

Materials and methods

Crosses were performed between seven Tuberosum and three Andigena parents in line \( \times \) tester design during summer 2001 at Central Potato Research Station, Kufri (31°08’N, 77°18’E, 2530m amsl). Four Tuberosum male parents (CP 1704, MS/82–797, JN 2207 and Kufri Badshah) and three Andigena male parents (JEX/A 805, EX/A 680-16 and JEX/A 318) were crossed to three Tuberosum female parents (Kufri Jyoti, Kufri Ashoka and MS/89-1095). The Tuberosum parents were selected primarily on the basis of large tuber size; high yielding ability and most of them are used frequently in intra-Tuberosum crosses in cultivar development programmes. Andigena parents were selected on the basis of good tuber size and yield. Seedlings and subsequent clonal generations were raised at Central Potato Research Station Jalandhar (31°02’N, 75°02’E, 237m amsl). Seedlings of each cross at the 6-7-leave stage were transplanted to field. At harvest 3 tubers per seedling for each of 30 randomly selected genotypes per progeny were retained to form three replications of first clonal generation. The same procedure was applied to form material for second clonal generation (SCG). In the 2002–2003 and 2003–2004 autumn crop seasons, trials were laid out in Randomised Complete Block Design with three replications and a plot size of 3.6 square metres comprising 2 rows planted at intra and inter row spacing of 20 and 60 cm, respectively. Normal management and pest control practices were carried out. Haulm cutting of the crop was done 75 days after planting. The crop was harvested in each season 20 days after haulm cutting.

Characters studied

1. Tuber number per plot
2. Average tuber weight in grams per tuber calculated by total yield per plot/ total number of tubers per plot
3. Total yield in kilograms per plot
4. % dry matter
5. Specific gravity

For % dry matter estimation, 500 g tubers pieces were cut into small pieces and oven-dried at 80 °C to a constant weight. Specific gravity was determined by the weight-in-air and weight-in-water method.

Statistical analyses

Homogeneity of error variance was tested by two-tailed F test. Combining ability analysis was done based on Kempthorne (1957). Heterosis and heterobeltiosis were calculated as per the following formulae:

\[
\text{Heterosis} (\%) = \frac{(F_1 - MP)}{MP} \times 100
\]

\[
\text{Heterobeltiosis} (\%) = \frac{(F_1 - BP)}{BP} \times 100
\]

\(F_1\) is the mean value of hybrid progeny, \(MP\) is the average value of two parental clones. \(BP\) is the value of better parent in a cross. Significance of differences in average performance for parents and progeny means, heterosis (\%) and heterobeltiosis (\%) were tested using Student’s t test for comparing means based on samples of different size. Canonical analysis was done using SPAR1 software package (IASRI, New Delhi). Two-dimensional canonical diagrams were prepared based on scores of first, second and third canonical variates of hybrid families and their Tuberosum and Andigena parents.

Results

Analysis of variance for parents and progenies over two clonal generations showed that mean squares due to parents, progenies and parents versus progenies were significant for the characters tuber number, average tuber weight, yield, % dry matter and specific gravity (data not shown). The interactions parent \( \times \) clonal generation, progeny \( \times \) clonal generation and parent versus progeny \( \times \) clonal generation were non-significant for all the five characters.

Compared to the three Andigena accessions, seven Tuberosum parents included in this study had wider range for yield, average tuber weight, tuber number and specific gravity (Table 1). Andigena parents differed from Tuberosum parents by having low average tuber weight and yield and higher % dry matter and...