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Short Communication

Reciprocal effects in potato (*Solanum tuberosum* L.) x Andigena-Tuberosum intergroup hybridization under shortdays

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Abstract

Six Tuberosum and five Andigena parents were used to generate 23 Tuberosum × Andigena direct and 23 reciprocal progenies. These progenies were evaluated for total yield, marketable yield, tuber number, average tuber weight and per cent tuber dry matter in second and third clonal generations. Evaluation of progenies in field was done in Randomized Complete Block Design with split plot taking direction of cross (Andigena versus Tuberosum as female) as sub-plot and parental combination as main-plot. Significant variation was recorded in progenies for the characters studied. Results revealed that that reciprocal cross differences in inter group crosses were in general not significant for all the characters. The lack of reciprocal cross differences in short-day length environment in Indian plains shows that crosses can be attempted in either direction while breeding cultivars for Indian plains.

Key words : Andigena, reciprocal cross effects, *Solanum tuberosum* L, tuberosum, yield

In potato a number of reports have indicated differences in reciprocal progenies of Potato (*Solanum tuberosum* L.) when inter-group hybrids were studied (1, 2). The high magnitudes of these differences had been reported especially for yield. But there are some reports where no such reciprocal cross effects were found in inter-group hybrids. Knowledge of occurrence or non-occurrence of such differences in different environments/material types is important for selecting parents for hybridization in breeding programmes especially when attempting inter-group crosses. Primitive cultivated potatoes of *Solanum tuberosum* group Andigena are being used to broaden the genetic base of group Tuberosum (*Solanum tuberosum* group Tuberosum) material. The immediate usefulness of Andigena material is in the form of its crosses with Tuberosum accessions. Short day adapted Andigena accessions have been found to be useful parents in breeding programmes for short day sub-tropical environment [3]. Keeping this in view the objective of the present study was to investigate whether the direction of cross in crosses between Andigena and Tuberosum genotypes affects agronomic characters in breeding potato clones for sub-tropical short-day environment in India.

Six Tuberosum and five Andigena parents were grown and crossed to generate 23 Tuberosum × Andigena progenies and 23 exact reciprocal progenies (Table 1). Three hundred true potato seeds (TPS) of each of the 46 progenies were treated with 2000 ppm gibberellic acid (GA_3) for 24 hr for dormancy breaking. After drying in shade TPS were sown in seedling trays during last week of September 2007. Seedlings at the three- to four-leaf stage were transferred individually to small polythene bags for further growth. Finally, 60 seedlings of each cross at the six- to seven-leaf stage were transplanted to the field. The seedlings of a single progeny were planted together. At harvest, three tubers per seedling for each of the 45 randomly selected genotypes per progeny were retained to form three replications of the first clonal generation in next autumn (October to December) crop season. The same procedure was applied to form material for a second

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Table 1. Parental lines used in hybridization to generate reciprocal cross progenies for two years

Accession	Source country	Import year	Exact name of accession	Parentage	Salient feature
JN 2207	India	-	JN 2207	JF 4928 × Spika	Improved high yielding Tuberosum breeding line
JN 1197	India	-	JN 1197	JF 4928 × PI 161695-1	Improved high yielding Tuberosum breeding line
CP 3290	Hungary	1992	Hope Hely	-	Good tuberization ability
CP 1909	USA	1971	B6532-10	-	Good tuberization ability
CP 2013	Mexico	1977	Atzimba	-	Good tuberization ability
CP 2376	Peru	1987	Cruza 27	-	Good tuberization ability
A.98-47	-	-	A.98-47	JEX/A 318× JEX/A 855	Improved Andigena clone for tuber size and yield
A.98-97	-	-	A.98-97	JEX/A 44× EX/A 680-16	Improved Andigena clone for tuber size and yield
JEX/A 804	USA	1969	PI280883	-	Andigena accessions with good tuberization ability
JEX/A 592	USA	1969	PI243438	-	Andigena accessions with good tuberization ability
EX/A 680-16	USA	1980	R12	-	Andigena accessions with good combining ability for yield

– = Not known

(SCG) and third clonal generation (TCG) material in successive autumn crop seasons. Evaluation of progenies and parents in SCG and TCG were done in Randomized Complete Block Design with split plot in 2009-2010 and 2010-2011 crop seasons, respectively. Direction of cross (Andigena versus Tuberosum as female) was taken as sub-plot and parental combination as main-plot. Experiments were laid out in three-row plots with three replications. Each row contained 15 plants. There were 45 genotypes planted together per progeny in each replication. The intra and inter row distances were 20 cm and 60 cm, respectively. Data were recorded on total yield (kg/ plot), marketable yield (kg/plot), tuber number and tuber dry matter (%), while average tuber weight (g) was calculated by dividing total tuber yield/ plot with tuber number/ plot. The data were pooled over years and analysis of variance was done according to Randomized Complete Block Design with split plot [4].

Analysis of variance showed that mean squares due to parental combination were significant for all the studied characters *viz*., tuber number, marketable yield, total yield, average tuber weight and per cent dry matter (Table 2). This shows that significant variation was present in progenies for the characters studied. Year × parental combination interaction was significant for marketable and total yield. Mean square due to Tuberosum *versus* Andigena as female were non significant for all the 5 characters. This shows that general conclusion about more useful direction in crosses of Andigena and Tuberosum can not be drawn. Parental combination × Tuberosum *versus* Andigena interaction was significant for all the 5 characters. This shows that some progenies performed better for some of these traits in one direction of crosses while there were some other progenies which performed better for some characters in opposite direction of cross. There were some progenies for which reciprocal cross effects were significant for all the 5 characters (Fig. 1).When Tuberosum accessions were used as females 8, 6, 6, 7 and 8 progenies performed statistically better for tuber number, marketable yield, total yield, average tuber weight and per cent dry matter, respectively. While if Andigena accessions were used as females 8, 7, 5, 5 and 9 progenies performed statistically better for tuber number, marketable yield, total yield, average tuber weight and per cent dry matter, respectively. These results suggests that attempting crosses involving both Tuberosum and Andigena accessions in both cross directions could be useful in selecting better progenies/clones in breeding programmes.

Table 2. Mean squares of the analysis of variance of tuber characters in 23 reciprocal biparental crosses over two years

Source	d.f.	Mean square for				
		Tuber number/ plot	Marketable yield (kg/plot)	Total yield (kg/plot)	Average weight (g)	Per cent tuber dry matter
Years	1	268.058	20.53**	10.33**	152.71**	0.083
Replications in years	4	116.62	0.42	0.57	19.34	0.040
Parental combination	22	30448.80**	11.37**	11.32**	608.08**	7.512**
Year x parent	22	390.85	1.42**	1.31*	15.38	0.034
Error	88	236.63	0.56	0.68	12.12	0.146
Tuberosum vs. Andigena as female	1	676.17	1.31	2.52	35.29	0.001
Year x Tuberosum vs. Andigena as female	1	109.70	0.97	1.05	7.77	0.001
Parental combination x Tuberosum vs. Andigena as female	22	7736.91**	6.03**	6.20**	201.44**	3.750**
Year x Parental combination x Tuberosum vs. Andigena as female	22	729.43**	0.95	0.85	21.68	0.019
Error	92	215.19	0.61	0.75	15.68	0.110

*,**Significant at 0.05 and 0.01 level of probability, respectively

Results revealed that reciprocal cross differences in inter group crosses were in general not significant for all the characters. There are reports that offspring with Tuberosum as a female parent outyielded their reciprocal cross with Andigena or wild species as female. Cubillos [1] observed reciprocal differences as high as 33% for yield in *Solanum tuberosum* Group Andigena-Group Tuberosum crosses. Hoopes *et al.* [2] has documented reciprocal differences of 19% for yield in Andigena-Tuberosum crosses in favour of Tuberosum cytoplasm. Sanford and Hanneman [5] attributed high reciprocal yield differences in four exact reciprocal Tuberosum-Andigena crosses to differences in maturities of the parents in such crosses. Estrada [6] also observed reciprocal differences for yield and maturity in *Solanum curtilobum*-Tuberosum crosses, but these were attributed to differential success of euploid and aneuploid gametes. Kidane-Mariam and Peloquin [7] reported reciprocal differences for yield in 4x-2x crosses, but these differences were attributed to differences in the meiotic mode of the 2n eggs and the 2n pollen formation. Although all of the previous reports have involved a bias toward the maternal parent, Simon and Peloquin [8] reported reciprocal differences in the potato associated with paternal inheritance affecting the position of callus formation on the stamens (filament vs. anther) in tissue culture. Reciprocal cross differences were reported by Jansky [9] in Tuberosum haploid and wild species crosses. When the wild species were used as the female parent the tuberization and tuber size were reduced. Vines, stolons, and tubers were larger when the wild species was used as a male parent. However reciprocal differences for tuber yield are not always different [10]. Reciprocal differences can be affected by day length of the environment where they are grown [2, 11]. Some of the reports ascribed this distinct performance to cytoplasm-nuclear interactions, because it also affects male fertility [12, 13].

In the present study reciprocal cross difference due to difference in group (Andigena or Tuberosum) of female parent were lacking. The lack of reciprocal cross differences for tuber yields in inter group hybrids in this breeding material also confirms that short-day length environments are not conducive detecting cytoplasmic effects on this character, as already reported by Golmirzaie and Ortiz (14) in International Potato Centre (CIP) breeding material having source of cytoplasm *S. demissum*, *S. stoloniferum*, *S.*

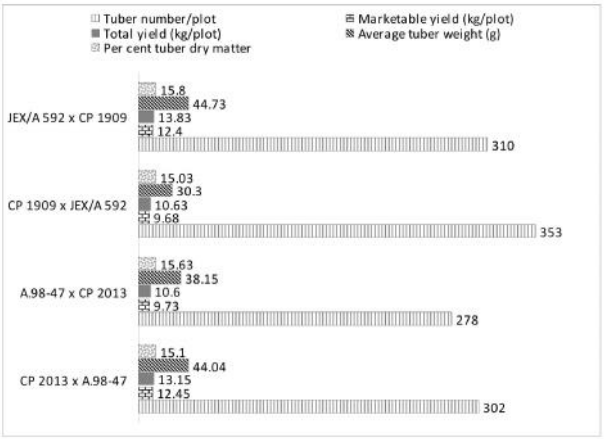

Fig. 1. Progenies with significant reciprocal cross effects for all the 5 characters

tuberosum and *S. andigena*; and Hilali *et al.* [15] in Tuberosum haploids-Phureja crosses. Golmirzaie and Ortiz [14] reported that cytoplasmic effects are more important for reproductive characteristics such as pollen production than for tuber yield.

The lack of reciprocal cross differences for tuber yield and related characters in short-day length environment in Indian plains shows that crosses involving Andigena and Tubeosum accessions can be attempted in either or both the directions while breeding cultivars for Indian plains.

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