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Short Communication

Comparison of hybridization *in-situ* and on decapitation in glasshouse in potato

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Potato needs long days for flowering. Hence, in India hybridization for the potato-breeding programmes is carried out at the Central Potato Research Station, Kufri (32° N and 77° E and 2500 above msl) that represents hill conditions, where potato crop is grown during summer, the season when potato can flower [1, 2]. But heavy rainfall and severe incidence of late blight disease during this period, reduce fruit setting and damage the berries before these are ready for harvest. To avoid these problems, hybridization in glasshouse/ polyhouse was advocated [3, 4]. But due to limited space, it is not possible to grow all the required parental lines in glasshouses. Decapitation of the female parents from field-grown plants at flowering stage and their use for hybridization in glasshouse by growing them in tap water or nutrient solution can be another alternative [5-9]. But in these studies comparison of hybridization on decapitants with that of intact plants under field conditions was not done [6, 7, 9] or different cross combinations were used in two methods [5]. Further, in these studies only percent berry setting was reported and the information on berry, seed and seedling characters was lacking. Hence, the present investigation was conducted to compare the efficiency of these two methods, that is, hybridization *in-situ* (in open field) versus on decapitation (in glass house).

In 2002 and 2003, each year five crosses (Table 2) were attempted under field as well on the decapitants in the glasshouse. The decapitants were the stems of the females with floral buds, cut from the field and kept in wide mouth bottles (1 liter) containing Hoagland's nutrient solution [10]. The nutrient solution was replaced every 10 days. Inflorescences of both intact plants in the field and the decapitants in the glasshouse were trimmed leaving only 5-6 buds of nearly uniform pre-anthesis stage per flower bunch. These were emasculated in the evening and pollinated next day morning with the fresh pollen. Each cross-combination was repeated four times (used as replications) with 75 pollinated buds per replication. Data were recorded on percent berry setting (calculated from number of buds pollinated and number of berries formed) at 30 days and 60 days after pollination (DAP). The berries were harvested after 60 days of pollination and data were recorded for average berry weight and average number of seeds per berry. In the year following the hybridization, the seeds were treated with 2000 ppm GA for 48 hours (to assure dormancy breaking) and sown in paper cups (3" diameter) filled with 1:1 (v:v) mixture of compost and sand, six seeds per cup. After 30 days of sowing, data were recorded on seedling vigour on 1-5 visual score, 1 = very poor to 5 = very good [10]. Statistical analysis was conducted using the software MSTAT-C (Michigan State University, USA). Data were analyzed in two factor randomized design, i.e. crosses as one factor and place of hybridization (decapitation and in-situ) as another factor and analysis of variance was computed and CD values were calculated to compare the means.

Analysis of variance showed significant differences among crosses for all characters in both the years (Table 1), indicating the presence of genetic variability for berry setting, berry weight, number of seeds per berry, seed germination as well as the seedling vigour. This confirms the earlier reports [9, 11, 12] that the hybridization success as well as the seed and seedling characters of the crosses were affected by the parents involved. Differences between *in-situ* and decapitation methods of hybridization were significant only for berry setting (both at 30 and 60 DAP), average berry weight and number of seeds per berry. The interaction effects between the method of hybridization and the cross-combination were significant for percent berry set (both at 30 and 60 DAP), and average berry weight in both the years, and for the number of seeds per berry and seedling vigour in 2002 only (Table 1).

The percent berry setting was higher in the

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Table 1. Analysis of variance for different traits related to artificial hybridization in potato

Source	df	% berry setting at 30 DAP@	% berry setting at 60 DAP	Average berry weight	Number of seeds per berry	% seed germination	Seedling vigor
Summer 2002							
Crosses (C)	4	1219.02**	928.94**	1.160**	21981.16**	23.35**	1.63*
Method of hybridization (M)	1	657.23**	1678.32**	1.764**	10475.25**	2.35	0.29
C × M	4	668.88**	672.25**	0.057**	223.61*	1.22	1.87*
Error	27	4.48	11.52	0.005	86.34	1.25	0.52
Summer 2003							
Crosses (C)	4	2873.35*	1785.35**	3.67**	158112.85**	591.33**	5.08**
Method of hybridization (M)	1	7960.29**	7056.46**	5.67**	10562.50**	0.76	0.03
C × M	4	384.68**	295.7**	1.52*	238.63	5.78	0.09
Error	27	2.38	2.70	0.148	108.73	15.48	0.28

*,**Significant at $P \leq 0.05$ and 0.01 % respectively; @DAP = Days after pollination.

decapitation method than that of *in-situ* method both at 30 and 60 DAP in both the years (Table 2). Percent setting, was lower at 60 DAP than at 30 DAP in both the methods, but the decline was higher (82.64% in 2002 and 93.74% in 2003) under *in-situ* than that of (59.13% in 2002 and 75.54% in 2003) in the decapitation method. The decline was higher in 2003 than in 2002 in both the methods and this also varied from cross to cross within and between years (Table 2). Thus, premature dropping of berries appears to both due to genetic and environmental factors, and their interaction. Mechanical disturbances due to movement of the personals and factors like rain, late blight incidence etc., also leads to berry dropping. The higher berry setting as well as lower berry dropping in the decapitation method thus clearly shows its superiority over the *in-situ* hybridization. But the number of seeds per berry were higher in *in-situ* than the decapitation method (Table 2). However, much higher number of seeds per pollination (when multiply % berry setting with number of seed per berry) was obtained in the decapitation method than that of *in-situ* hybridization. Peloquin and Haugas [8] had also obtained more number of seeds by using the decapitations compared with the field-grown plants in the interspecific hybridization in potato.

Average berry weight was significantly higher in the *in-situ* method than that of in the decapitation

Table 2. Comparison of the hybridization methods for the performance of the crosses for various characters in potato

Cross	% berry set at 30 DAP		% berry setting at 60 DAP		Average berry weight (g)		Number of seeds per berry	
	F	D	F	D	F	D	F	D
Summer 2002								
K. Chipsona-1 × MP/92-35	42.7	65.2	34.6	63.6	3.35	3.09	366.5	334.7
K. Swarna × MP/92-35	58.8	37.9	51.8	34.8	3.62	3.07	358.3	332.8
K. Kumar × MP/92-35	43.0	54.1	35.4	52.3	2.96	2.40	331.3	312.3
K. Neela × MP/92-35	35.4	39.1	26.6	36.9	2.75	2.75	2.25	272.8
CP 21 84 × MP/92-35	59.0	83.2	48.7	74.4	3.45	3.12	417.3	373.0
Cross mean	47.8	55.9	39.5	52.4	3.20	2.80	349.2	316.8
$CD_{(0.05)}$ cross	1.1		1.7		0.04		4..6	
$CD_{(0.05)}$ *in-situ* versus decapitation	0.7		1.1		0.02		2.9	
$CD_{(0.05)}$ cross × method of hybridization	1.5		2.4		0.05		6.6	
Summer 2003								
CP 2132 × MP/97-921	11.6	15.2	3.4	12.0	3.06	2.29	145.0	108.7
CP 2172 × MP/97-1008	38.3	74.3	28.6	66.0	2.95	2.89	380.2	367.0
CP 2407 × MP/92-35	33.5	65.6	13.5	51.9	4.12	3.85	427.5	387.0
CP 2417 × MP/97-625	35.7	68.4	22.3	46.8	4.96	2.72	195.5	158.7
CP 3251 × MP/97-784	42.4	79.2	27.8	51.8	2.73	2.30	129.5	93.7
Cross mean	32.3	60.5	19.1	45.7				
$CD_{(0.05)}$ cross	0.8		0.8		0.2		5.2	
$CD_{(0.05)}$ *in-situ* versus decapitation	0.5		0.5		0.1		3.3	
$CD_{(0.05)}$ cross × method of hybridization	1.1		1.2		0.3		7.3	

F = Field, D = Decapitants in glass house; DAP = Days after pollination.

method (Table 2). This may be due to continued plant growth under the *in-situ* conditions, whereas the decapitants being without roots did not grow further after these were cut from the mother plant, but could sustain on the Hogland's nutrient medium so as to produce berries that were thus expectedly of smaller size. However, this did not affect the quality of the seeds produced, as there was no significant difference between decapitation and *in-situ* hybridization for percent seed germination and seedling vigour (Table 1).

Thus, it is concluded that that decapitation method for hybridization is a viable alternative to *in-situ* hybridization for getting more percent berry setting and of the same quality as from *in-situ* hybridization. Though it requires a little more efforts in terms of maintaining the decapitants by timely supply of the nutrients, etc., these efforts are worth undertaking.

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