

## **POLLEN COMPETITION AT GAMETOPHYTIC AND SPOROPHYTIC PHASES IN SUNFLOWER** **(*Helianthus annuus* L.)**

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### SUMMARY

Competitive ability of pollen parents involving ten restorers, three maintainer lines and thirty hybrids were studied at gametophytic and sporophytic level. Three pollen parents (R X-13, R IV-83 and R-857) recorded more than 80 percent pollen germination and more than 50  $\mu$ m pollen tube length ten minutes after incubation in pollen germination media. This indicated differential reaction in pollen viability of the parents at the gametophytic level. This was reflected in high self-fertility percentage in the hybrids involving these three pollen parents at the sporophytic level. Identification of competitive pollen parents at the gametophytic level and its utilization in developing pollen mixture hybrids in lieu of hybrid mixtures is of practical significance in getting higher yields in sunflower.

**Key words:** gametophytic, sporophytic, pollen competition

### INTRODUCTION

In the life cycle of any plant species, gametophyte phase (haploid) and sporophyte phase (diploid) alternate in the life cycle. Most of the research in plant breeding has been directed towards the sporophytic phase, while the research on the gametophytic phase is rather limited. Screening of a large number of pollen parents for desirable traits is a basic step in the heterosis breeding programme. Screening at the sporophytic level will be of longer duration and time consuming. For selecting better pollen parents, selection pressure at the gametophytic (pollen) level will be easier for certain traits and the study may be later extended to the sporophytic level. The gametophytic fitness depends mainly on pollen quality which includes pollen germination and pollen tube growth.

Post-pollination competition may be more important than pre-pollination. Mulcahy (1979) showed that gametophytic characters expressed in pollen tube competition played an active role in the rapid evaluation of angiosperms. Male

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fecundity can be influenced by pollen competitive ability when mixed pollen loads occur in stigmata of *Hibiscus mascheutos* (Snow and Spira, 1991). Mixture of compatible pollen from different donors significantly increased seed set and increased the time of berry maturation by five days in *Vaccinium corymbosum* (Vander Kloet, 1991).

Hence, the study was taken up to screen competitive pollen parents at the gametophytic and sporophytic levels in sunflower.

## MATERIAL AND METHODS

A total of ten restorer parents and three maintainer lines of ovule (CMS) parents were studied for pollen germination and pollen tube growth by using the pollen germination media developed by Keshavamurthy *et al.*, 1994. The percentage of germinated pollen and the pollen tube length were assessed 10 minutes after pollination. A total of ten microscopic slides were observed for each pollen parent and from each slide five random microscopic fields were observed for recording the percent of pollen germination and pollen tube length. The data were subjected to statistical analysis by using factorial randomised block design (Snedecor and Cochran, 1967).

The pollen competitive influence in the sporophytic phase was studied in 30  $F_1$ 's derived from crosses of the three CMS lines with the ten restorer lines. Equal pollen quantities from the restorers and the respective maintainer lines were used for crossing. The resulting 30 hybrids were planted after the head-to-row progeny method with the row length of 45 m and the spacing of 30 x 15 cm, in three replications, at RRS, Raichur, during kharif 1995. Four hundred random plants in each hybrid combination were assessed for percent fertile plants and percent sterile plants. The data were statistically analyzed using factorial randomised block design (Snedecor and Cochran, 1967).



Figure 1: Competitive pollen parent R X 13 with high pollen germination percent and tube growth in sunflower

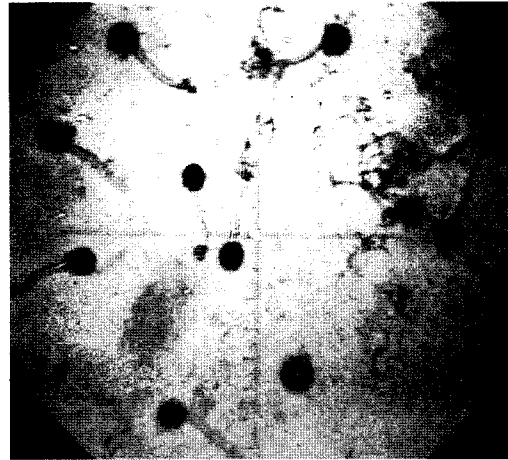


Figure 2: Competitive pollen parent R IV 83 with high pollen germination percent and tube growth in sunflower

## RESULTS AND DISCUSSION

The effect of the pollen parents was highly significant for percent pollen germination and pollen tube growth (Tables 1 and 2). In contrast, the effect of the female parent and interaction effects were significant neither for pollen germination nor for tube growth, indicating that the ovule parents did not have influence on pollen germination and tube growth on pollen germination media, since the stigma extract of the female was a pre-requisite and an important component of the pollen germination media in sunflower (Keshvamurthy *et al.*, 1994).

Table 1: Pollen germination percent of male parents in pollen germination media in the gametophytic phase

Pollen parents	Pollen germination percent recorded with stigma extracts of respective female parents in pollen germination media			Mean
	CMS 234	CMS DSF 15	CMS 4546	
R IV-83	86.00	86.90	86.20	86.36
R X-13	83.10	83.50	84.00	83.53
R-857	81.00	80.00	81.00	80.73
R 6D-1	80.00	80.00	81.00	80.33
R IV-43	78.20	78.00	79.00	78.40
R-8297	78.00	78.00	77.00	77.66
RHA-274	68.00	67.00	68.00	67.66
RLC-2 Br	63.00	63.00	62.00	62.66
R-678	56.00	56.00	56.00	56.00
R V-34	49.00	48.00	48.00	48.33
234 B	74.00	75.00	74.00	74.33
DSF-15B	77.00	76.00	76.00	76.33
4546 B	70.00	71.00	71.20	70.73
Mean	72.61	72.49	72.57	72.56
F test	**			
C.V.%	2.18			
CD at 5%				
Females (F)	NS			
Males (M)	0.81			
F x M	NS			

Pollination in a sunflower plant does not depend on its own pollen but on foreign pollen. The self-incompatibility mechanism in sunflower makes the ovule parent accept foreign pollen in preference to its own pollen, thus encouraging cross-pollination. The influence of stigma extract on pollen germination was studied in three females. The influence of stigma extract on pollen germination on all three ovule parents was not significant.

Out of the ten pollen parents, three pollen parents, R X-13, R IV-83 and R-857, recorded more than 80 percent pollen germination and more than 50  $\mu\text{m}$  length within ten minutes after incubation in the pollen germination medium. The male

parent R IV-83 was significantly superior in pollen germination (86.36%) followed by R X-13 (83.53%), R-857 (80.73%) and R 6D-1 (80.33%). This clearly indicated the presence of varietal differences in the role of alien pollen in fertilization. However, cross incompatibility may be one of the causes for poor pollen germination and tube growth in R LC-2 Br, R VI-78 and R V-34. In general, low pollen germination and low pollen tube growth were observed when the ovule parents received their own pollen, comparatively to the respective maintainer lines.

Table 2: Mean pollen tube length ( $\mu\text{m}$ ) of male parents in pollen germination media of 3 female parents at gametophytic phase

Pollen parent	Stigma extracts of ovule parents			Mean
	CMS 234	CMS DSF 15	CMS 4546	
R-857	59.00	58.60	58.60	58.73
R X-13	55.00	55.10	54.50	54.87
R-IV-83	51.00	52.00	52.20	51.73
R 8297	45.00	45.00	44.00	44.67
R 6D-1	42.10	42.00	42.50	42.20
RHA-274	32.00	32.00	33.00	32.33
R VI-78	31.00	31.50	31.00	31.17
R IV-43	24.00	25.00	24.00	24.33
RLC 2 Br	19.00	18.50	19.00	18.83
R V-34	19.50	18.50	18.00	18.67
234 B	23.00	23.00	23.00	23.00
DSF-15 B	23.10	23.10	23.00	23.07
4546 B	16.00	14.00	16.00	15.33
Mean	33.82	33.72	33.75	33.76
F test	**			
C.V.%	7.06			
CD at 5%				
Females (F)	NS			
Males (M)	1.21			
F x M	NS			

The results of mixed (B+R) pollen competition at the sporophytic level presented in Table 3 revealed that in general, the fertility percent in the hybrids was higher than 80, comparatively with the pollen parents R X-13, R IV-83, R-857 and R 6D-1, indicating that these pollen parents were highly competitive in fertilization, which increased in higher seed set. In the gametophytic phase the male parents R X-13, R IV-83 and R-857 have shown better pollen germination (>80%) and better tube growth (>50  $\mu\text{m}$ ), which resulted in high fertility percent. After receiving their own pollen, the ovule parents recorded comparatively low pollen germination and tube length, apparently supporting the fact that sunflower prefers alien pollen source when available.

The present study also revealed that in post-pollination, the ovule parent has preference for foreign pollen and competitive pollen parents can be identified for heterosis breeding with a specific combination.

Table 3: Percent of fertile and sterile plants obtained in A X (B+R) pollen combinations in the sporophytic phase in sunflower

Pollen source (B + R)*	Female parent			Mean % plants	
	CMS 234	CMS DSF 15	CMS 4546	Fertile	Sterile
B + R X-13	86.37	91.29	90.86	89.51	10.49
B + R IV-83	92.48	81.26	92.23	88.65	11.35
B + R-857	84.48	80.98	62.81	86.09	13.91
B + R 6D-1	80.60	73.77	88.64	81.00	19.00
B + R IV-43	75.33	74.22	85.05	78.20	21.80
B + RHA-274	73.41	70.76	80.14	74.77	25.23
B + R-8297	78.73	42.59	72.25	64.52	35.48
B + R V-34	59.36	56.46	73.48	63.10	36.90
B + RLC-2 Br	70.33	40.84	70.62	60.59	39.41
B + R VI-78	51.19	56.64	40.74	49.52	50.48
Mean	75.23	66.88	78.68	73.60	26.40
234 B	-	-	-	0.00	100.00
DSF 125B	-	-	-	0.00	100.00
4546B	-	-	-	0.00	100.00
F test				**	
C.V.%				1.08	
CD at 5%					
Females (F)				0.41	
Males (M)				0.75	
F x M				1.30	

\* Equal quantity pollen of R-lines (male parent) and respective B-line (maintainer line) was used to pollinate the three CMS lines

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## **COMPETICIÓN DE POLEN EN LAS FASES GAMETOFITA Y ESPOROFITA DE GIRASOL (*Helianthus annuus* L.)**

### **RESUMEN**

La capacidad competitiva del donador de polen era investigada a los niveles gametofita y esporofita en 10 restauradores, 3 mantenientes y 30 híbridos de girasol. Tres donadores de polen (R X-13, R IV-83 y R-857) alcanzaron a más de 80% de germinación de polen y más de 50  $\mu\text{m}$  de tubo de polen durante 10 minutos después de la incubación en el medio para la evolución de polen. Eso resultó en un alto porcentaje de autofecundación en los híbridos de estos tres donadores de polen al nivel esporofita. La identificación de los donadores de polen competitivos al nivel gametofita y su utilización para la producción de híbridos por la mezcla de polen en vez de la utilización de la mezcla de híbridos tiene una importancia práctica para alcanzar los rendimientos superiores en el girasol.

## **CONCURRENCE ENTRE LES POLLENS DANS LES PHASES GAMETOPHYTE ET SPOROPHYTE DU TOURNESOL (*Helianthus annuus* L.)**

### **RÉSUMÉ**

L'aptitude concurrentielle des donneurs de pollen pour dix restaurateurs, trois agents de conservation et trente hybrides de tournesol a été examinée au niveau des gamétophytes et des sporophytes. Trois donneurs de pollen (R X - 13, R IV - 83 et R - 857) ont enregistré plus de 80% de germination du pollen et une longueur du tube de pollen de plus de 50  $\mu\text{m}$  de germination du pollen. Ceci indique une réaction différentielle dans la viabilité du pollen des parents au niveau des gamétophytes, ce qui résulte en un pourcentage élevé d'autofertilisation chez les hybrides de ces trois donneurs de pollen au niveau des sporophytes. L'identification de donneurs de pollen concurrentiels au niveau des gamétophytes et leur utilisation pour la création d'hybrides à l'aide de mélanges de pollen plutôt que l'utilisation de mélanges d'hybrides a une importance pratique dans l'obtention d'un plus grand rendement chez le tournesol.