

EFFECT OF STIGMATIC MANIPULATION ON POLLINATION AND SEEDSET IN SUNFLOWER.

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ABSTRACT

In our previous studies of self-compatibility and autogamy in sunflower, floral manipulation resulted in increased seedset in some genotypes. It was uncertain whether this increase was due to stigmatic manipulation or simply increased pollination. A split-plot design was used with two cytoplasmic male sterile analogs of a strongly and a weakly autogamous line as main plots, and four pollination treatments as subplots. Each line was isolated under Delnet bags and treatments included floral manipulation followed by pollination with pollen from unrelated sources (cross-pollination) and pollen from each respective maintainer line. Identical treatments were performed on non-manipulated heads. Mean cross-pollinated seedset of both lines was significantly higher for the unmanipulated treatment (69%) than the manipulated (41%). Thus, manipulation reduced seedset, presumably due to floral injury. The same trend occurred for maintainer line pollination, but the difference was not significant. Thus, in our previous studies increased seedset of manipulated male fertile heads was due to increased pollination. This study indicates that two opposing processes contribute to eventual seedset on manipulated male fertile heads — increased pollination and floral injury. The failure to account for floral injury in our previous studies may have led to underestimates of self-compatibility.

INTRODUCTION

Floral manipulation of isolated sunflower heads resulted in increased seedset (Putt, 1941; George *et al.*, 1980). The latter study showed manipulated seedset provided better estimates of self-compatibility than autogamous seedset. The objective of this study was to determine whether the increased seedset resulting from manipulation was due to some physical stimulus of the stigmata or simply a result of increased pollination. If manipulation alters the stigmatic surface enough to allow penetration of incompatible pollen, increased seedset would result (Frankel and Galun, 1977). The site of the incompatibility reaction in sunflower has been reported at the stigma, style, and the ovule (Ivanov, 1975; Williams, 1964; and Purss, 1973). Different germplasm may be a factor in this variability.

MATERIALS AND METHODS

Two cytoplasmic male sterile inbred lines, cmsB and cmsD

and their maintainer analogs, B and D, were used. These highly inbred genotypes are Northrup King Company proprietary lines. Inbred B is highly autogamous and inbred D is weakly autogamous (George *et al.*, 1980).

The trial was sown at Woodland, California, on a Yolo clay loam soil April 28, 1981. A split plot design with two replications was used with inbreds as main plots and pollination treatments as sub plots. Individual heads of each cms inbred were isolated under Delnet bags and treatments were pollination with pollen from unrelated sources (cross-pollination) and pollination with pollen from each respective maintainer line. Treatments were performed on both manipulated and unmanipulated heads of each line. Manipulation was accomplished by gently rubbing the face of the head through the bag on a daily basis. Collected pollen was dusted on the heads. The amount of pollen applied per head was not measured but was considered ample to ensure adequate pollination.

Bagging treatments were applied to individual plants which had been thinned to a uniform spacing of 45,000 plants/ha. All plots were bordered by plants of the same genotype. Main plots were single rows 76 cm apart. Cultural practices including surface irrigation were applied as needed during the growing season.

Percentage seedset was calculated after counting filled and unfilled achenes on whole heads. Arc-sine transformation of the data was performed prior to statistical analysis.

RESULTS

Mean squares for inbreds and pollination treatments were significant (Table 1). The cross-pollinated unmanipulated seedset was significantly higher than for other treatments (Table 2).

Table 1. Mean squares from the analysis of variance of pollination data.

Source	Mean Square
Replication	97.47
Inbreds	1998.31*
Replication x Inbred	5.80
Pollination treatment	393.94*
Inbred x pollination treatment	80.10
Error	42.59

*Significantly different at the 5% level of probability.

Table 2. Percentage seedset for two inbreds after cross-pollination and maintainer line pollination for manipulated and unmanipulated treatments.

Treatments	Genotypes		Mean %
	cmsB* %	cmsD* %	
maintainer pollinated manipulated	57bc	9c	33b
maintainer pollinated unmanipulated	69ab	24bc	47b
cross-pollinated manipulated	52c	29b	41b
cross-pollinated unmanipulated	82a	57a	70a
Mean	65	30	48
C.V. for genotypes = 5.6%			
C.V. for pollination treatments = 15.1%			

*Figures followed by the same letter in each column are not significantly different at the 5% level of probability.

For *cmsB*, unmanipulated seedset was not significantly different regardless of pollen source (Table 2). A similar situation occurred for manipulated seedset. Maintainer pollinated treatments were not significantly different whether manipulated or not, although the manipulated treatment was lower. However, cross-pollinated treatments were significantly different with the unmanipulated treatment being greater than

the manipulated.

For *cmsD* (low autogamy), manipulation reduced seedset in the cross-pollinated treatment but did not under maintainer pollination. Cross-pollinated seedset was greater than maintainer pollinated seedset for both manipulated and unmanipulated treatments.

Table 3. Percentage seedset for inbreds over pollination and manipulation treatments.

Treatments	Genotypes		Mean %
	<i>cmsB</i> %	<i>cmsD</i> %	
unmanipulated over pollination treatments	76	41	59
manipulated over pollination treatments	55	19	37
cross-pollinated over manipulation treatments	67	43	55
maintainer pollinated over manipulation treatments	63	17	40

Orthogonal comparisons indicated that the mean seedset of unmanipulated treatments (59%) was greater than for manipulated treatments (37%) (Table 3). The mean seedset of cross-pollinated treatments (55%) was significantly greater than that for maintainer pollinated treatments (40%).

DISCUSSION

If manipulation had some stimulating effect on stigmata, then higher seedset might be expected. Since manipulation reduced seedset (Table 3), floral injury was probably an important factor.

For highly inbred lines and their male sterile analogs, backcrossing to the sterile can be regarded as genetically equivalent to self-pollination. For *cmsB*, maintainer pollinated seedset was not different from cross-pollinated seedset over manipulation treatments (Table 3). This confirms the high self-compatibility of this genotype (George *et al.*, 1980). For *cmsD*, maintainer pollinated seedset was significantly lower than cross-pollinated seedset regardless of the manipulation treatment (Tables 2 and 3). This result was unexpected because the line had relatively high self-compatibility in previous studies (George *et al.*, 1980). Inbred *cmsD* must carry self-incompatible alleles that are environmentally sensitive.

For both lines maintainer seedset following manipulation was lower than seedset without manipulation although the differences were not significant. Additional replication would have provided greater precision and would be recommended in future studies.

In previous studies, manipulation increased seedset pre-

sumably due to increased pollination. This study indicates that two opposing forces contribute to seedset in manipulated heads — increased pollination and floral injury. Estimates of self-compatibility may have been previously underestimated due to failure to account for floral injury (George *et al.*, 1980).

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