pollinate. However the other 3 hybrids had significantly lower self fertility and a poor self pollinating ability. The first 2 hybrids were similar to the two hybrids tested in this trial in that their self fertility was good and their self pollination reasonable. The small differences between the self and natural pollination treatments in George and Shein's (1980) best varieties may be due to a slightly different self pollination technique. Nevertheless, their work shows that self fertility can be a limiting factor in some hybrids. The results of this current trial would suggest that self pollination and not self fertility is the limiting factor to good seed set in the absence of pollinators. However, there is a large range of available hybrids with different genetic backgrounds and it is very hard to extrapolate across this range from work on just two hybrids. Therefore, it is suggested that screening for better seed set in hybrid sunflowers should be for a better self pollinating ability and better self fertility.

Fine muslin bags were used to exclude pollinators in this trial. The use of parchment or paper bags in this type of work is not recommended, as seed sets can be adversely affected by the use of inadequately ventilated bags during hot weather (Free, 1970). An interesting result was reported by Landridge (1974). He recorded a nil pollination seed set of 5% for Hysun 30 under bags (presumably paper) when flowering occurred over a particularly hot period (35 — 40°C). This was much lower than expected especially when the same treatment in cage trials gave a 63% seed set.

The performance of Sunfola in this trial was as expected for an open pollinated variety except for the small number of heads (3/46) which had the ability to pollinate and fertilize themselves. This means that the potential exists to develop a self pollinating and self fertile open pollinated variety, if the need ever arises.

Suggested preliminary guidelines for a standard seed set screening technique are:—

1) Choose sowing rate so that large heads (300 — 400 cm^2) are obtained (equivalent of 19.5 — 22.5 cms (7.7 —8.9") diameter). The bigger head size class is chosen as a marginal self pollinating ability may only manifest itself in larger heads e.g. DeKalb 500.
2) Trial should be fully irrigated. Moisture stress can cause a significant drop in percentage seed set (Forrester *et al.* loc. cit.).
3) Use well ventilated bags e.g. muslin, to isolate insect pollinators.
4) Compare nil pollination and natural pollination treatments in the same head size range. (Include self pollination treatment, if it is desired to know whether self pollination or self fertility or a combination of both, is the limiting factor).
5) Record temperature during flowering period.

The preceeding guidelines outline a method to screen seed sets. These seed set figures alone are of little value as increase in seed size can compensate to a certain extent for low seed set. Hence, the important question is: how low can seed set go before compensation is no longer effective and yield begins to fall? This and the equally important question of the effect of pollination treatment on oil content/quality, will be examined in later papers.

ACKNOWLEDGEMENTS

I wish to thank Mr R. Hall, Miss B. Brown and Mr B. Browne for their untiring technical assistance and Mr R. Taggart and Mr N. Mills for their assistance in growing the crop. This research was funded in part by the Oilseed Research Committee.

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EFFECT OF ISOLATION BAGS ON SEEDSET IN SUNFLOWER.

T1982GEN08

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ABSTRACT

Altered seedset under isolation bags could bias estimates of autogamy and self-compatibility. To study this effect, a split plot design was used where main plots were two F1 hybrids and two inbred male fertile lines. Sub-plots were natural open-pollination (OP) and artificial open-pollination (AOP). The AOP treatment was performed daily on Delnet isolated heads by hand pollinating with foreign pollen. Mean seedset across inbreds for the OP (64%) and AOP (49%) treatments was significantly different but the mean seedset across hybrids was not. Thus genotypes were differentially affected by bagging. The reduced AOP seedset for one inbred was greater than observed in previous studies and suggests either a genotype x environment interaction for bag effect or severe floral injury during pollination. These results indicate that all studies of self-compatibility and autogamy should include an estimate of the effect of the isolating device on each genotype in each environment.

INTRODUCTION

Reliable estimates of autogamy and self-compatibility can only be obtained from isolated heads. Autogamous seedset under different types of isolation bags has differed significantly in previous studies (Hamilton, 1921; Putt, 1941; Kalton, 1951; Gundaev, 1971; and Robinson, 1980). If an isolation device affects genotypes differently, estimates for each genotype must be standardized for valid comparisons. Comparisons between biased estimates of autogamy and self-compatibility at different environments cannot be accurately interpreted.

The objective of this study was to estimate the effect of isolation bags on seedset. This was attempted in a previous study (George *et al.,* 1980) but accurate estimates were precluded by inadequate pollination.

MATERIALS AND METHODS

Two hybrids, BE and DG, and two inbred male fertile lines, C and G (Northrup King Company proprietary lines) were used. Genotype C is a maintainer (B) line, G is a pollinator (R) line, whereas BE and DG are single cross hybrids between cytoplasmic male-sterile (A) lines and R lines. In a previous study of these genotypes, C and DG were weakly autogamous and lower in self-compatibility than the highly autogamous genotypes, G and BE (George *et al.*, 1980).

The trial was sown at Woodland, California on a clay loam on May 15, 1980. A split plot design with five replications was used. Main plots were genotypes with sub-plots being pollination treatments. Treatments were artificial open-pollination where pollen from open-pollinated cultivars was transferred by leaf each day and an unbagged open-pollinated check. Delnet plastic perforated bags (PQ-218 with average pore size 0.116 mm^2) were used.

Bagging treatments were applied to single rows 6.1 m long and 76 cm apart. Main plots had single rows as borders. Plots were thinned to a uniform spacing of 45,000 plants/ha. Cultural practices including surface irrigation were applied as needed during the growing season. Honeybee *(Apis mellifera* L.) counts were made mid-morning on ten heads per plot of the open-pollinated treatment for five successive days during flowering to determine adequacy of pollinator activity (Table 3). Counts were transformed by X + 0.5 prior to analysis.

The percentage seedset for each plot was determined from the mean of ten heads by counting filled and unfilled achenes in two sectorial transects (each approximately 22½°) taken at random across each head. Arc-sine transformation of data was used prior to statistical analysis.

RESULTS

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

Source	Mean Square
Replications	10.37
Genotypes	351.39**
Replications x genotypes	4.83
Pollination treatments	198.69**
Genotypes x pollination treatments	57.48**
Error	2.39

*Significant at the 1% level of probability.

Table 2. Mean open-pollination (OP) and artificial open-pollination (AOP) percentages for 2 hybrids and 2 inbred lines at Woodland, California, 1980.

	Treatments	
Genotype	OP* %	AOP* %
C	67b	51d
G	61c	47d
BE	73a	72a
DG	74a	74a

C.V. (genotypes) = 4.1%
C.V. (bagging treatments) = 2.9%

*Figures followed by different letters are significantly different at the 5% level of probability.

Analysis of variance of the seedset data revealed highly significant effects for genotypes, bagging treatments and their interaction (Table 1). For inbreds C and G, artificial open-pollination resulted in less seedset than natural open-pollination (Table 2). No difference was noted for the hybrids. Isolation bag effect was not related to the level of autogamy or self-compatibility in these genotypes.

Table 3. Mean honeybee counts for 2 hybrids and 2 inbred lines at Woodland, California, 1980.

Genotype	Mean Bee Count (10 heads)*
C	3.7c
G	1.4d
BE	17.3a
DG	12.2b

C.V. = 7.7%

*Figures followed by different letters are significantly different at the 5% level of probability.

DISCUSSION

That the isolation bag effect was noted on highly inbred lines and not on the hybrids may be related to the homozygosity or lack of genetic buffering of these lines (Allard and Bradshaw, 1964). Microclimatic changes due to the isolation bags may be important here. Seedset of open-pollinated inbreds was less than for the hybrids and the seedset on the primary head of the R line (G) was less than seedset on the B line (C). This result has also been found in earlier studies (Putt, 1941; Schuster, 1970; George *et al.*, 1980).

For genotype G, the ratio of artificial open-pollination to open-pollination (77%) was lower than its self-compatibility (96%) measured in an earlier study (George *et al.*, 1980). Seasonal differences may be responsible though these were considered relatively small. Kalton (1951) described the differential effects of environments in Canada and Texas on autogamous seedset of weakly autogamous inbreds using paper isolation bags. These differences may be related either to an environmental effect on autogamy or on the isolation bag effect or possibly on both. Alternatively, floral injury may have been greater from abrasion during leaf pollination than from pollen transfer by manipulating the head through the bag. Smaller floret size of G compared to other genotypes may be a factor contributing to greater injury.

Lack of adequate pollination reduces open-pollinated seedset. Artificial open-pollination would then compare more favorably than is actually the case. Cobia and Zimmer (1978) state that 2.5 bees per 10 heads on a warm morning are adequate for pollination of a cultivar. All genotypes, except G, exceeded this value (Table 3). The optimum bee number for the primary head of an R line would presumably be much lower than for the much larger head of an open-pollinated cultivar. Hence the value for G is considered adequate for pollination. Further study is needed to determine pollination requirements of inbred lines.

In this study of four genotypes, a difference due to isolation bag effect was found for the two inbreds. Other inbreds need to be studied before a general isolation bag effect can be assumed. The presence of possible genotype x environment interaction necessitates the estimation of isolation bag effect for each genotype, for each environment, to minimize bias in estimates of autogamy and self-compatibility.

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