The Potential of Self-Incompatibility (SI) in Spring Rapeseed Breeding (*Brassica napus* L.)

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Introduction

In recent years, there have been many reports of heterosis in rapeseed (Grant and Beversdorf 1985 and references, Lefort-Buson and Dattée 1985 and references). Commercial exploitation of this potential will depend upon the development of systems of pollen control which will allow the production of seed at competitive prices relative to yield advantage.

SI allows the breeder the option of using more complex crosses like synthetics. Schuster (1969), Schuster and Michael (1979) and Grabiec and Krzymanski (1985) have reported experimental successes with synthetics.

The objectives of this research were:

1. to determine the effect of the number of parents on syn-1 performance
2. to measure the yield decline of syn-2 and syn-3 generations of selected syn-1 populations
3. to test the effectiveness of SI as a means of pollen control

Materials and Methods

1. Effect of number of parents on syn-1 performance

In order to simulate the syn-1 populations that would be expected with SI lines, hybrid seed was produced by hand-pollination of five double low spring rapeseed cultivars, (H)anna, (R)egent, (W)estar, (T)opas, and (L)ine. All possible 3, 4 and 5-parent syn-1 populations were produced by mixing the required proportion of hybrid seed. The experiment was designed as a 6 x 6 lattice with the 5-parent syn-1 entered six times; it was planted with two replications at one location in 1984.

2. Yield decline of selected syn-1 populations

To simulate yield decline, syn-2 and syn-3 populations were produced by hand pollination of open flowers with bulked pollen. The populations LW, HT, RLW, LHT, RLHT, RHLW, and RHTLW were chosen to include different proportions of European (L,T,H) and Canadian (R,W) germplasm. The experiment was designed as a randomized complete block with two replications at two locations in 1985, four replications at the same two

locations in 1986.

3. SI as a means of pollen control

Self-incompatible versions of Westar and Topas have been developed by introgressing S alleles from B. campestris cv. Candle and from B. napus ssp. napobrassica (Z allele obtained from Dr. S. Gowers, the Scottish Crops Research Institute, Invergowrie, Dundee DD2 5DA, Scotland). Hybrid seed of these two lines was compared to hybrid seed produced by hand pollination in a randomized complete block experiment with four replications at one location in 1986.

Results and Discussion

1. Effect of number of parents on syn-1 performance

To determine whether or not 3, 4 and 5-parent synthetics would yield as well as hybrids, the syn-1 yield was regressed on the number of parents (Table 1).

Table 1. Least Squares Estimates of Yield for Syn-I Generations

Syn-1 Entry	Yield (kg/ha at 10% moisture)
Parents	2117
2-Parent	2669
3-Parent	2660
4-Parent	2777
5-Parent	2657

The four degrees of freedom were partitioned into one contrast to test the difference between parents and syn-1 entries and another to test for heterogeneity among the syn-1 entries. The parents were significantly lower yielding than the syn-1s ($P<.01$ Scheffé's test); there was no difference in the yield of the synthetics ($F<1$).

2. Yield decline of selected syn-1 populations

On the basis of these results, 2,3,4, and 5-parent synthetics were included in the yield decline study which was tested at two locations for two years, a total of four experiments. One of these was discarded because the coefficient of variation was considered too high (18.8% compared to 5.7, 7.8, and 9.1%). A second test was excluded from the analysis because of heterogeneity of error variances (Bartlett's test for homogeneity of variances, data not shown). What follows are the results from two years at one location.

In the overall analysis of variance, the year x population interaction term was significant ($P = .05$). An examination of the data revealed that this was due to the 4-parent synthetics which showed significant ($P=.05$) yield decline from syn-1 to syn-2 in 1985 but not in 1986. The other populations showed similar trends in the two years and have been pooled over years. The results are summarized graphically (fig 1 and 2).The two populations of European germplasm, HT and LHT, did not show a consistant pattern of heterosis and yield decline as the other

populations did.

The yield advantage of the syn-1 over the high parent was consistent for both years for the LW and RLW populations but not for the 4-parent synthetics. While the pattern of response for the 5-parent synthetic is consistent over two years, the syn-1 is not significantly (P=.05) higher yielding than the high parent in either year.

3. SI as a means of pollen control

The experiment comparing the yield of the WT hybrid produced by hand pollination and using self-incompatible lines is summarized in Table 2.

Table 2. Yield of Hybrids produced by Hand Pollination and using Self-Incompatibility

Entry	Yield (kg/ha at 10% moisture)
WT - self incompatible	2386
WT - hand pollination	2393
Westar	1842
Topas	1961
Global	1757

Contrasts were used to test the difference in yield between the two hybrids and the superiority of the SI-produced hybrid over the high parent. The yield of the two hybrids was the same (P = 0.97). The hybrid is significantly higher yielding than Topas (P =.05).

Conclusions

Self-incompatibility is an effective means of pollen control in Brassica napus. 2 or 3-parent synthetics would appear to offer the best potential for the exploitation of heterosis. More extensive testing is necessary to assess yield stability of synthetics in different years and environments. Better estimates of hybridity will require the development of inbred lines homozygous for electrophoretic marker genes rather than inter-varietal crosses.

References

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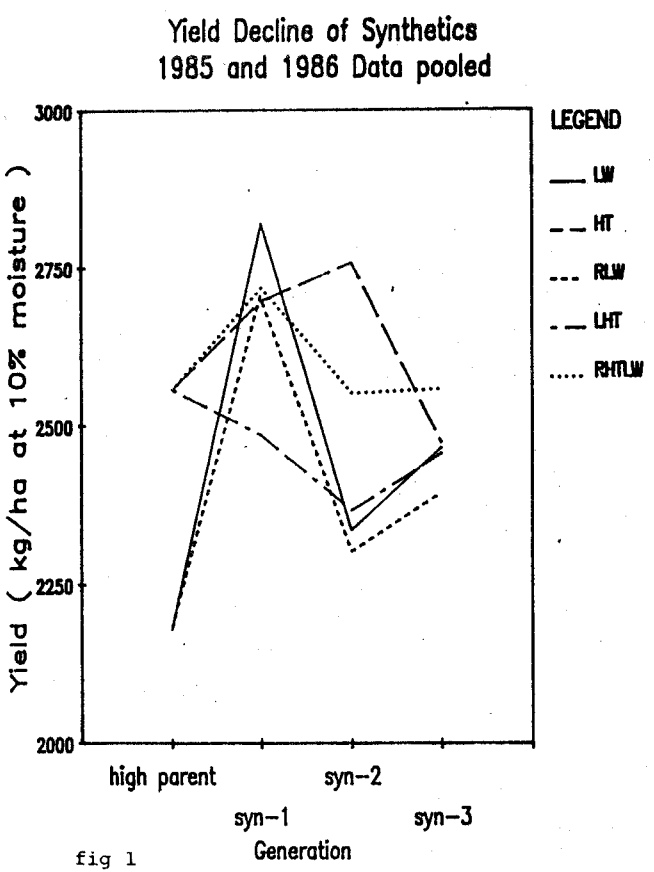
Yield Decline of Synthetics
1985 and 1986 Data pooled
Yield (kg/ha at 10% moisture)
3000
2750
2500
2250
2000
LEGEND
LW
HT
RLW
LHT
RHTLW
high parent
syn-1
syn-2
syn-3
Generation

fig 1

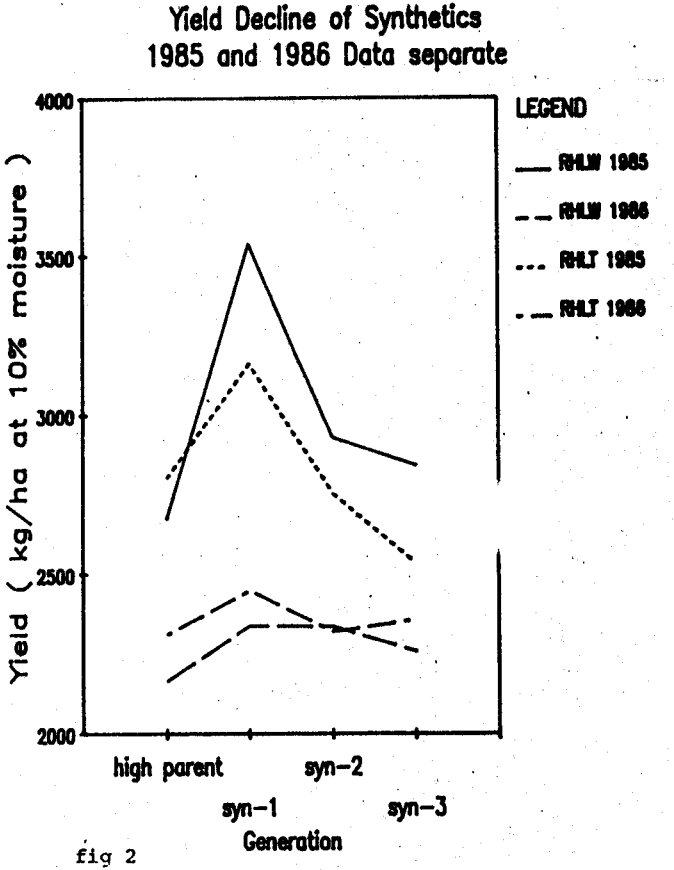
Yield Decline of Synthetics
1985 and 1986 Data separate
Yield (kg/ha at 10% moisture)
4000
3500
3000
2500
2000
LEGEND
RHLW 1985
RHLW 1986
RHLT 1985
RHLT 1986
high parent
syn-1
syn-2
syn-3
Generation

fig 2