TEST ON COMBINING ABILITY IN WINTER CANOLA (BRASSICA NAPUS L.) USING RECESSIVE GENIC MALE STERILITY

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INTRODUCTION

Considerable heterosis for seed yield in F_1 hybrids of rapeseed (Brassica napus L.) has been reported by various authors (Schuster 1969, Röbbelen 1985, Grant and Beversdorf 1985, Lefort-Buson 1987, Brandle and McVetty 1989). These results may encourage for the development of pollination control systems, i.e. male sterility, self incompatibility or gametocide application. But since the development of such material is highly complicated, costly and time consuming it should be worthwhile to obtain information about general and specific combining ability of the breeding material prior to its availability in a hybridising system. It is impossible, however, to produce sufficient F_1 hybrid trial seed by hand emasculation and pollination. Therefore the present investigation was directed to create test hybrids in the actual germplasm with different seed parent lines by using a recessive genic male sterility system.

MATERIALS AND METHODS

The parental material used for the present experiment exclusively consisted of lines free from erucic acid and low in glucosinolate content.

Two German breeding lines (Chr1775 and Chr1617) were converted into male steriles by repeated backcrosses using a recessive genic male sterility system found by Takagi (1970) after mutation treatment with gamma-irradiation. For this trait TAKAGI had demonstrated monogenic inheritance. As pollinators 38 lines were chosen representing the European double low winter rapeseed germplasm.

The backcrossing procedure for transfer of genic male sterility into the breeding lines started in 1984. To abbreviate the backcrossing program the recurrent parent was crossed into every F_1-generation without prior selection of male sterile types in the F_2. Heterozygous genotypes could be identified by analysing the selfed progenies in the following generation before the next backcross step (Fig. 1). Non-segregating F_2 progenies represent dominant homozygoucity at the ms-locus, so that only the progenies of heterozygous genotypes had to be backcrossed. By this means the time for the necessary three backcrosses could be cut to half.

The production of F_1 seed for replicated trials was conducted in the field in 1988 by using the ms/fertile segregating seed parent as a single row of 3m length, surrounded by plots of the pollinator lines. Fertile segregants in the seed parent row could easily be identified before flowering and removed. Each combination was harvested separately.

In 1989, the first series of 38 entries (seed parent Chr1775) and the two high yielding new varieties "Lirajet" and "Falcon" were grown in a lattice design with three replications at three locations. Seeding rate was 80 seeds/m². Plot size varied from 10m² to 13.6m². All plots were assessed for seed yield, oil content and lodging. In 1990, the second series with Chr1617 as seed parent and the two check varieties "Lirajet" and "Falcon" was planted under the same conditions as the first series. Yields per plot were adjusted to 9% moisture and compared to the mean yield of the two check varieties.

RESULTS

38 double low winter rapeseed lines were crossed as pollinators with two double low lines which were converted into male steriles by three backcross steps.

The seed yield of the test hybrids ranged from 85% to 107% in the first series of testcrosses and from 99% to 115% in the second series compared to the two check varieties. The second testcross series outyielded the first one by a mean of 8% (Fig. 2).

The phenotypic variance of seed yield between the two testcross series was not significantly different. Estimates of general combining ability for seed yield showed a negative value (-0.98) for the first tester line Chr1775 and a positive value (0.98) for the second tester Chr1617.

The oil content (45.8%) of the harvested seeds of the F_1 hybrids was the same as that of the check varieties, whereas the lodging resistance was slightly lower than that of the check varieties.

DISCUSSION

Most researches concerning hybrid vigor in rapeseed show high heterosis in yield compared to midparent or better parent levels. This is more evident in crosses of different geographical origin and pedigree. Grant and Beversdorf (1985) reported of highest specific combinations for seed yield heterosis between Canadian and European cultivars and Lefort-Buson et al. (1987) found similar results in hybrids between European and Asiatic selfed lines. In our investigation only European winter rapeseed breeding stocks were included which meet the qualitiy requirements for erucic acid and glucosinolate contents in the seed. This narrows the genetic basis of the material and makes it difficult to definitely outyield the best competitive varieties. On the other hand Brandle and McVetty (1989) found significant yield differences between cultivar hybrids and hybrids derived from cultivar inbred lines indicating the presence of differences in combining ability among cultivar derived inbred lines.

The test on combining ability started when the sterile tester lines were backcrossed three times to the recurrent parent. This number of backcrosses means a transfer of approximately 93% of the genotype of the backcross parent. This may not be a sufficient homozygoucity for finding the best specific combinations.

The seed parent of the first testcross series (Chr1775) was a low yielding and lodging susceptable line possessing a low frequency of favorable alleles. It was not chosen for identifying high yielding hybrid combinations but for a good differentiation of lines crossed with this tester. Unexpectedly the variance of seed yield between the two testcross series was not significantly different. Therefore both testers show the same capacity of differentiation between the pollinator lines. The cross with the second seed parent (Chr1617) which was a high performing line itself resulted in higher hybrid yields in general. To verify the high general combining ability line Chr1617 has been backcrossed to the Polima CMS system transferring the line into an isogenic male sterile and maintainer, respectively.

Further investigations with other testers,inbred and broad based, are necessary to get closer information about the general combining ability of the 38 pollinator lines.

CONCLUSIONS

Knowledge about combining ability in Canola winter rapeseed is a prerequisit for the production of hybrid varieties. In this study, a recessive genic male sterility was used to produce sufficient seeds for replicated performance trials with two tester lines.

One tester line showed high general combining ability effects for seed yield. This line is directly used as CMS line in the Polima cms system.

Further testers are necessary to obtain information about combining ability in the actual germplasm.

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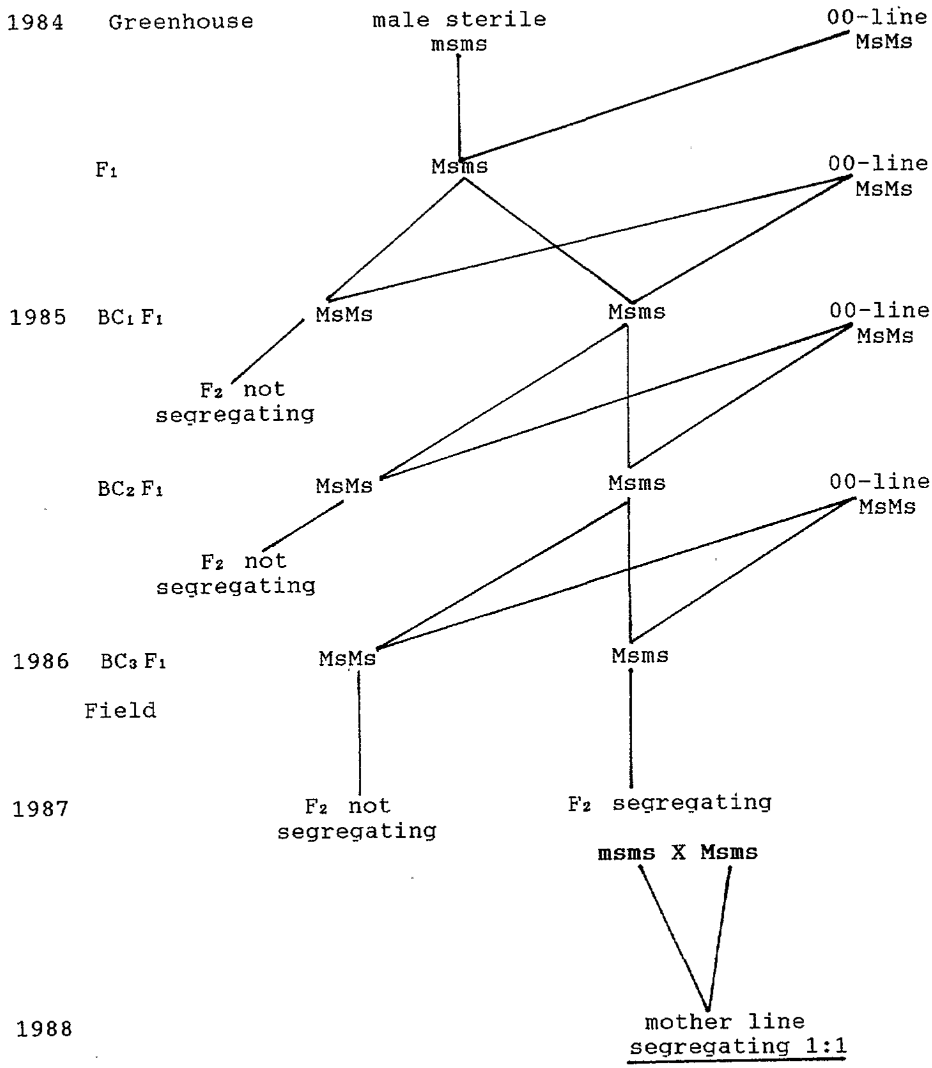

Fig. 1. Backcrossing procedure of lines into recessive genic male sterility

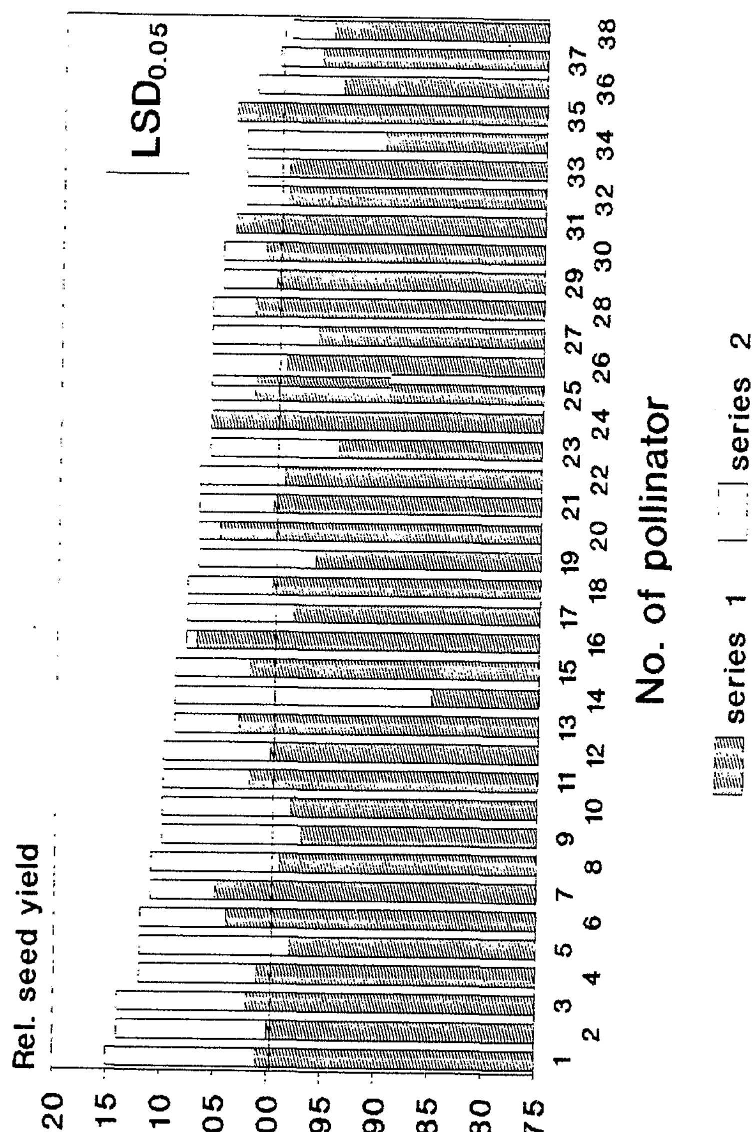

Fig. 2. Seed yield of F_1 hybrids between 38 pollinator lines and two different seed parents compared to check varieties (100%)