BREEDING HYBRID VARIETIES IN OILSEED RAPE (BRASSICA NAPUS) USING SELF-INCOMPATIBILITY

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INTRODUCTION

Much criticism is levelled at the use of self-incompatibility (SI) in the breeding of hybrid varieties of vegetable Brassica crops, because of the sib problem and of the high costs of producing seed of parent lines by bud pollination. For oilseed rape these problems should be viewed rather differently. Firstly it should be possible to tolerate a certain amount of sibs within the hybrid because of the lower inbreeding depression of B. napus compared to the diploid vegetable forms and because homogenity of an agriculture crop is of less importance. Secondly, parent line production by bud pollination for single cross hybrids for this widely grown crop is quite unacceptable, but if a complex breeding scheme using the high multiplication rate of oilseed rape is used the costs of the bud pollination method are no longer of such great importance. For these reasons and because using CMS for hybrid breeding in oilseed rape is still not satisfactory, work to breed hybrids in both winter and spring oilseed rape, using SI, has been started at Danish Plant Breeding.

MATERIALS AND METHODS

Tests for SI was conducted by observing pollen tube growth 24 hours after self pollination. Pistils were stained with alkaline aniline blue and observations carried out using UV-microscopy (Martin 1959). To confirm the results, the plants were isolated inside plastic bags and the seed set estimated at ripening.

Self-incompatible B. napus was found in the offspring of plants of spring oilseed rape which had shown bad seed set after selfing. The plants were tested for SI, inbred and propagated by bud pollination. To investigate the inheri-tance of the SI, self-incompatible plants were crossed with self-compatible plants from both spring and winter oilseed rape.

To introduce SI from B. campestris, crosses were made between B. napus and various B. campestris varieties, using the latter species as pollinator (Mackay 1977). SI from B. oleracea was introduced by crossing with B. campestris, using embryo culture (Chen et al. 1988) and the former species as mother. Regenerated plants were treated with colchicin to double the chromosome number.

RESULTS AND DISCUSSION

Breeding schemes

Having economical seed production and satisfactory seed set of the commercial hybrid in mind, two breeding schemes were attempted at Danish Plant Breeding. They are based on the model that SI in *B. napus* can be controlled by a single *S* locus, on either genome A or C. Plants heterozygous at the *S* locus for an active allele and a non active allele can be self-incompatible (dominant SI) or self-compatible (recessive SI). Other inheritance patterns which have been described (e. g. Gowers 1989) can be ignored for practical reasons, as long as breeding material, which follows the above mentioned pattern can be selected and used.

The two breeding schemes are:

1. Modified three-way crosses with dominant SI (Gowers 1974). For an ideal hybrid of this type three lines are required:

a. Self-incompatible line (A) which is homozygous for one *S* allele and which SI is dominant over self-compatibility.
b. Self-compatible line (B) which is nearly isogenic to the self-incompatible line A.
c. Self-compatible line (C) which shows high combining ability to the cross A x B.

Line A must be propagated by bud pollination or by some other method which overcomes the SI. The single cross A x B will be 100% self-incompatible and will be used as mother line for the hybrid production. The *S* allele used and the genetic background of lines A and B should ensure that the single cross is sufficiently self-incompatible to minimize sibs in the hybrid. In the hybrid there will be a 1:1 segregation of self-compatible to self-incompatible plants. This means that half of the plants in the field will need cross polination from the other half. Experiments have to show whether this cross pollination process is effective in all oilseed rape growing environments, otherwise potential yield will be lost due to less then optimal seed set, in e.g. periods of bad weather conditions.

For a more heterogeneous hybrid two near isogenic lines are unnecessary. If the hybrid fullfill the agricultural and registration requirement for homogenity, a certain degree of heterogenity can be of benefit (see e. g. Léon 1987).

2. Three way crosses with recessive SI (Thompson 1978). For this type of hybrid - which will produce a total self-compatible hybrid - the following three lines are nesessary:

a. Self-incompatible line (A)
b. Self-incompatible line (B), which is cross compatible to A. For a homogeneous hybrid A and B should be nearly isogenic.
c. Self-compatible line (C) which shows high combining ability to the cross A x B.

The lines A, B and C must be selected in such a way, that (1) The single cross A x B is higly self-incompatible, and (2) The hybrid (A x B) x C is highly self compatible. This means that both S alleles of A and B provide recessive SI.

Self-incompatible plant material

Progenies of four single oilseed-rape plants provided self-incompatible material. The progeny of one plant was rejected, because the plants show low seed set after selfing, but it was impossible to observe the SI by UV-microscopy i. e. many pollen tubes are visible. This is not acceptable for a practical breeding programme.

Plants of the other three families confirm to the theory of a single locus dominant SI. Crossed with self-compatible plants the progenies were either totally self incompatible (i.e. the self-incompatible plant was homozygous) or segregate in a 1:1 manner (i.e. the self-incompatible plant was heterozygous). Backcrosses of self-incompatible plants from the cross self-incompatible x self-compatible to self-compatible plants provided also families which segregate in a 1:1 manner.

These plant materials perform four important requirements for use in hybrid breeding:

1. The SI is reliably determinable with UV-microscopy.
2. There is no indication of weakening of SI in heterozygous compared to homozygous plants.
3. There is no increase of seed set after selfing plants under high temperature conditons e. g. during the summer in the glasshouse.
4. The lines set sufficient seed after bud pollination.

These self-incompatible lines are then used in a programme to develop hybrids by the first mentioned method. Handling of this dominant SI is relatively easy because the SI can be transferred to good breeding material of both spring and winter oilseed rape by simple backcrossing. Plants can be tested for SI with UV-microscopy before crossing.

For the theoretically best breeding scheme with recessive SI, no material is currently available. To develop such material, crosses were made, to introduce the wide range of S alleles from B. campestris and B. oleracea. Crosses between B. campestris and B. napus are easly achieved, but a simple backcrossing scheme (Mackay 1977) will only produce dominant SI. Therefore plants from the cross (B. napus x B. campestris) x B. napus were tested for self-compatibility and then a search is made for self-incompatible individuals in their selfed progeny. In all further backcrosses one selfed generation must be included to transfer the recessive character. Using the same method, self-incompatible B. napus plants, derived from resynthesis from B. oleracea x B. campestris, were backcrossed to normal self-compatible oilseed rape.

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