HYBRID OILSEED RAPE - THE SELF-INCOMPATIBILITY SYSTEM EXPLAINED

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ABSTRACT

Application of the suppressible (recessive) system of self-incompatibility to the production of 3-way hybrids in oilseed rape (*Brassica napus* ssp. *oleifera*) is described. This system has the merit that conventional lines of oilseed rape may be used as pollen parent, resulting in a fully self-compatible hybrid product. A small scale study using phenotypic markers showed that this system produced average hybridity levels of 92.5%.

INTRODUCTION

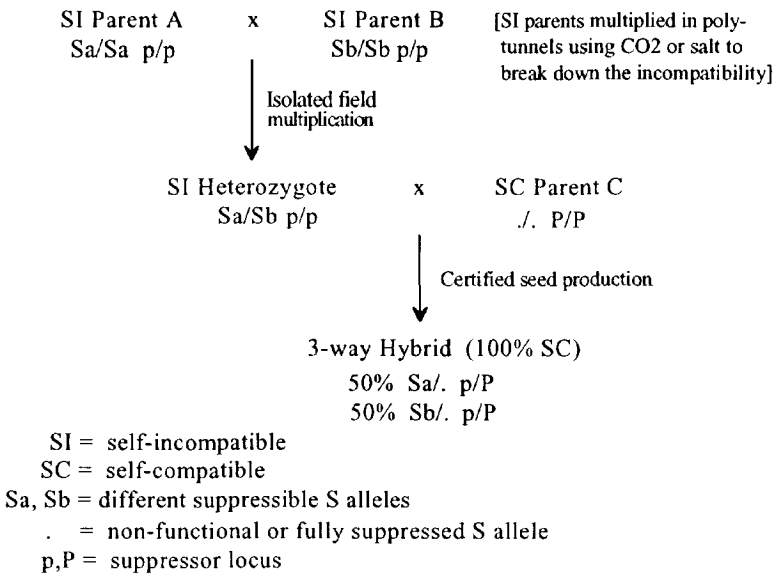
Current developments in the production of hybrid varieties of oilseed rape may appear rapid but much preliminary research and development underpins the present status of each hybridisation system available to breeders. In the case of the system based upon self-incompatibility (SI) work was initiated as early as the 1970s under the direction of Dr K Thompson (1978) at the Plant Breeding Institute. This demonstrated that synthetic *B. napus* could be produced which was self-incompatible and could be used as the basis for a hybridisation system. Furthermore a number of spontaneous self-incompatible plants of *B.napus* were found (rarely) in large populations of plants. This material was transferred to Cambridge Plant Breeders Ltd (CPB) in 1987 and has been developed to the stage where hybrids based upon the SI system were entered into National List trials in Denmark, France, Germany, Italy and the UK in 1994.

DESCRIPTION OF THE SYSTEM

The early work established two important principles governing the behaviour of self-incompatibility in *B.napus*. Firstly, both the S locus resident on the A genome (from *B.rapa*) and the S locus on the C genome (from *B.oleracea*) may carry functional S alleles. Secondly, there is an independent factor carried by conventional lines of oilseed rape which is capable of suppressing the action of some, but not all, S alleles. S alleles have subsequently often been referred to either as dominant or recessive but should, perhaps more correctly, be described as non-suppressible or suppressible. In Canada where spring cultivars of *B.napus* are prevalent hybrid systems have been developed that are based upon the use of the non-suppressible S alleles, this system

leads to the production of hybrid oilseed rape varieties where 50% of the grower's crop consists of individual plants that are self-incompatible. A full seed set then depends upon cross pollination. In contrast for the winter oilseed rape hybrids developed at CPB the system utilises suppressible S alleles. This permits the production of finished hybrids which are fully self-compatible and therefore not dependent upon cross pollination for full seed set.

Schematic diagram for hybrid production using suppressible self-incompatibility



SI = self-incompatible
SC = self-compatible
Sa, Sb = different suppressible S alleles
. = non-functional or fully suppressed S allele
p,P = suppressor locus

Recent studies being carried out at the John Innes Centre have shown that there are interactions between the S loci on the A and C genomes and the P (suppressor) locus (Ekere, 1995). For breeding purposes, although the absolute classification of the S alleles may not be known, SI lines are readily assigned to distinct cross-compatible groupings.

Hybridity levels

To produce an acceptable product for the grower it will be necessary to achieve reliable levels of hybridity. International standards are yet to be finalised but it is likely that a minimum of 90% hybridity will be required in certified seed. The SI system is not perfect in Brassicas and some 'leakage' is to be expected which will lead to selfs (or sibs). The proportion of these sibs is affected by various factors such as the availability of cross-compatible pollen and the prevailing weather conditions but is mostly determined by genetic factors. Evidence obtained at CPB has shown that the available suppressible S alleles exhibit variation in strength owing to an unidentified background effect in the genome which modifies the strength of a given S allele. The selection of

parental SI lines for hybrid production has concentrated upon those lines with the strongest and most reliable self-incompatibility. In a small experiment carried out at CPB a recessive single gene marker for petal folding (an easily identifiable character) was used to estimate sibbing rates following hybrid production for simple two-way crosses. The recessive petal marker was carried by the SI female line which was crossed to full petal conventional lines of oilseed rape as male parent. Eight crosses were made in small insect proof cages with pollination by blow-flies. The subsequent hybrids were assessed in trial plots and scored for the proportion of folded petal types. Populations of about 1400 plants were screened giving an average hybridity of 92.5%, the minimum hybridity was 90% and the maximum 97%.

Suppression of self-incompatibility

The model production system using suppressible SI depends upon the use of conventional lines of oilseed rape to suppress the self-incompatibility. At CPB a wide range of conventional winter oilseed rape lines were screened to check for full self-compatibility in resulting F_1 hybrids. A total of 271 simple two way crosses between pure lines were studied. In each case the female was SI, for a suppressible S allele, and the male either a conventional CPB breeding line or a commercially available European winter rape. Five different S alleles were used and 77 different male lines. The crosses were grown either in rows in the field or in pots in a glasshouse, 3 plants were bagged at flowering time and self-incompatibility assessed by inspection of the seed set prior to harvest. Control lines known to be self-incompatible gave poor seed sets with pods averaging less than 3 seeds per pod. 262 crosses gave good seed sets consistent with full self-compatibility. The remaining 9 crosses showed intermediate levels of self-incompatibility and had in common one line carrying a newly introduced S allele. A further 8 crosses using the same female line were self-compatible. These observations confirm that there is a universal ability of conventional winter oilseed rape lines to suppress the activity of some S alleles and that intermediate alleles may exist which are not fully suppressible by all self-compatible conventional lines.

ACKNOWLEDGEMENTS

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