DESCRIPTION OF VARIOUS GENERATION MEANS OF FOUR OILSEED RAPE CROSSES GENERATED OVER TWO YEARS

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INTRODUCTION

At present the majority of the high quality summer rape cultivars are derived by pedigree method or a modification thereof, as for strict self-fertilizing crops. But at many breeding stations around the world intensive efforts are underway to develop cytoplasmic male sterile and genetic restorer systems for the production of hybrid varieties in oilseed rape.

For both types of varieties, lines and hybrids, the production of homozygous lines is necessary. Therefore, to a great extent, the successful outcome of such plant breeding programmes depends on the recombinant inbred lines which are superior to existing lines for whatever purpose they are used. There are several possibilities to produce inbred lines in oilseed rape such as the pedigree method, doubled haploid method (DH) and single seed descent method (SSD). The latter has mainly been used in cereals to advance many lines rapidly towards homozygosity without a selection step. SSD lines have also been used as a predictive tool for estimating the merits of crosses in early generations to produce best lines (Jinks and Pooni, 1976). Werner et al. (1989) investigated the performance of recombinant inbred lines from five different source populations in Brussels sprouts (Brassica oleracea var.gemmifera) and found that the recombinants performed, on average, less well than the parental material.

The present paper reports the results from two yield performance trials, including parents, F_2, F_3 and F_6 SSD lines. Two objectives of these trials were first, to compare the means of the various generations and secondly, to examine the distribution of a random sample of SSD lines with respect to agronomic characters.

MATERIALS AND METHODS

Three cultivars and three breeding lines of spring oilseed rape, Brassica napus, were used to produce four pair crosses. Four parents were of swedish (Korall, Sv8525942, Topas, Sv8524197) and two of french (Drakkar, P44) origin. Both Korall and Sv8525942 are homozygous lines, derived from spontaneous haploids found in Topas and Sv8524197, respectively. The following cross combinations, together with their reciprocal crosses, were performed by handcrossing.

CROSS 1 : Korall x Sv8525942
CROSS 2 : Topas x Sv8524197
CROSS 3 : Korall x Drakkar
CROSS 4 : Korall x P44

In both years the field experiment has been laid out as a completely randomized design at Svalöfsgården, Svalöv. Sowing was done with a Hege pneumatic precision drill at a density of 1.6g per plot. A plot consisted of 3 rows a 5m.

In 1988 the field trial consisted of the six parents and 8 F_2's with 4 and 3 replications, respectively, together with 32 F_3 families from each cross. Due to seed shortage only half of the F_3 families could be replicated. In 1989 the same parental material and F_2 families were assessed again with 12 F_3 families and 40 unselected F_6 SSD lines from each cross. Five of the SSD lines have been replicated.

RESULTS

A comparison of all derived generation means relative to the performance of the parents is given in Table 1. For F_2 and F_3 generations the parent means from 1988 and 1989 are the comparative base, whereas the F_6 generation is only compared to the parents tested in the same year.

Table 1. Relative values of generation means

Characters	Generations			
	P	F2	F3	F6
Yield kg/ha	100	111	96	92
Flowering in days	100	91	105	109
Height cm	100	103	102	99
Maturity in days	100	103	113	114
Standability (scale 0-100)	100	105	104	101
Protein %	100	100	96	100
Oil %	100	100	99	98
Oil yield kg/ha	100	112	96	92
Protein yield kg/ha	100	111	93	93
TSW g	100	101	97	98

For 8 characters the F_6 mean is equal or falls below the parents mean. Only flowering time and maturity display a bigger value but in these cases late flowering and late maturity is not desired. Especially for scandinavian conditions earliness is an important breeding goal.

The means of the parents and unselected F6 progenies together with their ranges for the various traits have been summarized in Table 2. The F_6 progenies flower and mature on average more than one day later than the parents. The parental range is exceeded in both directions and for all characters, but in no case does the average performance of the F_6 progenies show transgression over the parents. The F_6 progenies have a lower mean yield than their parents irrespective of the degree of heterozygosity in the parents. Nevertheless a number of SSD lines have been found with a higher yield performance than the best parent, Sv8524197. The highest proportion of lines outperforming the best

Table 2. Comparison of the means of F6 SSD progenies and parents, 1989

	Y	FT	H	MT	ST	PROT	OIL	TSW	OILY	PROTY
PARENTS										
Min	2266	12.5	98.28	6.25	50	43.32	45.05	2.89	1036	992
Max	2398	19.2	118.00	12.00	62	45.25	47.60	3.53	1089	1061
Mean	2318	15.2	104.86	8.87	61	44.29	46.44	3.34	1077	1027
F_6 PROGENIES										
Min	646	10.00	78.93	5.00	30	39.70	40.70	2.51	394	306
Max	2842	23.00	127.33	16.00	90	49.10	50.40	4.21	1397	1324
Mean	2151	16.62	103.96	10.19	62	44.63	45.92	3.30	990	960

parent were derived from cross 1 and 4 with 42.5% and 37.5%, respectively.

DISCUSSION

From theoretical studies by Snape and Riggs (1975), using computer simulations, it is known that for situations where heterosis is exhibited,only a few homozygous lines will be produced which exceed the F_2 mean of the cross from which they were derived. Results from the field experiments, including parent, F2, F3 and F6, in the present study confirm the above mentioned findings. The average performance of the SSD lines falls below the F_2, therefore a greater genetic advance would be expected by using the conventional pedigree method.

With the exception of the quality traits, all other characters exhibit heterosis. The amount of heterosis is always of paramount importance to a breeder and as in the F_1 generation there is often a shortage of seed this can be overcome by evaluating the F_2. The estimated magnitude of heterosis for the F1 in that experiment would be around 30% which is fairly consistent with results from other research workers (Sernyk and Stefansson, 1982).

The presence of positive additive x additive interaction in the parents or residual heterozygosity in four of the parents (Topas, Sv8524197, Drakkar, P44) are two possible reasons for the poor performance of the F_6 generation compared to the mean of the parents. For seed yield in cross 4, positive additive x additive epistasis in the parental lines were found, whereas in the other crosses this genetic component were not significant. This still indicates, that the highly selected parental material is good, in part, because of favourable gene combinations. However, during the recombination phase of the SSD procedure, these useful gene combinations were broken up and lost. In a similar study in Brussels sprouts (Werner et al. 1989) the SSD lines performed, on the average, less well than the parental material, which the authors explained by the presence of additive x additive genic interactions.

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