COMBINING ABILITY OF RESYNTHESIZED RAPESEED

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SUMMARY

A combining ability analysis of eight rapeseed forms derived from artificial resynthesis of B.oleracea x B.campestris, and three conventional varieties as pollinators showed strong differences for all investigated characters. In general, the general combining ability (gca) values were more important than those of the specific combining ability (sca).

A further experiment with ten varieties and the same pollinators revealed that in conventional breeding material the gca was also more important than the sca. In most cases hybrids between varieties outyielded crosses with resynthesized rapeseed. For short term yield improvement conventional material, therefore is more immmediately useful than the resynthesized one.

A topcross between 31 resynthesized rapeseed forms and three varieties showed that most of the F_1 hybrids exceeded the pollinators in vegetative characters except in the number of primary branches. Artificially resynthesized rapeseed is thus particulary useful for the improvement of vegetative characters and is recommended for fodder rape breeding. Furthermore, a striking apical dominance was found in combinations with resynthesized forms. This was indicated by a long main stem with a high number of flowers and pods. Despite such an enormous yield potential, there are disturbances in fertility, resulting in a low number of seeds per pod. This is the primary reason for the low yield of hybrids with resynthesized rapeseed. Nevertheless, some F_1 combinations were identified which outyielded the parental variety.

INTRODUCTION

Genetic variability is the prerequisite of any successful selection. In rapeseed the genetic diversity is limited for different reasons. But both diploid parents of this amphidiploid species exhibit an enormous variability in plant morphology and physiology resulting from at least 2000 years of selection for vegetable uses. An artificial resynthesis of rapeseed should, therefore, offer great chances for utilizing at least part of this variability in current rape breeding programmes (GLAND 1982). The aim of the following studies was to examine the genetic value of resynthesized material for rapeseed breeding by testing combining ability of resynthesized rapeseed with conventional breeding material.

METHODS

Altogether 31 resynthesized (resyn) rapeseed genotypes derived from crosses between a wide range of Brassica oleracea and Brassica campestris types as well as ten representative varieties were used as seed parents. F_1 hybrid seeds were produced on resyn rapeseed and the varieties by hand pollination using the varieties Jupiter, Planet and St 2648/80 as pollen donors. In the autumn of 1983 and 1984 F_1 and parents were planted in the field at three locations, i.e. Göttingen, Thüle (Westfalen) and Hohenlieth (Schleswig-Holstein); in 1984 the last location was omitted. Additional hybrids within conventional breeding material were tested only in 1984. Low seed set of the resyn geno-

types only allowed planting of microplots, each consisting of 6 plants with a 30 cm spacing between them. The experimental design was a randomized complete block design. All measurements were recorded for each plant individually. Details have been published by Kräling (1986).

RESULTS

Combining ability of eight resynthesized rapeseed genotypes

Eight resyn rapeseed genotypes were crossed with three varieties in a factorial manner. The resulting 24 hybrids were evaluated in five environments. The general combining ability (gca) values of the eight resyn rapeseed genotypes are presented in Table 1. For the vegetative characters H 240 and K 29 showed only negative effects. H 6, H 54 and G 65 had high gca effects in vegetative growth after winter and at anthesis. Positive effects on plant height and height of the main stem were found for H 54, R 32 and H 777. For number of flowers per main stem three resyn rapeseed genotypes showed positive gca values.

For the generative characters H 6 and H54 revealed the highest effects for yield per plant.

Table 1: Value of general combining ability (gca) for vegetative and generative characters; presented as deviation from the total mean.

	Vegetative characters			
Resyn rapeseed genotypes	Growth at anthesis	Plant height	Height of main stem	Flowers per main stem
H 6	0.70	-3.99	-1.33	-3.02
H 54	1.20	12.22	5.33	0.06
H 240	-1.10	-14.18	-2.63	-8.80
H 777	-0.05	5.88	7.38	6.42
R 32	0.01	8.88	3.88	8.52
G 65	0.41	-2.35	-4.66	-7.69
K 29	-0.19	-8.35	-7.91	-2.66
K 59	-0.96	2.20	-0.02	7.15
	Generative characters			
	Pods per main stem	Seeds per pod	1000 seed weight	Yield per plant
H 6	4.91	3.21	0.03	13.96
H 54	1.36	0.49	0.28	11.55
H 240	-7.56	0.79	-0.77	-18.36
H 777	0.87	1.60	-0.29	-5.13
R 32	4.77	-2.42	0.32	1.20
G 65	-0.87	1.80	0.17	2.62
K 29	-9.15	-3.07	0.17	-6.53
K 59	5.65	-2.37	0.10	0.69

Both forms also showed positive values for 1000 seed weight and seeds per pod. For the latter character, H 6, G 65 and H 777 had the highest effects. Positive gca values for number of pods per main stem were found for K 59, H 6 and R 32. The resyn genotypes H 6 and H 54 exhibited positive values for all generative traits; they were the best combiners.

Combining ability of convential material

This test included 30 F_1 hybrids between 10 lines and 3 testers, examined in 2 environments and one year. Considerable differences were found between the seed parents. They contributed to about 70% of the variation between the hybrids (Table 2).

Table 2: Relative part (in %; hybrids = 100) of the sum of squares for lines, testers and lines x testers in 6 traits.

Source of variation	Plant height	Height of main stem	Flowers per main stem	Pods per main stem	Seeds per pod	1000 seed weight
Hybrids	100	100	100	100	100	100
Lines	64.2	67.0*	70.8	54.6	67.5**	69.9**
Testers	9.1	17.2*	4.0	6.7	1.1	5.9
LinesXtesters	26.7	15.7	25.3	38.7	31.7	24.3**

Significant at P = 0.01 and P = 0.05

But no differences were found in yield per plant. In lenth of main stem differences occurred in the influence of the testers. But the sca was significant only for the 1000 seed weight. Therefore, for most traits of this breeding material gca was shown to be more important than sca.

Topcross with resyn genotypes

In the third experiment 31 resyn rapeseed genotypes were used as seed parents; they were topcrossed with three varieties. 54 F_1 hybrids were evaluated in two years. In the following, only for the 21 combinations with St. 2648/80 average performance, standard deviation and the ranges of variation are summarized in Table 3.

Table 3: Relative mean performance ($\bar{x}$), standard deviation (s) and range of variation of performance traits of 21 hybrids in comparison to the tester St. 2648/80 (=100%); according to yield tests in 1984 and 1985.

Character	$\bar{x}$	s	Range of variation	St.2648/80
Growth after winter	125.1	15.0	103.1 - 154.1	4.2
Growth at anthesis	115.4	11.5	90.8 - 129.2	5.2
Plant height	110.5	8.9	82.1 - 120.6	133.3
Height of the main stem	133.7	11.7	115.4 - 158.3	58.8
Branches of 1. order	91.6	9.1	76.0 - 107.1	12.0
Flowers per main stem	115.4	8.7	98.1 - 130.7	70.3
Pods per main stem	102.1	10.1	79.4 - 119.2	54.9
Seeds per pod	80.0	17.2	46.4 - 121.1	13.3
1000 seed weight	100.7	8.4	89.4 - 124.3	5.3
Yield per plant	101.0	20.9	51.5 - 156.3	56.4

All vegetative characters with the exception of number of primary branches were evidently improved in the hybrids. This general tendency was also true in the crosses with Jupiter and Planet. The F_1's started with a vigorous development after winter. But during further growth these drastic differences decreased. Generally the hybrids exhibited a greater plant height than the tester St. 2648/80. Nearly without exception the F_1's produced a low number of primary

branches. A striking apical dominance was expressed in the hybrids by a long main stem and high number of flowers per main stem. In the number of pods per main stem the F_1's reached the level of the variety. Disturbances in fertility caused a decrease in number of seeds per pod in the hybrids. Compared to St. 2648/80 the hybrids produced on an average 20% fewer seeds per pod. The 1000 seed weight and yield per plant of this tester were relatively low as compared to the other testers. Accordingly the hybrids reached a high level in 1000 seed weight and single plant yield. There was a strikingly high range of variation in the latter trait.

DISCUSSION

Combining ability of rapeseed up to now has been studied for breeding material. The present resyn material showed that for all characters the gca was more important than sca. Working with breeding material BARTKOWA-BRODA (1981); LEFORT-BUSON and DATTEE (1982) and ZHANG (1983) also found a strong predominance of gca effects confirming our additional data with unconventional material. Accordingly, a higher genetic gain can be realised in rapeseed by selecting the parental lines of hybrids on the base of their gca. The eight resyn genotypes differed too considerably in general combining ability for nearly all investigated traits. Since for nearly all characters additive gene effects were more important, it is possible to evaluate the gca of a larger set of resyn genotypes in a topcross.

Most of the evaluated topcross hybrids demostrated an improvement in vegetative performance as compared to the tester. This is of particular interest for fodder rape breeding. More over , our results showed that in hybrids with resyn rapeseed the main stem was extra ordinary promoted. Accordingly, the F_1 plants developed a higher number of flowers and pods in comparison to the testers. Furthermore, all crosses exhibited a lower number of primary branches. All this indicates a striking apical dominance. PRAKASH and ROUT (1983) also reported that resyn rapeseed genotypes developed a long main stem with a higher number of pods. TAYO and MORGAN (1975) and HENNING (1979) found that the main stem had the highest number of pods and seeds per pod.

With increasing plant density the main stem and the above primary branches become more important. To obtain a high yield per acre fewer primary branches, particulary branches of second order are required (ROEBBELEN and LEITZKE 1974, DIEPENBROCK 1977). Resyn genotypes obviously contain favorable alleles for such an ideal plant type. Some combinations with resyn rapeseed exhibited also a high seed yield compared to the respective tester. In such high yielding hybrids this heterotic increase was the result of an improved number of pods. Therefore the judgement that resyn rapeseed is useless for direct application is not supported. Resyn genotypes with a high general combining ability may be very valuable. But a general comparison between hybrids including conventional material and hybrids including resyn rapeseed showed that in most cases the former outyielded the resyn hybrids. Therefore for short term yield improvement conventional material is helpful more immediately than the resynthesized forms.

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