Higher yield stability for oilseed rape hybrids?

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ABSTRACT

In the last few years the number and the acreage of winter rape hybrid varieties has increased rapidly in Germany. Consequently it is of great interest if the hybrids offer advantages such as higher and more stable yields compared to the open pollinating winter rape varieties.
We selected a set of experiments which were conducted in a high number of environments and included as many hybrid varieties as possible (2-5) from the official variety trials (Landessorten-versuche). The traits yield and oil yield were analysed to address the question if hybrids have higher yields compared to open pollinating varieties and even more important to find out if the computed stability parameters confirm the hypothesis that the heterozygous genotypes of the hybrid varieties show stable yields in a wide range of environments.
In this study the regression model (Eberhart and Russell 1966) as well as the ecovalence (Wricke 1965) were computed using the SAS-program designed by Hussein et al. (2000). In addition Fox's rank analysis (Fox et al. 1990), a nonparametric measure of stability, was used. It comprises not only information concerning the reaction of the genotype in different environments but also the information whether the genotype is a high yielding variety compared to the other genotypes evaluated in the study.
Results show that the hybrids have significantly higher yields and oil yields and that the computed stability parameters confirm a higher yield stability as well as a more stable oil yield compared to open pollinating varieties.

Key words: Yield stability, rape hybrids, yield, oil yield,

INTRODUCTION

As the number and the acreage of winter rape hybrid varieties has increased in Germany in the last few years, it is of great interest if the hybrids offer advantages compared to the open pollinating winter rape varieties. Yield is obviously the most important trait, at the same time a high yield stability is of major significance. Possibly hybrids show a better performance for these traits as a result of heterosis. Can hybrids as a type achieve higher yields as well as more stable yields?

MATERIALS AND METHODS

To answer the questions above data from the official variety trials (Landessortenversuche) from the years 1998-2001 was used. The official variety trials seemed suitable as the field trials were conducted in a very high number of places all over Germany guaranteeing a broad spectrum of environmental conditions. The period before 1998 was not included in the analysis as the number of hybrids tested seemed too small.
Orthogonal cores for each year and trait were selected from this data. For the trait yield groups resulted that were cultivated at 57-67 locations in Germany (see table 1). As the number of hybrids still seemed rather low (2-3) a further group was created which includes five hybrids evaluated at a smaller number of sites. Data concerning the oil yield existed for far less locations (12 – 33) as the oil content was not analysed everywhere. A further group including two hybrid and two open pollinating varieties cultivated at 45 locations was created for this trait.

In this study the regression model (Eberhart and Russell 1966) as well as the ecovalence (Wricke 1965) were computed using a SAS-program designed by Hussein et al. (2000). Fox´s rank analysis (Fox et al. 1990), a nonparametric measure of stability, was used as it comprises not only information concerning the reaction of the genotype in different environments but also the information if the genotype is a high yielding variety compared to the other genotypes evaluated in the study. All parameters were computed for the traits yield and oil yield.

Table 1: Number of locations and number of hybrid and open pollinating varieties in the years 1998-2000 analysed for the traits yield resp. oil yield. (OP = open pollinating varieties, H = hybrid varieties).

Yield				Oil yield			
Year	No. locations	No. OP	No. H	Year	No. locations	No. OP	No. H
1998	67	8	2	1998	33	7	2
1999	67	6	2	1999	32	7	2
2000	57	3	3	2000	15	6	3
2001 Group 1	67	4	3	2001 Group 1	12	5	5
2001 Group 2	26	5	5	2001 Group 2	45	2	2

RESULTS

The yields of the hybrids were significantly higher than the yields of the open pollinating varieties in all groups (see Table 2). The ecovalence of the hybrids was lower in all years with exception of 1999, which means that a smaller genotyp*environment interaction resp. more stable yields were verified in nearly every year. All results apply to the oil yield as well.

Table 2: Yield, oil yield, their corresponding ecovalences and regression coefficients shown for the analysed groups.

Year	Type of variety	Yield (dt/ha)	Yield stability Ecovalence	Yield stability b	Oil yield (dt/ha)	Oil yield stability Ecovalence	Oil yield stability b
1998	OP	42,24	421,04	0,998	18,99	46,91	1,023
	H	46,72**	391,93	1,009	20,16**	40,39	0,919
1999	OP	48,30	456,08	0,958	21,23	55,15	0,962
	H	53,09**	521,11	1,127	22,67**	64,81	1,133
2000	OP	42,22	413,81	0,951	18,35	19,83	1,007
	H	45,49**	375,88	1,049	19,36**	16,41	0,985
2001	OP	44,79	509,53	0,915	19,38	16,16	1,037
Group 1	H	48,68**	438,15	1,114	20,24**	14,41	0,954
2001	OP	45,36	236,56	0,933	20,77	46,91	0,919
Group 2	H	48,08**	137,97	1,067	21,32**	40,39	1,081

b = coefficient of regression (Eberhart und Russell, 1966), OP=open pollinating variety, H = hybrid, ** = Hybrids are significantly (α =0,001) different from open pollinating varieties.

The regression coefficients of the hybrids were always higher for the trait yield than those of the open pollinating varieties. Thus the hybrid varieties have a stronger positive reaction to beneficial environmental influences. The regression analysis for the trait oil yield did not show such clear results.

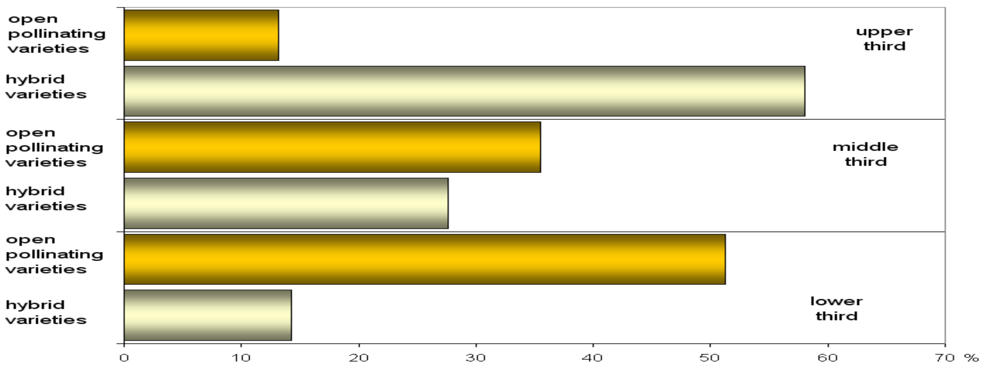

Fig. 1: Results of Fox's rank analysis depicted as the means of all analysed groups

The results of Fox's rank analysis (Fox et al. 1990) for the trait yield are shown in figure 1. The hybrid varieties were ranked in the lower third in only 14 % of the field trials. Consequently a randomly chosen hybrid variety has a probability of 86% of achieving a yield in the upper two thirds of the range under the conditions of the official variety trials. The rank analysis for the trait oil yield showed similar results though the differences between the hybrid and the open pollinating varieties are not as distinct.

There are pronounced differences between individual varieties for the traits yield and oil yield in both types of varieties. Yield and ecovalences of the varieties are depicted in figure 2 as relative values (respective group mean = 100 %). The hybrid varieties are mainly in the upper right quadrant where those varieties can be found that offer high and stable yields.

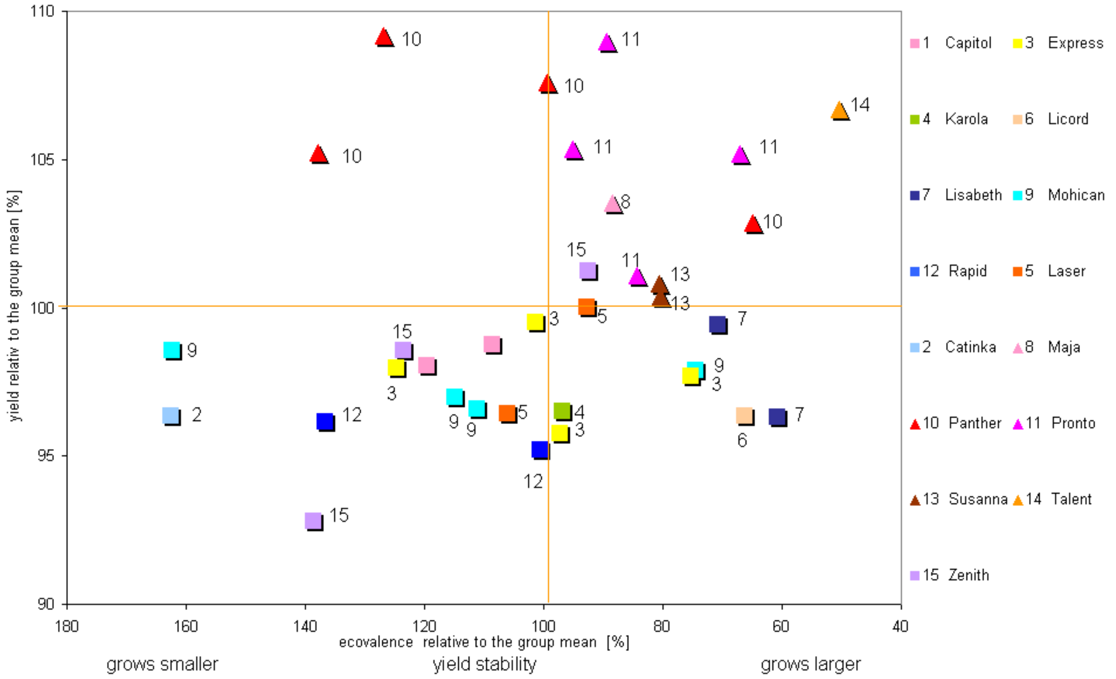

Abb. 2: Varieties depicted as relative values for yield and ecovalences (respective group mean = 100 %) based on the analysed groups (▲ = hybrid variety, ■ = open pollinating variety).

DISCUSSION

The statistical analysis confirms significantly higher yields and oil yields for the hybrids in all groups. The computed stability parameters show a higher stability for yield and oil yield in nearly all cases with the exception of the ecovalence in the year 1999.

The chance of a randomly chosen hybrid variety achieving a yield resp. an oil yield in the upper third of the range is considerably higher than for an open pollinating variety.

However individual varieties in both types of varieties may perform in a different way than the type as such. Altogether hybrids as a type offer higher and more stable yields than open pollinating varieties.

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