Some results on yield stability of winter-rape

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1. Introduction

For Brassica-species several investigations concerning the amount of genotype x environment interactions and the computation of stability-parameters can be found in the literature: WITCOMBE and WHITTINGTON (1971); JOARDER and EUNUS (1977); POSSELT (1978); JOARDER, GHOSE and SALEHUZZAMAN (1978); SCHUSTER and ZSCHOCHE (1981); HUEHN (1981). But in almost all these studies a stability-analysis has been considered only marginally. No comparisons of results using different concepts of stability have been performed. But for a characterization of yield-stability the amount of genotype x environment interactions as well as a knowledge of the different stability-parameters is of special interest. Therefore, some new results concerning yield-stability of winter-rape are given and discussed in the present paper. Furthermore, the correlations between the means of the lines for different characters and their corresponding stability-parameters are of fundamental importance in crop science and plant breeding.

2. Material and Methods

To study the phenotypic stability of winter-rape the results of an international series of field trials with new zero-erucic lines have been used for the years 1976, 1977 and 1978 [Banbury (Great Britain), Svalöf (Sweden), Armentieres (France), Göttingen and Hohenlieth (Federal Republic of Germany)]. The following characters have been analysed: 1000-seed-weight, oil-content, seed-yield and oil-yield. To characterize the phenotypic stability quantitatively, five stability-parameters are computed: "variance" of each line (over all locations), "ecovalence" (WRICKE), the two stability parameters of the common regression approach ("regression coefficient" and "sum of squared deviations from the regression") (EBERHART and RUSSELL) and the "genotypic stability" (HANSON). The stability-analysis has been performed for each year separately.

3. Results

The results of the two-way analyses of variance for the character "seed-yield" are summarized in table 1. (In this short communication only the results for "seed-yield" can be presented in an extended manner).

Table 1: Two-way analyses of variance for "seed-yield" in 1976, 1977 and 1978 (** resp. *** = significance for an error probability of 1% resp. 0,1%).

source of variation	year	d.f.	SS	MS	significance
locations	1976	3	9279.6	3093.2	***
lines		19	1675.0	88.2	***
locations x lines		57	1986.0	34.8	***
residuals		300	3206.0	10.7	
locations	1977	3	8150.5	2716.8	***
lines		11	1987.8	180.7	***
locations x lines		33	1561.7	47.3	***
residuals		180	1321.5	7.3	
locations	1978	4	16568.9	4142.2	***
lines		12	6982.0	581.8	***
locations x lines		48	1548.6	32.3	**
residuals		325	5193.7	16.0	

The highly significant locations x lines-interactions found for "seed-yield" in each year justify an extended quantitative analysis of the phenotypic stability of the single lines.

The stability-results for "seed-yield" are given in tables 2a, 2b and 2c.

For all the stability-parameters used in these computations the parameter-values of the lines show a strong variation between the different years. Also, for each stability-concept, the rank orders of the lines (according to stability) are extremely different in the different years. The same is true for the rank orders of the lines by using different stability-parameters for a certain year. These results can be concluded for the character "seed-yield" from tables 2a-2c. The same conclusions are valid for all of the other characters studied.

Table 2a: Stability-parameters:"seed-yield" 1976

lines	mean	variance	ecovalence	genotypic stabil.	regress. coeff.	sum of squared dev. from regr.
Sv 72/725	29.0	21.9	9.9	10.0	0.80	6.3
Sv 72/728	27.9	28.1	45.8	30.3	0.75	31.8
Sv 72/804	25.7	16.3	22.3	13.1	0.67	12.6
Sv 72/899	27.4	32.0	8.8	21.5	0.97	8.8
Sv 72/11058	28.1	57.7	33.7	67.2	1.25	27.8
R 39	32.3	44.8	2.7	28.4	1.14	0.7
R 40	30.1	35.7	12.3	28.0	1.01	12.3
R 41 B	31.7	52.0	9.8	46.1	1.29	2.0
R 42	28.3	27.0	1.8	11.2	0.92	1.3
R 46	27.6	41.1	24.3	41.6	1.03	24.1
W 302/75	27.9	84.9	67.4	120.1	1.51	43.2
W 506/75	26.1	38.1	19.2	35.0	1.01	19.2
W 587/75	28.7	32.3	6.5	20.5	0.98	6.5
W 701/75	29.6	28.5	1.8	13.1	0.95	1.6
W 744/75	29.3	53.3	45.4	68.9	1.11	44.1
Ar 259/74	30.8	22.3	24.7	19.3	0.72	17.8
Ar 326/74	28.2	23.2	3.6	7.7	0.85	1.7
Ar 476/74	32.8	46.9	45.8	61.6	1.01	45.8
Ar 619/74	34.1	43.3	9.0	35.1	1.15	6.9
Ar 622/74	32.9	20.3	5.4	5.4	0.80	1.7

For example, by using "ecovalence" and "sum of squared deviations from the regression" the high-yielding line R 39 (which is now the variety "Jet Neuf") shows a high stability in 1976 in all the characters. However, the "HANSON-parameter" and the "variance" give a lower stability to this line. In 1978 the situation is completely reversed.

The line "Ledos " (with low glucosinolate content) gave in 1978 the lowest "seed-yield" and "oil-yield" (in spite of it's highest "oil content"). But using the "HANSON-parameter" and the "variance" "Ledos " ranged in all four characters in the upper part of the stability rank order of the lines.

The correlations between the means of the lines in the different characters and their corresponding stability-parameters are presented in table 3.

Table 2b: Stability-parameters:"seed-yield" 1977

lines	mean	variance	ecovalence	genotypic stabil.	regress. coeff.	sum of squared dev. from regr.
Sv 72/725	31.9	57.0	28.2	44.8	1.03	28.1
Sv 72/11058	32.0	45.6	36.2	39.3	0.87	34.1
W 302/75	29.5	27.5	30.5	18.1	0.69	18.0
W 506/75	24.8	86.0	49.3	87.0	1.27	38.9
W 587/75	26.6	81.2	80.1	103.3	1.11	78.4
W 701/75	35.0	27.6	8.2	6.8	0.75	6.1
W 744/75	29.3	41.3	8.7	16.7	0.92	9.1
Ar 259/74	31.0	58.1	37.8	52.3	1.00	38.0
Ar 396/75	33.8	55.6	7.6	29.5	1.09	6.4
Ar 476/74	33.0	44.4	4.5	16.6	0.98	4.5
Ar 619/74	33.7	70.0	9.8	44.8	1.24	1.5
Ar 622/74	34.9	41.3	12.6	17.0	0.91	12.1

Table 2c: Stability-parameters:"seed-yield" 1978

lines	mean	variance	ecovalence	genotypic stabil.	regress. coeff.	sum of squared dev. from regr.
R 39	39.7	20.9	44.0	44.4	0.74	38.7
R 41	40.4	34.7	26.9	64.8	1.18	24.1
R 51	37.7	21.3	14.6	31.0	0.93	14.2
Ledos	24.7	11.1	45.7	24.9	0.49	24.9
W 506/75	31.5	18.6	2.0	19.5	0.94	1.7
W 587/75	31.7	35.9	35.3	71.3	1.16	33.0
W 701/75	36.3	21.2	1.2	24.5	1.01	1.1
W 744/75	31.2	22.4	16.5	34.2	0.95	16.5
Ar 212/75	38.5	30.6	12.4	49.3	1.17	9.9
Ar 396/75	37.5	31.1	8.2	48.4	1.21	4.4
Ar 403/75	37.3	21.3	5.2	26.7	0.99	5.2
Ar 476/74	35.9	33.0	14.6	55.4	1.22	10.6
Ar 619/74	37.7	32.9	50.6	72.6	1.00	50.6

The correlation-coefficients between the means of the lines and the stability-parameters show a strong variation from year to year. Also, for different stability-parameters (based upon the same year) these correlations differ considerably. Here "1000-seed-weight" shows the most uniform results with positive correlation-coefficients between 0.24 and 0.66.

Table 3: Correlation coefficients between the means of the lines and the different stability parameters

character		vari-ance	eco-va-lence	geno-typic stabil.	re-gress. coeff.	sum of squared dev.from regr.
seed-yield	1976	+0.09	+0.17	-0.02	+0.17	-0.15
	1977	-0.58	-0.76	-0.74	-0.34	-0.70
	1978	+0.25	-0.16	+0.37	+0.54	+0.04
oil-content	1976	+0.61	-0.08	+0.58	+0.66	-0.01
	1977	+0.53	+0.55	+0.43	+0.42	+0.23
	1978	-0.11	+0.55	+0.07	-0.20	+0.43
oil-yield	1976	+0.14	-0.28	-0.06	+0.30	-0.23
	1977	-0.21	-0.67	-0.42	-0.02	-0.55
	1978	+0.60	-0.19	+0.55	+0.60	0.00
1000-seed-weight	1977	+0.66	+0.55	+0.64	+0.59	+0.25
	1978	+0.31	+0.55	+0.38	+0.24	+0.44

4. Discussion, conclusions and summary

At first, these studies have shown that in winter-rape usually highly significant interactions between lines and locations may occur. But, nevertheless, numerically these interactions represent an only limited part of the total variation. This result is in accordance to the findings of POSSELT (1978). The relevance of this result for selection-purposes needs no further comments. Concerning the stability-results the dominating year-effects are especially conspicuous. One obtains different stability rank orders of the lines 1) in different years (using the same stability concept) and 2) for different concepts of stability (using the same year). That means, the different stability parameters usually result in very different stability rank orders of the lines. For the correlations between the means of the lines and the corresponding stability parameters no generally valid and unique results and dependencies can be worked out: One obtains very different results in different years (using the same stability parameter) as well as for different stability concepts (using the same year). However, in spite of the large differences of the correlation-coefficients for different years and for different stability parameters almost all of the correlation-coefficients are numerically medium or low. Therefore, a selection of lines which are high-yielding as well as of high stability seems to be possible.

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