CHARACTERIZATION OF THE STRENGTH PROPERTIES OF WINTER RAPE SILIQUES IN THE ASPECT OF THEIR CRACKING SUSCEPTIBILITY

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Seed shedding during the ripening and harvest of plants causes, every year, considerable losses of sowing and consummable material. In the case of winter rape the losses are assessed at 5-20 % of the total yield and depend on numerous factors (Szot, 1983, 1985). This undoubtedly constitutes a problem, even a partial solution of which may bring in considerable amounts of valuable material. This problem concerns both the plant culture and harvest technology. On the basis of available literature one can conclude that the breeders of new varieties have at their disposal a very modest methodological base, making it impossible for the mechanical properties of plants to be assessed objectively with relation to the processes of harvest and threshing. In the studies by Tomaszewska (1964), Loof (1961), or Josefson (1968), the resistance of siliques to cracking was determined, but the determination was indirect, which precluded any comparisons of the results obtained, both among the methods used and within periods of several years.

Acquiring knowledge on the mechanical properties of rape siliques will permit for the identification of that ripeness phase of the plant which will guarantee the maximum reduction of both qualitative and quantitative losses. Hence, the objective of the present study is to evaluate the strength properties of rape siliques, including the identification of the intervariety differentiation, which should allow for a potential determination of the susceptibility of particular varieties to silique cracking.

MATERIAL AND METHOD

The study was carried out on the siliques of 23 varieties and strains of winter rape, originating from comparative investigations. The siliques were collected during the full ripeness phase. Measurements of the mechanical properties of the siliques were carried out on an INSTRON strength testing apparatus. According to the method adopted (Tys, 1985), the siliques of each of the varieties were subjected to torsion, during which the seams joining the two pod halves cracked and opened. The diagram received from the recorder was used to calculate:

- the energy causing the cracking of the whole silique, i.e. overcoming the elasticity of the siliques and adhesion of their seams (A),
- the energy causing the overcoming of the siliques seams adhesion (ΔA),
- the energy characterizing the silique elasticity (A'),
- the energy causing the first cracking of the silique (A''),
- the maximum torque at which the first silique cracking occurs (Ms),
- the torsion angle at which the first silique cracking occurs (α).

The parameters enumerated accurately characterize the silique as to its strength properties and permit for the assessment of the varieties studied in the aspect of their susceptibility to cracking and seed shedding.

RESULTS

The winter rape varieties adopted for the study differ considerably as to their morphological properties, these being related also to the strength properties (Table 1). The longest siliques characterized the Darmor variety - 98 mm, and the shortest - the Rubin variety, 79.9 mm. The greatest silique weight was that of the Belinda variety - 0.2965 g, and the lowest silique weight - - that of the BOH 384 variety, 0.1640 g. Also with respect to the number of seeds per silique the varieties tested displayed a considerable differentiation, with 33.3 seeds in the case of the Belinda variety as the highest value, and 20.7 seeds, in the case of Jet Neuf, as the lowest. Investigating the weight of 1000 seeds it was found that the highest value of this parameter was that of the Jet Neuf variety, at 5.47 g, and the lowest, at 3.27 g, that of the BOH 384.

The measurement results obtained indicated a considerable variability in the mechanical properties of rape siliques, determined by the variety properties (Table 2). On the basis of the mean values of energy causing the cracking of the whole silique (A) it was established that the values vary within the range from 7.24 mJ to 20.06 mJ. The highest values of this energy characterized the Lirakotta variety, and the lowest - the Lirabon variety, with the latter, apart from the torsion angle α , clearly differed from the other varieties. The extreme mean values corresponding to silique elasticity (A' = 4.71 mJ - - 11.19 mJ) and to seam strength (ΔA = 2.54 - 8.87 mJ) are also those for the same varieties. On the other hand, the highest values of the energy causing the first cracking, of the torque at which the first cracking occurs, and

Table 1. Mean values of the strength parameters of the winter-rape siliques.

Variety	A	A′	ΔA	A″	M_s	α
Lirakotta	20.06	11.19	8.87	1.97	7.56	0.52
Marinus	17.43	9.53	7.89	2.73	8.29	0.66
Beryl	18.96	10.92	8.04	1.32	5.50	0.48
Belinda	19.24	11.15	8.07	1.47	6.52	0.45
Gundula	18.46	10.94	7.41	0.90	5.32	0.34
Ridana	16.82	9.84	6.98	0.81	5.09	0.32
Rubin	16.22	9.12	7.09	1.59	6.10	0.52
BOH 183	16.69	9.83	6.78	1.45	5.93	0.49
Licantara	16.57	10.28	6.29	1.11	5.55	0.40
Mirander	16.98	9.70	7.27	0.84	5.25	0.32
Doral	16.09	9.58	6.49	0.81	5.09	0.32
Darmor	14.37	8.48	5.89	1.91	6.08	0.63
Jet Neuf	13.81	8.55	5.26	1.35	5.29	0.51
Korina	12.15	7.53	4.61	0.60	4.01	0.30
Jupiter	13.01	7.29	5.71	0.71	4.08	0.35
Tandem	13.22	7.68	5.53	1.03	4.93	0.42
Liglandor	10.48	6.31	4.17	1.02	3.94	0.52
Bienvenu	11.99	7.41	4.52	0.81	3.61	0.45
Jantar	10.07	6.84	3.22	0.77	2.91	0.53
BOH 384	9.79	6.07	3.72	0.60	3.01	0.40
Lindora	9.66	5.97	3.68	0.51	3.00	0.34
Santana	9.44	6.02	3.41	0.69	2.91	0.46
Lirabon	7.24	4.71	2.54	0.43	1.92	0.45
LSD (P=0.05)	2.08	1.28	1.27	0.26	1.24	0.13

Table 2. Morphological properties of the winter rape siliques.

Variety	Length of siliques	Weight of siliques	Number of seeds per silique	Weight of 1000 seeds
Lirakotta	90.5	0.2673	27.8	4.95
Marinus	84.1	0.2364	29.7	4.36
Beryl	87.8	0.2566	29.8	4.50
Belinda	95.5	0.2965	33.3	4.56
Gundula	88.4	0.2236	27.3	3.81
Ridana	94.5	0.2496	28.3	4.44
Rubin	79.9	0.2109	27.5	3.64
BOH 183	80.4	0.2111	30.8	3.27
Licantara	88.7	0.2207	27.6	4.42
Mirander	88.5	0.2447	29.1	4.41
Doral	87.4	0.2325	27.2	5.15
Darmor	98.0	0.2336	30.9	3.87
Jet Neuf	89.8	0.2040	20.7	5.47
Korina	90.1	0.1839	22.8	4.34
Jupiter	92.3	0.2392	28.1	4.64
Tandem	95.8	0.2266	31.7	3.98
Liglandor	87.4	0.1842	26.7	3.90
Bienvenu	83.1	0.2072	26.7	4.29
Jantar	84.7	0.2104	25.7	5.37
BOH 384	83.2	0.1640	24.9	3.37
Lindora	90.1	0.2546	24.9	4.13
Santana	86.9	0.1699	27.3	3.41
Lirabon	87.6	0.1673	21.2	4.69
LSD (P=0.05)	3.87	0.0206	2.63	1.23.

of the torsion angle at which the first cracking occurs, were observed in the case of the Marinus variety ($A'' = 0.43 - 2.73$ mJ; $M_s = 1.92 - 8.29$ Nmm; and $\alpha = 0.30 - 0.66$ rad). The lowest angle value was that for the Karina variety. Analizing statistically the parameters under discussion, one can note that they seem to group the varieties into 5 groups significantly differing from one another. In the Table the varieties as listed in the order obtained by arranging the parameter values from the highest to the lowest. This sequence does not concern the torsion angle, the values of which form three groups of varieties, somewhat different from the former groupings. Siliques of the highest strength parameters, i.e. the most resistant to cracking, are those of the following varieties: Marinus, Lirakotta, Beryl, and Belinda. The least resistant are: BOH 384, Lindora, Santana, and Lirabon.

The greatest angle at which the first cracking occurs in displayed by siliques of the following varieties: Marinus and Darmor, the lowest angle values being those for Jupiter, Lindora, Gundula, Ridana, Mirander, Doral, and Korina. Hence, these varieties are significantly differentiated in their susceptibility to strain, this being important in the assessment of silique elasticity.

The correlation coefficients calculated have shown that there are significant relationships between the siliques weight as well as the number of seeds in silique and all the strength parameters studied except of the torsion angle (Table 3).

Table 3. The correlation coefficients between morphological properties and strength parameters of the winter rape siliques.

	A	A'	ΔA	A''	M_s	α
Length of siliques	0.139	0.135	0.146	-0.005	0.119	-0.168
Weight of silique	0.729*	0.702*	0.740*	0.409*	0.620*	-0.027
Number of seeds per silique	0.599*	0.558*	0.625*	0.475*	0.580*	0.198
Weight of 1000 seeds	0.115	0.152	0.078	0.009	0.062	-0.031

*) significant correlation

CONCLUSION

The investigations carried out showed a very extensive differentiation in the morphological and strength properties of 23 varieties of winter rape. If the morphological properties are, to a considerable extent, dependent on geometrical factors and environmental conditions, the variability of the mechanical properties is the primary factor determining the quantity and quality of the seed material obtained. The susceptibility or resistance to silique cracking is reflected in the losses that may occur in the final phase of plant ripening and during harvest. The results obtained clearly indicate a very extensive differentiation in all the strength parameters of rape siliques collected in the same ripeness phase, which supports the view that they will show differing responses at identical harvest conditions. Therefore, applying an objective method for the evaluation of the strength properties of siliques, one can foresee their response to the effect of external forces, which means that there is a possibility of verifying and testing plant material in this respect already at an initial stage of breeding projects. For varieties in established cultivation, on the other hand, it is possible to determine the optimum time of harvesting, and to design an appropriate harvesting technology.

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