AN EVALUATION OF THE MECHANICAL PROPERTIES OF WINTER RAPE STEMS

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Winter rape, as the fundamental oil plant of our climatic zone, occupies an important position in the crop structure, and its yield is determinated by a number of factors and depends, to a considerable degree, on the application of an appropriate harvest technology. It should be noted that with a single-stage combine harvest the seed losses due to shedding come up to approximately 10-12 % of the total yield. A number of elements bear on such high losses, and one of those, undoubtedly, is the condition of the field, which is determined by agrotechnical factors, and primarily by the resistance of the plants to lodging.

In view of the above, it seems to be necessary to get to know the mechanical properties of rape stems that determine their strength characteristics. Considering the fact that the stems are heterogeneous material, it is particularly difficult to design an appropriate method for the determination of the mechanical parameters of material of this kind (Skubisz, 1982; Skubisz - in press).

It was established that mechanical parameters determined in dynamic-static experiments will permit sufficiently accurate determination of the physical properties of rape stems. These involved also the determination of the variability of the mechanical properties along the stems, and an analysis of relationships between the parameters studied.

MATERIAL AND METHOD

The study was carried out on the stems of 4 varieties of winter rape: BOH 384, Licantara, Doral, and Jet Neuf. The measurements were carried out on 30 stems representative of a given variety. Then, after the separation of siliques and off-shoots, the stems were cut up into six successive sections, beginning at the root, on which the determinations of mechanical parameters were carried out to determine the distribution of the parameters along the lengt of the stems. The strength characteristics of the rape stem was obtained by determining the shearing energy (E_d) in dynamic tests, the tests being carried out using an East German apparatus operating according to the pendulum hammer principle (E_s) at a velocity of v= 2.1 m/sec. Static tests were used to determine the shearing energy and the maximum shearing stress (τ max). To this end the maximum shearing force was determined on the Instron strength testing apparatus, by means of a special attachment adapted for shearing stems of various diameters, in which two stem cross-sections were simultaneously sheared. The shearing energy in static tests was obtained by integrating the surface area found from the graph using a curve plotted by mans of the sample shearing force. The shearing stress was found from the formula:

$$\tau_{max} = \frac{P_{max}}{2\,S}$$

where:

P_{max} - maximum shearing force

S - total cross-section area of the stem

In turn, the cross-section area (S) was determined by means of an English-made T Areometer.

RESULTS

The results obtained permitted for the determination of the variability of the parameters along the length of the stem (Figs 1 through 5) and for the analysis of the relationship between the parameters studied. The variability of the mechanical parameters was described by means of a square polynominal. The shearing energy values obtained in the dynamic tests decrease in the direction from the base of the stem to its top, in all the varieties tested, with the BOH 384 variety charecterized by the highest values of this parameter, and the Jet Neuf variety - by the lowest. A similar character of variability, but with a much more violent change in values at the base of the stem, was displayed by the shearing energy as determined in static tests. It is generally observed that the shearing energy in static tests is considerably lower than the shearing energy in dynamic tests. Somewhat different is the variability, along the length of the stem, of the shearing energy per stem cross-section area unit (E_d/S, E_s/S). In most of the varieties tested, a much more rapid decrease in the values was observed along the stem section from the base to the first off-shoot, and a minimal variability of the values along the stem portions above the first off-shoot.

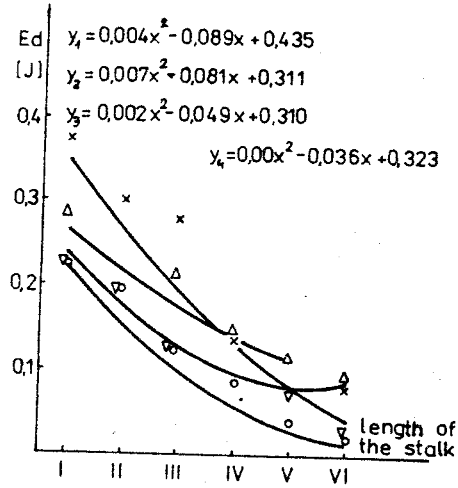

Fig. 1. Distribution of the values of the shearing energy in dynamics tests along the stem of 4 varieties of rape (x, o, Δ, ∇ - the experimental points, y_1, y_2, y_3, y_4 - regresion curve, x, y_1 - BOH 384, o, y_2 - Doral, Δ, y_3 - Licantara, ∇, y_4 - Jet Neuf)

Investigating the shearing stress of rape stem, the authors observed a variability similar in character to that of the shearing energy per a unit of stem cross-section area. Here, however, there was much greater differentiation within particular varieties, and only the Jet Neuf variety was exception to the rule. The most rapid decrease in the shearing stress value was observed in the BOH 384 variety, particularly in the lower portion of the stem, while the Doral and Licantara varieties were characterized by a greater stability in that portion of the stem.

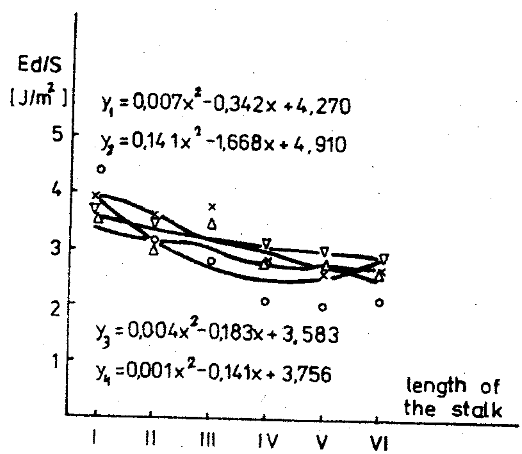

Fig. 2. Distribution of the values of the shearing energy per stem cross-section area unit in dynamics tests along the stem of 4 varieties of rape; explanations as Fig. 1.

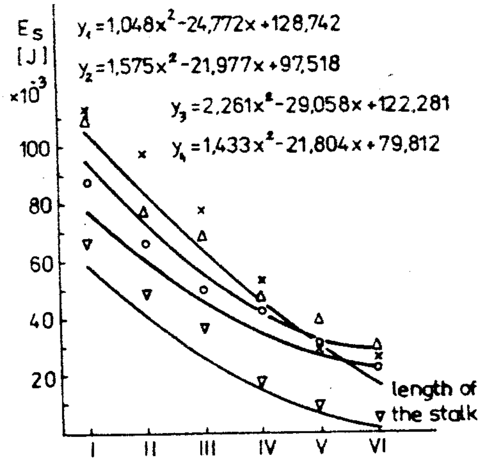

Fig. 3. Distribution of the values of the shearing energy in static tests along the stem of 4 varieties of rape, explanations as Fig. 1.

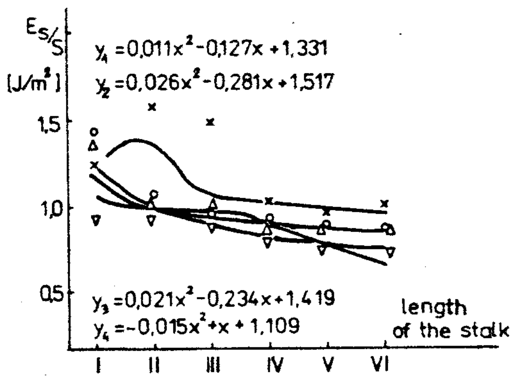

Fig. 4. Distribution of the values of the shearing energy per stem cross-section area unit in static tests along the stem of 4 varieties of rape, explanations as Fig. 1.

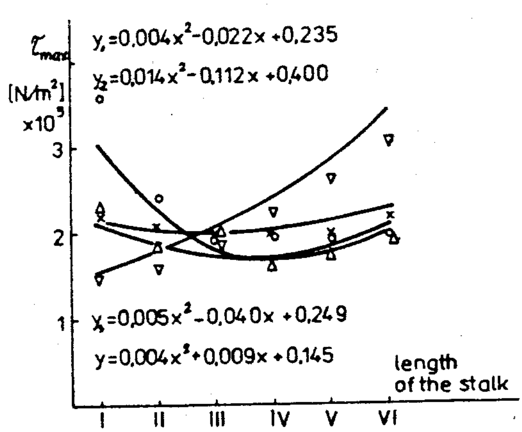

Fig. 5. Distribution of the values of the shearing stress along the stem of 4 varieties of rape, explanations as Fig. 1.

The correlation coefficients determined showed an especially high positive relationship between the shearing energy values from dynamic and static tests (BOH 384 - r = 0.923; Licantara - r = 0.935; Doral - r = 0.945; Jet Neuf - - r = 0.931). Also, a high positive correlation was found between the shearing energy values per a unit of stem cross-section area, determined in dynamic and static tests (BOH 384 - r = 0.746; Licantara - r = 0.744; Doral - r = = 0.773; Jet Neuf - r = 0.383). At the same time, a high correlation occurred between the parameters determined in static tests, where the values of correlation coefficients between the shearing energy and the shearing energy per a unit of stem cross-section area were respectivelly: BOH 384 - r = 0.820; Licantara - r = 0.904; Doral - r = 0.810; and Jet Neuf - r = 0.558. The lowest correlation was that between the shearing energy and the shearing stress, where the coefficient values were: BOH 384 - r = 0.171; Licantara - r = = 0.479; Doral - r = 0.270; and Jet Neuf - r = 0.503. The correlation between the shearing energy per a unit of stem cross-section area and the shearing stress was somewhat stronger, with the correlation coefficient values as follows: BOH 384 - r = 0.507; Licantara - r = 0.692; Doral - r = 0.674; and Jet Neuf - r = 0.468. Generally speaking, the physical properties of the Jet Neuf variety differ fundamentally in their variability from those of the other varieties.

As a result of variance analysis (Table 1), it was found on the basis of shearing energy values determined in both types of tests that there are no significant differences betwen the BOH 384 and Licantara, and between the Licantara and Doral varieties, while there were significant differences between BOH 384 and Jet Neuf, and between Licantara and Jet Neuf.

Table 1. Significance of the differences between the mean values of the shearing energy in dynamic and static tests for 4 varieties of rape.

Variety	E_d	E_s
BOH 384 - Licantara	0	0
Licantara - Doral	0	0
Doral - Jet Neuf	0	+
BOH 384 - Doral	+	+
BOH 384 - Jet Neuf	+	+
Licantara - Jet Neuf	+	+

where:

\+ - significant difference to the advantage of the first variety

CONCLUSION

The study presented herein permitted for the obtaining of the spread of variability of the mechanical parameters studied along the length of the stem. It was found that the character of the variability of the parameters analyzed can be described by means of square polynominals. On the basis of the correlation coefficients determined, the authors found a positive correlation between the parameters established in the course of dynamic tests and those from static tests. All of the four varieties involved displayed a similar character of variability, with the exception of the Jet Neuf variety. It was found that the shearing energy determined in dynamic and static tests allowed for comparable assessment of the intervariety differences.

As follows from the foregoing, the results obtained permitted for the determination of the mechanical properties of the stems of winter rape, and showed a considerable variability in the strength parameters along the stem length. The study allowed also to define the relationships between the parameters analyzed.

REFERENCES

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