Crack resistance of pods in some varieties of winter rapeseed

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Abstract

The aim of the study was to determine susceptibility of seven distinct varieties of winter rapeseed (Lisek, Californium, Kronos, NK Faire, Nelson, Smart, and Toccata) to seed pod cracking. The resistance to pod's cracking was determined by applying torque under twist of 180˚ in a special holder using INSTRON device. The developed method allowed the researchers to determine the twisting angle at which seed pod cracking occurs (pod's resilience), the maximum torque required for pod cracking, as well as overall force applied to shatter a pod. The results of the study point for the Nelson and Toccata varieties to be the most resistant to seed pod cracking, and exhibiting higher resistance than the Kronos variety. The pods of these varieties were also described in terms of much higher twist angle values at which seed pod crack occurs.

Key words: Rapeseed, varieties, pod cracking, shatter, method.

Introduction

The high loss in rapeseed at the end of seed maturity phase and during harvest can reach up to 20% (..) and be caused by low crack resistance of seed pods and seed thresh ability. The problem is not only in economy - lower yields - but also in the risk that relates to un-sprout seeds that dwell in the land after the harvest. Following years, they become danger to genetic purity of new varieties.

Several studies were conducted years ago to explain the seed loss and ways to reduce seed shatter and thresh ability in Sweden, Czech & Slovak Republic, Poland, Austria and England (1-38). The volume of collected work as well as countries of authors stand for significance of the problem of vulnerability of seed pods to shatter that is common for all the regions where rapeseed is cultivated.

The problem dwells also in the lack of varieties that are resistant to shatter and seed thresh ability. Culture of such varieties involves investments in specific methods to provide precision in the valuation of resistance of pods to cracking. One of such methods is pod twisting (applying torque) in order to determine durability of seams that glue the pod together (14 - 16). This method is useful as it illustrates close correlation between the measured force required to crack the seed pod and the actual shatter of seeds in the field (33 -38).

Materials and methodology of study

The seed pod cracking resistance tests were carried on seven varieties of winter rapeseed - the: 1 – Nelson; 2 – NK Fair; 3 – Californium; 4 - Kronos; 5 - Lisek; 6 – Smart; 7 - Toccata. All the seed pods were procured from laboratory plantations and as such were mature. To measure the seed pod cracking resistance, a method of pod twisting was applied (Fot. 1, Fig. 2) with the use of INSTRON shatter device. Applying this method, all the seed pods were placed in clasp and twisted under constant angle of $\phi = \pi$ rad (180^0), which was sufficient to cause complete crack of the seams in the pod. Each variety was described in detail in terms of the pod's resistance to shatter. Such description of mechanical properties of rapeseed is essential for the seed breeders to develop new varieties.

Result of study and Discussion

Following delivered results, it was established that the examined varieties of rapeseed (1 – Nelson; 2 - NK Fair; 3 – Californium; 4 – Kronos; 5 - Lisek, 6 – Smart; 7 - Toccata) demonstrate substantial variegation on account of the seed resistance to shatter. All the examined seed pods were described in terms of the following mechanical properties (Fig. 2 - 3):

$M_{max.}$- maximum twisting torque at which first crack in the seed pod occurred;

ΔA – energy required to overcome cohesion of seams in the seed pod;

α – seed pod twist angle after which first crack occurred.

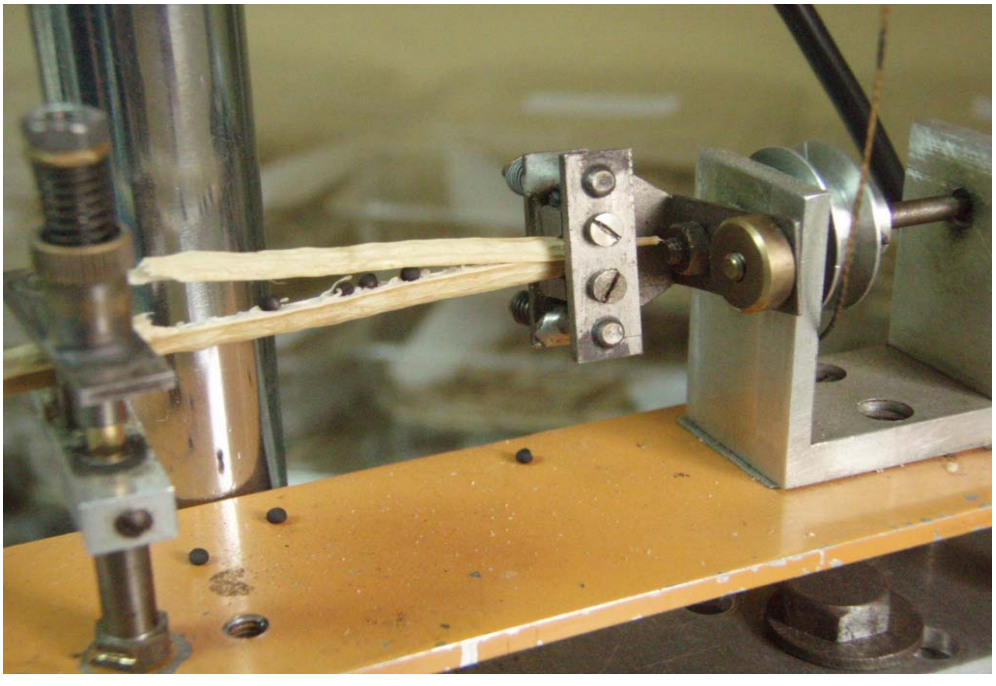
Assessment of pods after application of maximum twisting torque shows that, for Nelson and Toccata one should apply much greater twisting torque to induce first crack than for seed pods of other varieties. For the Nelson variety the M_{max} was on average 18,9 Nmm, while for Toccata it was 16,4 Nmm. The lowest M_{max} values were found in the case of the Kronos variety – 5,4 Nmm. For other varieties the values were met within 6,5 – 9,6 Nmm. Evaluation of resilence of respective varieties measured by angle (α) at which first crack occurred has demonstrated similar tendency. The widest angle was applied for the Nelson variety (1,0 rad) and for Toccata (0,7 rad). The lowest value was reported for the pods of the Kronos variety – 0,36 rad

and were almost three times lower than for the winning – Nelson. The twist angle for rapeseed pods at which first cracks occur was for other varieties varying from 0,43 to 0,56 rad. Examining the resistance of seams to cracking (ΔA) it was established that, as in the case of other parameters, the best (highest) values were reported for the Toccata variety – 15,9 mJ and for Nelson – 13,9 mJ. The lowest values were found in the case of the NK Fair variety – 4,4 mJ. Other varieties were relatively marginal in difference.

Comparing results of all the examined varieties, it should be stated that the Nelson and Toccata varieties are to be described in terms of unusually high resistance of seed pods to shatter. This relates to all the examined parameters (M_{max}, α, ΔA). Comparing to historically examined varieties (since 1979 several families and varieties have been studied) it should be stated that none of them has ever achieved such high parameter values, to describe seed pod resistance to shatter. From all the varieties examined so far in the history, the highest values were reported for the Gorczański variety (M_{max} – 9,9 Nmm; α – 0,71 rad; ΔA – 9,7 mJ) that was studied in 1977 – 1979 (38) and some family genders studied in the Svalof Institute in Sweden (33). Particularly promising is the wide angle α, that describes the pod resilence which prevents the pod from cracking.

Conclusions

Seed pods in all the examined varieties were described in terms of different resistance to mechanical forces (seed pod twisting). Such varieties as the Nelson and Toccata exhibit particularly high resistance to torque which presumes that they are the most resistant to seed shatter and threshability.



Fot. 1. Device for twisting rapeseed pods

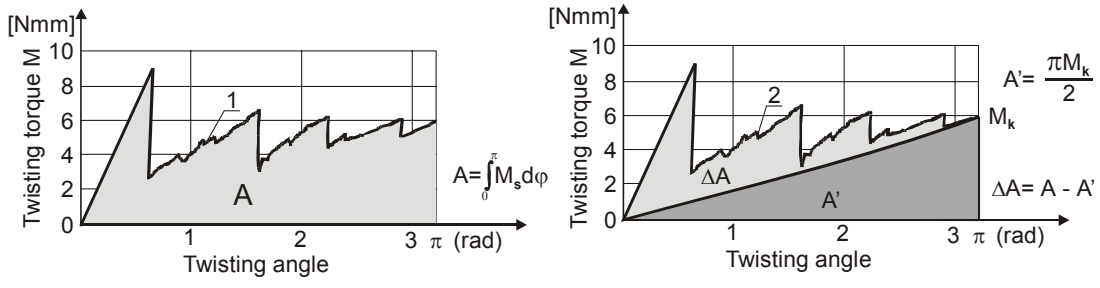


Fig. 1. Different torque values in function of twisting angle, determining the energy needed for complete pod crack (breaking seam cohesion and pod resilence under twisting process): M_{max} – maximum twisting torque (Nmm); α – twisting angle at which initial pod cracking occurred (rad); A' - energy elastic siliques (mJ); A'' – energy needed for initial cracking of pods (mJ); ΔA – energy needed to crack pod seams ($\Delta A = A – A'$); 1 – curve plotted during pod twisting; 2 - curve elastic pods.

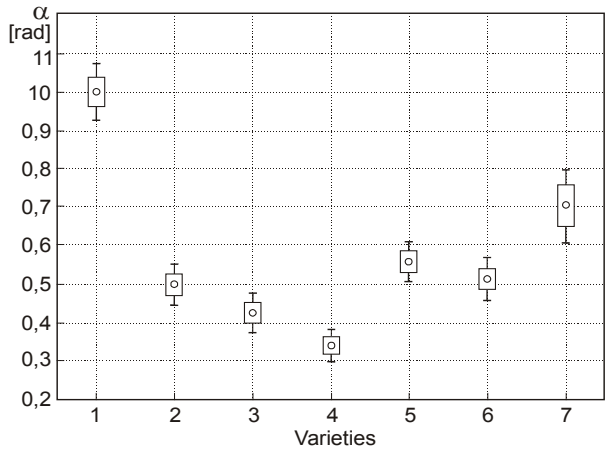


Fig. 2. The twisting angle for investigated varieties

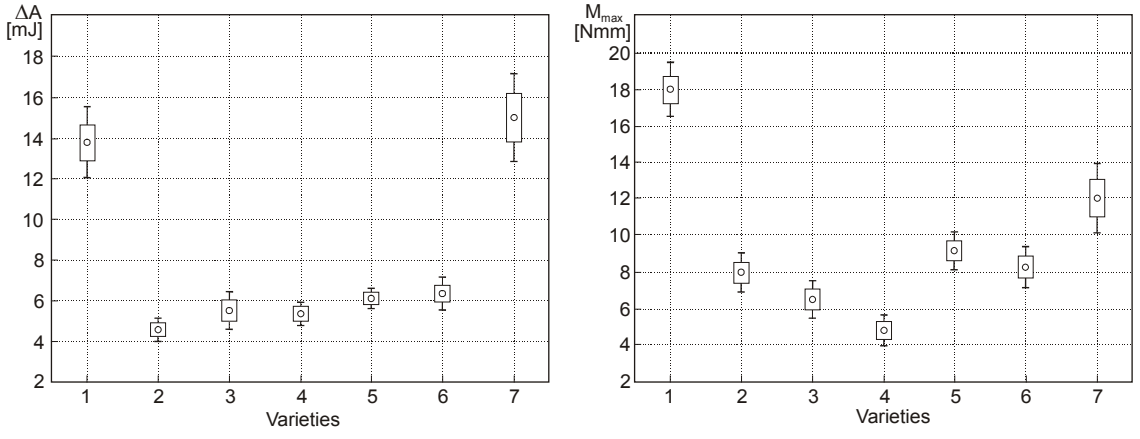


Fig. 3. Energy (ΔA) and maximal moment (M_{max}) for investigated varieties

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