STUDIES OF RAPESEED RESISTANCE TO MECHANICAL DAMAGE

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Mechanical damage is one of the main reasons for the lowering of rape seed technological value. It inluences the quality of stored seeds and worsens both the quantity and quality of rape seed oil.

The main source of mechanical damage is the process of harvesting, and all the processes connected with drying, cleaning and storing of rape seeds. Most of the studies on the extent of mechanical damage focus on the relation between mechanical damage and seed moisture contents both in field and laboratory experiments. The size of damage is also linked to the influence of some working units of combine harvester.

Seed resistance to mechanical damage is also related to such factors as: seed size, constitution, and position during mechanical loading, as well as the type of mechanical loading (dynamic, static) (1,2,3,8).Most of these studies deals with leguminous plants as they are especially exposed to mechanical damage.

Szot and Kutzbach (9) considered variability of individual seeds resistance to damage in relation to their moisture contents and rotational velocity of hitting element, and gave a mathematical description of this phenomenon. Model experiments of this type allow for getting to know the factors that influence the character of rape seed damage.However, they have one disadvantage, that is the lack of coordination between basic studies and their application. Hence it is impossible to solve the problem of rape seed damage on the way from the producer to the factory processing.

MATERIALS AND METHODS

The object of the present study was winter rape var.Jupiter. Both field and laboratory test were carried out. The aim of the field experiments was determination of the number of damaged seeds in relation to some chosen working parameters of combine harvester threshing unit.

The parameters chosen for settings were as follows:

1. working outlet gap - three widths: 7, 16, 24 mm
2. threshing drum rotations - four speed levels:from 13 to 30 m/s

Seed samples of differentiated moisture contents (i.e. 9, 15 and 18%) were collected from the combine reservoir.Hence, the size of damage was studied in relation to: seed moisture contents at harvest, the width of the working gap, and rotations of the threshing drum.

In order to widen the scope of the studied parameters, to eliminate those factors that can make the analysis of the field experiments difficult, laboratory-stand experiments aiming at the determination of the influence of wide range of seed moisture contents and centrifuge beater (simulating the work of the threshing drum) on the size of damage were undertaken. The studies were conducted at 7 different moisture levels from 4 to 21% and on 9 levels of the centrifuge beater velocity from 4 to 28 m/s. The seeds taken to the centrifuge experienced single strokes by the beater mounted on the centrifuge shaft. Only the seeds of the size from 1.9 to 2.1 mm were taken into consideration.

The estimation of damage was conducted on 5g samples (with 3 repetitions) that represented each of the experimental combination. Seeds

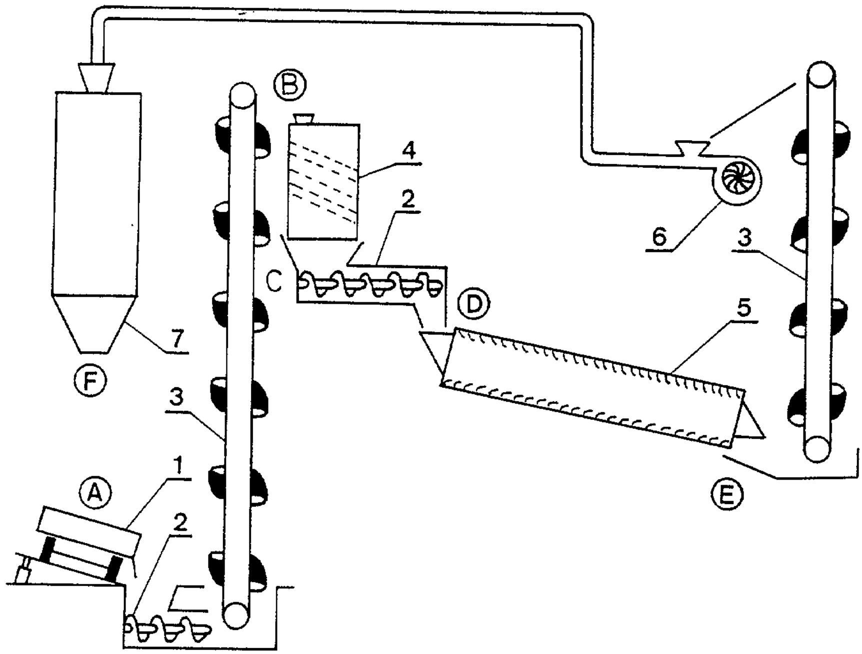

Fig. 1. The scheme of the postharvest rapeseed technological process
A - F - sampling site
1- trailor, 2- screw conveyer, 3- cub conveyer,
4- cleaner with sieves, 5- dryer, 6- pneumatic conveyer,
7- silo

Samples were then taken to the laboratory, where moisture content and physical state of seeds were studied. Moisture content was checked by drying in the laboratory dryer according to the Polish Standards, immediately after the samples had been delivered to the laboratory. Then the samples were put out to achieve air dry moisture content, equal for all the samples (6.5 - 7% w.b.). Seeds physical state was determined as the amount of: mechanically damaged seeds, underdeveloped (dead) seeds and foreign material (weeds seeds, straw etc.). All these categories were expressed in this study as a weight percentage of air dry matter and were evaluated by a visual inspection of 10g subsamples (two in each of the samples), according to the Polish Standards. The mean values of the two measurements were regarded as characteristic of individual samples. Kernels were considered damaged if the seed coat was split or if they were broken, cracked or chipped. All parts of the kernel (parts of skin as well as parts of cotyledon) were taken into consideration when evaluating the amount of mechanically damaged seeds. Kernels were considered underdeveloped if they were small, dried up and wrinkled.

RESULTS

Twenty two subsamples (eleven samples from one sampling location in two replications) were analyzed. Moisture content, the amount of mechanically damaged and underdeveloped seeds, as well as the amount of foreign material, were taken into consideration. The mean values were placed in Table 1. Standard deviations were calculated and included in the Table, to indicate the degree of sample variability.

Analyzing the amount of mechanically damaged seeds, it is easy to notice, that the percentage of damage increased as the seeds moved through the technological process. However, there were instances where damage levels decreased after a handling operation. This occured only by cleaning and was a result of separating of the whole and the broken seeds on the sieves. This decrease was neglected in this paper as very small (0.02 - 0.27%).

Table 1. Changes in the physical state of rape during handling in a typical Polish drying station

Sampling location	Year	Moisture content%		Mechanical damage%		Under-developed%		Foreign material%	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
FT (1)	1988	11.0	2.22	1.56	0.61	0.56	0.54	1.24	0.67
BC (2)		11.9	1.66	1.58	0.36	0.27	0.44	1.45	1.29
AC (3)		12.1	1.61	1.51	0.53	0.54	0.68	1.40	1.01
BD (4)		11.4	1.62	1.66	0.69	0.60	0.66	1.91	1.51
AD (5)		6.1	0.96	1.69	0.37	0.59	0.69	1.27	0.51
FC (6)		6.2	0.32	3.16	1.00	0.30	0.33	1.04	0.46
FT (1)	1989	12.9	3.99	1.74	0.17	4.02	0.13	2.65	0.17
BC (2)		13.4	3.78	1.76	0.13	3.69	0.11	2.91	0.12
AC (3)		13.6	3.65	1.74	0.19	3.13	0.10	2.43	0.13
BD (4)		10.5	0.72	2.78	1.11	5.21	0.14	2.19	0.06
AD (5)		7.0	1.41	2.95	0.10	3.61	0.12	2.53	0.25
FC (6)		6.3	0.47	5.51	0.26	2.19	0.12	2.49	0.12

(1) From trailor
(2) Before cleaning
(3) After cleaning
(4) Before drying
(5) After drying
(6) From conveyer to the storage bin

The first samples, taken from the trailor expressed the physical state of rapeseed after harvesting. The average amount of damaged seeds occured within this operation varied from 1.56 to 1.74% in 1988 and 1989, respectively. Seeds were slightly damaged during the next operation (conveying) and the average increase in the percentage of damage was about 0.02% in both cases. Then, the percentage of damaged seeds insignificantly decreased during cleaning, but it increased to 1,66 and 2.78% during the next operation, i.e. conveying to the dryer. Such a great increase in the second case, could be caused by errors in sampling techniques (samples were taken from the flow of seeds). This admission was confirmed by a higher standard deviation. Damage level increased also during drying (0.03% in 1988 and 0.17% in 1989), but the highest increase of broken seeds was observed after drying, when hot seeds were conveyed to the storage bin. The total damage level was 3.16 and 5.51% for 1988 and 1989, respectively. This rapid decrease of rapeseed quality could be explained by the influence of the pneumatic transport, unconvinient for such a delicate material as rapeseed as well as by a higher temperature of dry rape. Probably those both factors had such a great influence on the seed physical condition.

Table 2. The amount of mechanically damaged seeds associated with different handling operations, as a percentage of total damage level

Sampling location	Year	
	1988	1989
Harvesting	49.4	31.6
Transport to cleaning	0.6	0.4
Cleaning	0.0	0.0
Transport to drying	2.5	18.5
Drying	1.0	3.1
Transport to storage	46.5	46.4

The above results do not clearly show how much of the total damage can be attributed to either harvesting, drying or transport operations. The data presented in Table 2 compare the amount of mechanically damaged seeds associated with each handling operation as a percentage of total damage levels. Harvest damage were represented by the damage present in the samples taken from the trailor. Damage caused by the next operations was detrmined by considering the samples taken before and after each of them. The decrease of the amount of mechanically damaged seeds during cleaning operation was insignificant and neglected in Table 2.

The harvesting and the post-drying conveying were a major contributor to mechanical seed damage. The drying operation caused 1.0 in 1988 and 3.1% of damage in 1989. The rest of the damage was caused by the conveying operations both before cleaning and before drying. The higher amount of damage during transport before drying in 1989 shoud be considered as a result of error caused by the sampling technique used (see higher standard deviation for this result - Table 1).

The average moisture content was naturaly higher before drying and rapidly decreased to the expected 6% after drying operation. It is necessary to notice higher standard deviations for moisture content measurements before drying than after drying, what seems to indicate differentiated moisture levels of seeds deliverd to the drying station and nearly equal moisture level after drying.

The amount of underdeveloped (dead) seeds didn't change as seeds moved from one operation to the next. But the total amount of underdeveloped seeds in 1988 was about four times smaller than in 1989. It could be caused by different vegetation conditions (weather, diseases etc.).

The percentage of foreign material generally depended on harvesting and was nearly on the same level as seeds moved through the handling system from harvesting to storage. This indicated an inefficient cleaning operation.

CONCLUSIONS

1. Major contributors to mechanical rapeseed damage were by half: harvesting and post-drying conveying, which caused in all 95,9% of damage in 1988 and 78% in 1989.
2. Pneumetic transport of dry rapeseed caused about 46% of the total

damage and should not be used for rapeseeds.
3. Drying was conducted properly and the required moisture content of rape was achieved, and the damage level didn't increase significantly during this operation.
4. The method of seed damage evaluation by the visual inspection is very slow and the results may depend on the experience of the person who condacts it. It seems necessary to elaborate a new objective method of rapeseed quality testing.
5. The influence of rapeseed higher temperature on its mechanical resistance should be checked in the future investigations.

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