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QUALITY ASSESSMENT OF THE OPERATION PROCESS OF HEID TECHNOLOGICAL LINE THRESHING UNIT FOR CORN COBS

Anna Dębska[a], Jerzy Bieniek[a*], Leszek Romański[a], Zbigniew Kowalczyk[b], Krzysztof Kwietniak[c]

[a]Institute of Agricultural Engineering, Wroclaw University of Environmental and Life Sciences
[b]Institute of Agricultural Engineering and Informatics, University of Agriculture in Krakow
[c]SAATBAU Sp. z o. o. in Sroda Slaska
[*]*Contact details: ul. Chełmońskiego 37/41, 51-630 Wrocław, e-mail: jerzy.bieniek@up.wroc.pl*

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ABSTRACT

The article presents the quality assessment of the operation of HEID technological line threshing unit in SAATBAU Sp. z o.o. company in Środa Śląska. Evaluation of the CIMBRIA abrasive machine was made based on the macro and micro damages of seeds, which were made after threshing and through determination of seeds germination capacity and energy. Tests were carried out for five corn varieties: *Bosman, Sl Normo, Odilo, Okato, Wikana*. The calorymetric method was applied for determination of mechanical damages to seeds. The biggest macro-damages were reported at the level of 4.2% and micro-damages at the level of 14.5%. The increased values of damages occurred after threshing. The highest germination capacity was 96%. On this basis it was stated that the quality of the operation of the threshing unit was within the norm.

Introduction and the objective of the paper

Three cultivation plants: wheat, corn and rice have the fundamental meaning in the global agriculture. Corn is a grain on account of the obtained crops. For 20 years the area of its cultivation as well as crops in the world increased by 1/3 (Dragańska, 2010). It is one of the most productive cultivation plants. Corn is cultivated for seeds, silage and sometimes for green forage. The main reason, for which corn is significant in fodder production, is including it to the main component of food for cattle and monogastric animals (Dubas, 2004; Radzyńska and Szymańczak, 2010). In case of seeds, costs of production of one energy unit are lower than for other grains. From one hectare of a corn plantation 7-10 tonnes of dry seeds may be obtained. It should be mentioned that also price of energy included in the corn silage is one of the cheapest among the volumetric fodders. In Poland, cultivation of corn is strictly related to the zoning. Therefore, particular climatic regions are referred to a relevant variety. Corn cultivation is the highest in the following voivodeships: Dolnośląskie, Opolskie and Wielkopolskie (Księżak, 2008).

The symptom of full maturity of a seed is the so-called black spot stage, namely, a small black spot at the base of the caryopsis next to a germ. Early variety reach full maturity in September whereas middle-late varieties in October. Corn for seeds may be harvested when the water content in seeds, in relation to a variety is within 31-37%. A two-stage method is used at the harvesting of corn for seeds where the smallest damage to seeds occurs. Then, a full-value sowing material is obtained. The first stage consists in harvesting cobs and their barking. Cobs after teh removal of covering leaves are dried in the temperature that does not exceed 42ºC (Sęk and Przybył, 1998; Grundas et al., 2002; Kowalik, 2011; Szymanek and Dreszer, 2011; Bieniek, 2013). Threshing takes place when the water content in seeds drops below 15%, sometimes threshing is carried out at the moisture of approx. 18% with later additional drying of seeds. The sowing material, which must be of a high class is prepared and stored by Seed Central Station. The objective of the research was to carry out the quality assessment of the operation process of the HEID technological line threshing unit for corn cobs.

Place and subject matter of the research

The research was carried out in SAATBAUS POLSKA Sp. z o.o. in Środa Śląska. The object of the research consisted of the threshing and abrasive unit CIMBRIA HEID (figure 1), which is included in the HEID technological line for after-crop treatment of corn cobs. Before threshing, cobs were dried. After drying, corn cobs are transported to an abrasive machine, where cobs are threshed with the force produced by an engine and due to rubbing of cobs against each other and with smooth, rounded rotor ribs. Separated seeds fall down through slits between the cage bars towards the outlet, whereas rachises are transported to the end part of the machine, where the outlet channel is placed. In the next stage, the corn seed is transported to the separator and cobs rachises are transported with belt conveyors outside the building (The Manual of the abrasive machine MR20 PNr 609038).

Five corn varieties were selected for the research: *Bosman*, *Odilo, Okato, SL Enormo, Wikana*. Corn cobs were harvested in the physiological maturity stage after approx. 2 weeks after the so-called black spot appeared. Bourgoin JDL 410D and Bourgoin GX 406A were used for harvesting (Molendowski, 2006).

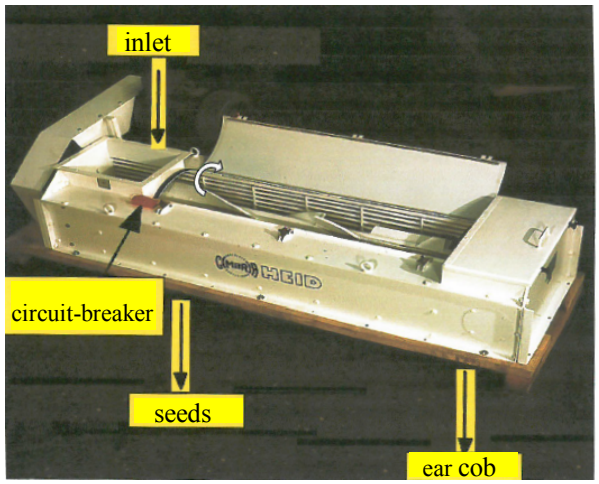
Bosman is a mixture of the Semi Flint caryopses type. The variety is characterized with big cylindrical cobs. This plant is high, well leaved, and resistant to lodging with high content of starch in a seed. It is a variety of an intensive nature, showing a very high potential of cropping on better soil test stands. The second researched variety was *Sl Normo.* It is a variety which is lodging resistant and has a high crop of dry and fresh mass. It belongs to middle-early single mixtures with the Semi Flint caryopses type.

Odilo variety is a single mixture of corn with an early time of maturity and the Semi Flint caryopses type. When cultivating *Odilo* variety, very high crops of silage with high starch content may be obtained. This variety is characterized with a perfect early vigour and high yield of dry mass.

Okato is a middle-early seed variety, of a single mixture of Saatbau Linz variety. It is characterized with Semi Flint caryopses, high mass of thousand seeds, wholesomeness and mainly with lodging resistance.

Wikana is the fifth investigated variety. It is a three-line mixture characterized by high crop of fresh and dry mass of silage. Moreover, it has wholesome cobs and low susceptibility to lumpy smut, stem and root lodging.

a)



b)

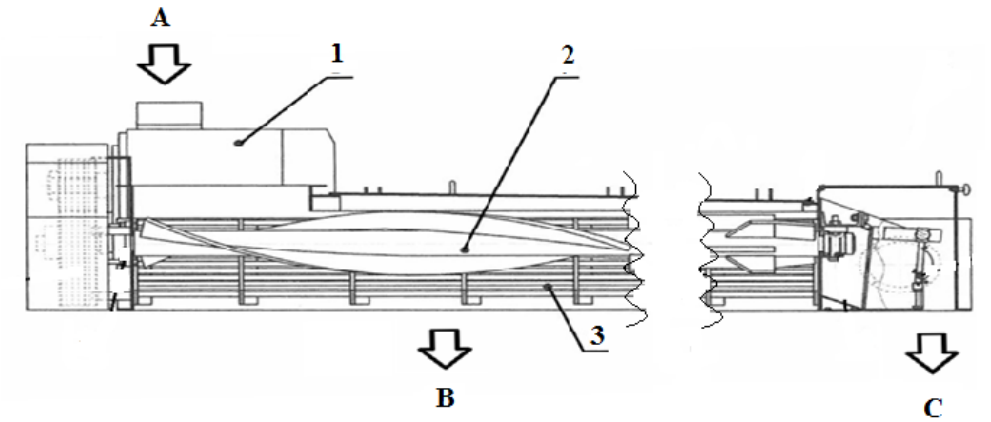


Figure 1. Huller MR 20: a – view, b– scheme: 1 – motor, 2 – rotor, 3 – wire screen, A – ear cob inlet, B – grain falling through the bars of the cage, C – outlet corn cobs (Source: Manual huller MR20)

Methodology of research

Assessment of the quality of the exploitation process of CIMBRIA HEID MR20 threshing unit was carried out through analysis. The most important factors were macro and micro damages of seed and the seed germination capacity and energy after threshing. Tests were carried out in two stages. In the first one, corn material was obtained before transferring it to the threshing unit. In the second one, material samples were obtained after the material left the abrasive machine. Each time after the first and the second stage, moisture of the material was determined. All tests were carried out in 15 repeats for each variety. Output mass of each sample was 15 g. Seeds before and after threshing were subjected to the visual control and those, where damages were reported were weighed. Whereas, in order to determine damages in the remaining mass, it was bathed in Lugol's iodine. After 40 minutes a dye was filtered with a sieve. With the use of a magnifying glass, micro-damages to caryopses in the form of dark spots on the seed were determined. All seed samples were weighed with a precision up to 0.1 g. Tests with regard to the germination capacity and energy were carried out in the laboratory of SAATBAU POLSKA Sp. z o. o. company.

Research results and their analysis

According to the norm PN-94/R-74015, which defines the quality requirements for corn, the maximum number of seeds may not exceed 10%. The results, which were obtained, show that only one variety exceeded this border. Analysing of the number of micro-damages in the seeds, showed that the biggest damages before threshing occurred at *Okato* variety (4.2%), then *Bosman* (1.3%), *Wikana and Sl Enormo* (0.5% each) and *Odilo* (0.1%). After threshing the following macro-damages occurred: *Okato* (13.3%), *Bosman* (2.8%), *Odilo* (1%), *Wikana* (0.5%) and *Sl Enormo* (0.35%). Whereas the biggest micro-damages before threshing occurred for: *Okato* (1.17%), *Bosman and Odilo* varieties (0.67%). In case of *Wikana* and *Sl Enormo* varieties no damages were reported. After threshing, the biggest micro-damages occurred for the following varieties: *Okato* (14.5%), *Bosman* (7.2%), *Sl Enormo* (0.83%) and in case of *Wikana and Odilo* (0.5%). A variety with the biggest macro- and micro-damages before and after threshing is *Okato*variety. *Wikana* and *Sl Enormo* varieties had the same number of damages, they differed only with a percentage content of micro-damages after threshing. Before threshing, the percentage content of micro-damages of *Odilo* variety was 0.67% and was higher than after threshing (0.5%). The research proved that the biggest macro- and micro-damages occurred in case of *Okato and Bosman*. These varieties had the moistest seeds.

Moisture of the tested varieties before drying was within 37.6-42.1%. According to the norm PN-R-74104 the seed moisture after drying should not exceed 14.5%. It was found out that any of the investigated varieties after threshing did not exceed this border (table 1). Moisture was within 11.2-12.8%. Varieties *Okato and Bosman*had the highest moisture of corn cobs before drying and after drying the moisture was higher in comparison to other

varieties. It can be justified by the fact that these varieties have thick and big cobs, which influences the prolongation of the drying time. The lowest moisture before drying was in case of *Wikana variety* (37.6%), which after drying had 11.4% of moisture. *Sl Enormo* variety before drying had moisture of 37.8% and after drying the lowest from all the investigated varieties (11.2%). Both varieties had the lowest moisture of seeds both before as well as after drying.

Table 1
Moisture of corn ear cobs

Corn variety	Moisture (%)	
	Before drying	After drying
Okato	41.8	12.8
Bosman	44.1	12.3
Odilo	39.3	11.9
Wikana	37.6	11.4
Sl Enormo	37.8	11.2

Seeds viability, which may be determined with the germination capacity and energy is one of the significant quality properties of seeds. Table 2 presents a percentage participation of the germination size of the investigated varieties. Each variety was characterized with greater germination capacity and energy. *Okato*had the lowest germination capacity and energy, then *Bosman, Odilo, Sl Enormo and Wikana*. *Wikana and Odilo* had the same germination capacity which was 95%. However, the first one had 3% higher germination capacity. Germination capacity and energy depended on the investigated variety.

Table 2
The capacity and energy of germination of the tested sub-species

Corn variety	Germination (%)	
	Germination energy	Germination capacity
Okato	79	82
Bosman	82	85
Odilo	89	95
Wikana	92	95
Sl Enormo	92	96

In the final stage of research, a statistical analysis of the obtained results was carried out. When comparing results of macro-damages after threshing, it was reported, that the highest average and the standard deviation as well as the median was in case of *Okato* variety (table 3). While, the lowest statistical figures were for *Sl Enormo* variety. Whereas, when discussing macro-damages of seeds after threshing, it was reported that *Okato*variety had the biggest arithmetic mean, median and standard deviation. In case of micro-damages before threshing, the lowest mean, median and standard deviation appeared for *Wikana and Sl Enormo* (table 3).

Table 3
Statistical analysis of macro- and micro-damages before and after threshing

Variety of corn	Type of damages (%)					
	Macro-damages					
	Before threshing			After threshing		
	Arithmetic mean	Median	Standard deviation	Arithmetic mean	Median	Standard deviation
Okato	4.17	3.33	1.67	13.33	12.33	3.84
Bosman	1.33	2.33	1.89	2.83	2.33	0.75
Odilo	1.1	1.33	0.47	1	0.33	0.59
Wikana	0.5	0.33	0.23	0.5	0.33	0.24
Sl Enormo	0.5	0.67	0.21	0.34	0.33	0.11
	Micro-damages					
Okato	1.17	0.67	0.48	14.5	12.33	6.58
Bosman	0.67	0.67	0.24	7.2	7.67	2.95
Odilo	0.67	0.67	0.22	0.5	0.33	0.23
Wikana	0.0	0.0	0.0	0.5	0.43	0.21
Sl Enormo	0.0	0.0	0.0	0.67	0.43	0.36

According to the statistical analysis, in each case the standard deviation did not exceed 40% of the mean, which in case of a non-uniform biological material is an acceptable value and proves the repeatability of results.

The obtained results of relative values of macro- and micro-damages of seeds were presented in figures 2 and 3. Both in the first as well as the second case, according to presumptions, their increased values occurred after threshing. In case of macro-damages, their relative value in border cases increased by approx. 330% and in case of micro-damages even by 500%, which does not mean that these are non-acceptable values.

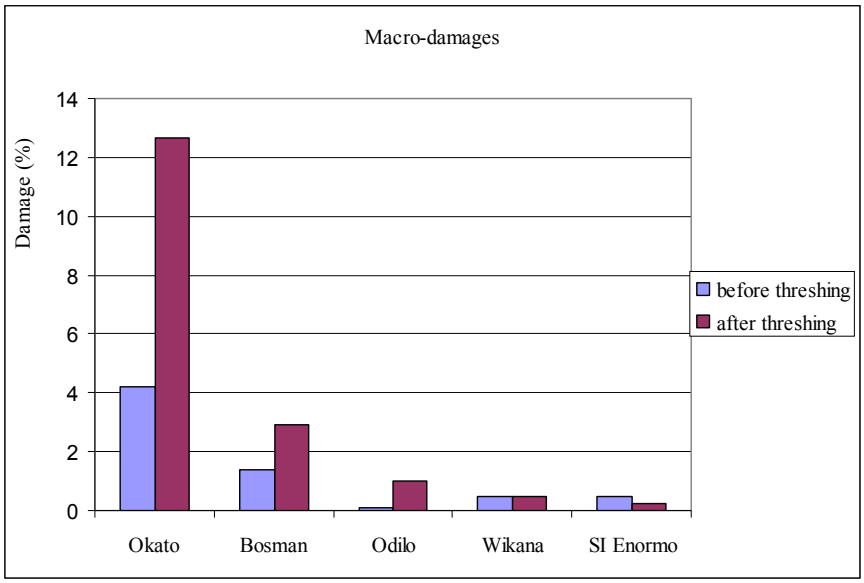


Figure 2. Macro-damages before and after threshing

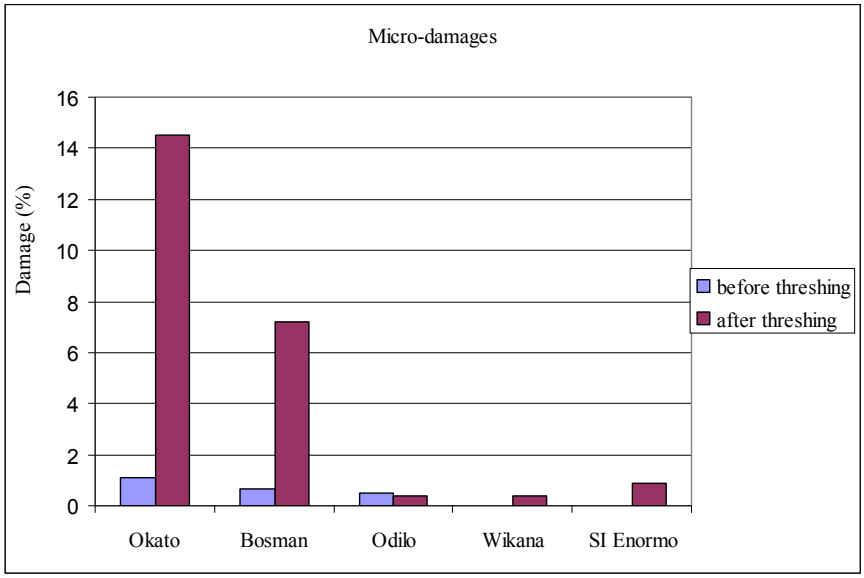


Figure 3. Micro-damages before and after threshing

Conclusions

1. *Bosman (44.1%)* and *Okato* (41.8%) varieties had the highest moisture of corn cobs before drying. The lowest moisture before drying was in case of *Wikana variety* (37.6%), which after drying had 11.4% of moisture. For the investigated corn varieties the cobs moisture after drying did not exceed the admissible norm.
2. Number of damages, capacity and energy of germination of seeds is strictly related to a variety. The biggest macro- and micro-damages before and after threshing were in case of *Okato* variety. This variety had also the lowest capacity (82%) and energy of germination (79%). Whereas the smallest damages before and after threshing were reported for *Wikana* and *SI Normo,* varieties, they also had the biggest capacity (95-96%) and energy of germination (92%).
3. When assessing the quality of operation of HEID line threshing unit, it may be stated that the technological process performed by it guarantees obtaining the sowing seed quality of corn with parameters pursuant to applicable norms.

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OCENA JAKOŚCI PROCESU EKSPLOATACJI ZESPOŁU OMŁOTOWEGO KOLB KUKURYDZY LINII TECHNOLOGICZNEJ HEID

Streszczenie. W artykule przedstawiono ocenę jakości pracy zespołu omłotowego linii technologicznej HEID w firmie SAATBAU Sp. z o. o. w Środzie Śląskiej. Oceny łuszczarki CIMBRIA dokonano na podstawie powstałych po omłocie makro i mikrouszkodzeń ziarna oraz poprzez określenie jego siły i energii kiełkowania ziarna. Badania przeprowadzono dla pięciu odmian kukurydzy: *Bosman, Sl Normo, Odilo, Okato, Wikana.* Do wyznaczenia uszkodzeń mechanicznych ziarna wykorzystano metodę kolorymetrii. Największe makro- uszkodzenia ziarna stwierdzono na poziomie 4,2%, a mikrouszkodzenia na poziomie 14,5%. Zwiększone wartości uszkodzeń występowały po jego omłocie. Największa siła kiełkowania wynosiła 96%. Na tej podstawie stwierdzono, że jakość procesu eksploatacji zespołu omłotowego odpowiadała normie.

Słowa kluczowe: łuszczarka, uszkodzenia mechaniczne, odmiana, ziarno kukurydzy