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Maize Grain Damage during Harvest

Through mechanical stress from impact and friction during maize grain harvest considerable losses in quality and quantity occur. Besides the threshing and separating elements, other element's design, combine settings and, very significant, material properties (maize variety, cultivation conditions, grain moisture content) affect grain damage. The factors causing grain damage and Hohenheim experimental results from various test rigs are reported about.

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Dedicated to Prof. Dr. Ing. Dr. h.c. H. D. Kutzbach on occasion of his 65th anniversary.

Keywords

Combine, maize, damaged grain

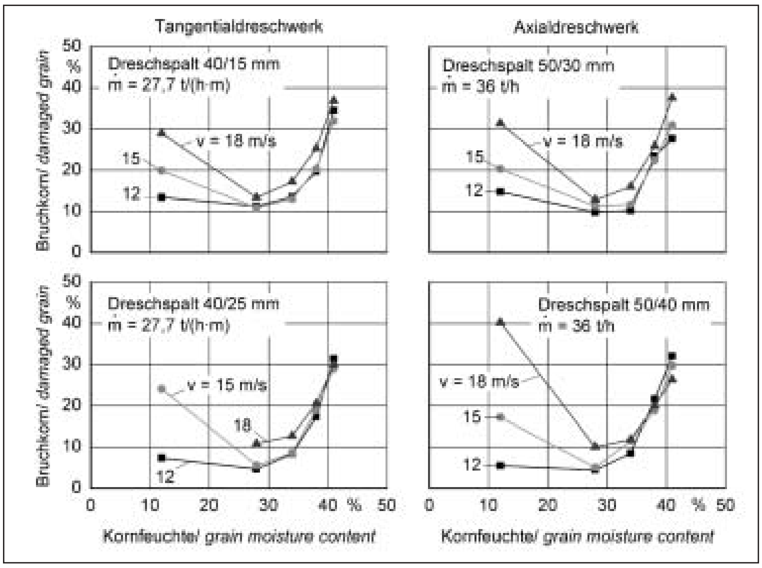

Fig. 1: Influence of grain moisture content on damaged grain in a tangential threshing unit (left) and in an axial threshing unit (right)

Maize grains are subject to multiple strain during harvest (started with picking the corncob and following the threshing in the combine). The harvest of maize for feed and consumption goods is mostly carried out by a combine with a maize picking header. Due to mechanical strain during harvest, important losses in mass and quality occur.

In this paper selected examples about the influence of threshing and separating systems, grain moisture content, peripheral speed and total throughput on grain damage will be reported.

Consequences of grain damages

Cause by intensified competition, quality goods are more and more asked for, so that maize batches with high parts of damaged grain are charged with an higher price reduction.

Losses in quality of seed consist predominantly of interference of germination capacity. Damaged grain can only be sold as animal feed [1]. But also with consumption and animal feed grain damages have negative effects. On the one side there is a reduction of quality, because of non optimum storage. This results in an increase of microorganisms and it abets the spoilage. On the other side losses of mass arise, because of small pieces of damaged grain. These pieces are blown onto the field by the cleaning unit. After tests in Hohenheim with winter wheat these losses are between 0.5 and 2 % of the total grain mass [2].

Causes of for grain damage

The task of a combine is to detach the grain from the cobs, separate the grain from the material other than grain (MOG) and collect the complete, clean and undamaged grain into the grain tank. To attain this the harvested material is processed mechanically by different working elements. In doing so, the mechanical strain can also result in grain damages. The grain is stressed intensely especially in the threshing unit of the combine, which has to detach the grain from the ears and to separate a high part of the grain.

The grain is hardly stressed by the cutting platform, the straw walker for maize-straw-separation and by the cleaning unit. The mechanical strain is bigger during grain conveyance to the grain tank and during emptying the grain tank.

The settings and adjustments of the combine and specially the physical properties have a great influence on grain damages besides the constructive design, the formation of these working elements and the threshing- and separation-system [3].

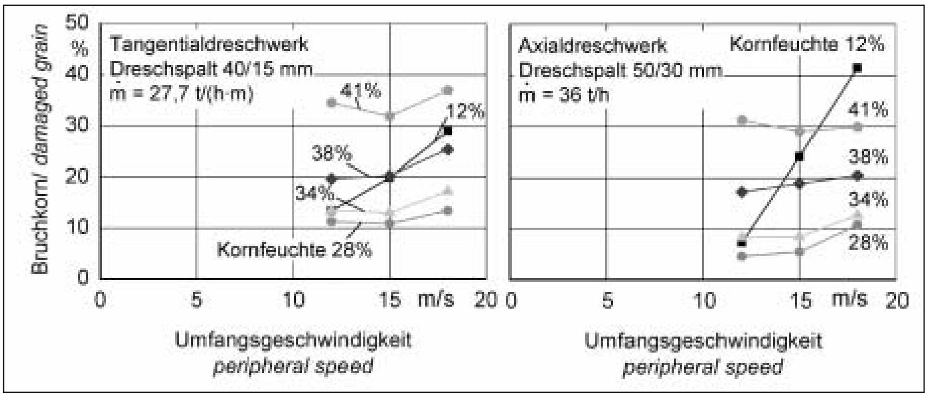

Fig. 2: Influence of peripheral speed on damaged grain in a tangential and an axial threshing unit

Test set-up and test performance

To determine the working quality of combines analysis on different test stands with freshly harvested and stored winter wheat are carried out in Hohenheim. They also determine the influence on grain damage [4]. The tests are carried out with axial and tangential threshing units.

The tested axial threshing unit has a rotor of 2.82 m length and a diameter of 0.61 m. The test material was conveyed through a feeder-house axial to the rotor. The tested tangential threshing units with rear beater had a threshing cylinder diameter of 0.45 m resp. 0.56 m plus a threshing cylinder width of 1.27 m, 1.30 m and 1.40 m. The assembly of the test stands was partly described in the LANDTECHNIK [2].

The fresh harvested test material had a grain moisture content between 28 and 41% w.b. depending on testing day and testing year. It was picked up partly by hand and partly with a corn picker with switched of husker. Grain moisture content between 9 and 12% w.b. was attained by a bin-drier, with ambient air.

The maize ears in husks are evenly distributed on a conveyor belt (length of 6 m) and conveyed to the different threshing units. The period of the test was between 7 and 10 s. This time was sufficient for the threshing procedure of axial and tangential threshing units but not to asses the deposition performance of the walkers. As there are no or nearly no grain damages by the straw walker, the damaged grain can be applied to the total volume to ascertain the grain damage by tangential threshing units.

The separated maize was collected and analysed. The separated grain samples (each 100 g) were tested for damages. Undamaged means that there were no visible changes (clefts, plastic deformation).

Results

Influence of threshing and separating system
Grain damages of the tangential threshing units are higher than the grain damages of the axial threshing unit, which was tested at the same time, except for a grain moisture of 12% w.b. and a peripheral speed of 18 m/s (*Fig. 1*). Among other things, the reason is the lower grain separation of nearly 10% of the threshing concave, compared to the axial threshing unit. The part of the grains, which has to pass the small concave clearance on the whole length of the threshing concave is relatively high. Thereby it will be intensively processed. The adjustment of the concave clearance (15 resp. 25 mm at a tangential and 30 resp. 50 mm at a axial threshing unit) has a very less influence on the grain damages by both, the threshing and the separating systems, because of a higher grain separation of the threshing concave when the clearance is narrower.

Influence of the crop properties
Fig. 1 and Fig. 2 show the influence of grain moisture to the grain damages clearly. Dry grain (Uk = 11% w.b.) appears higher damaged. At this extremely low grain moisture, which cannot be reached at harvest in Germany, the maize grains get damaged at the first touch with the threshing unit, so the peripheral speed has also a high influence. With a grain moisture between ~25 and 28% w.b. grain damages are on the lowest point. Kustermann [1] found out a similar influence of the grain moisture. At crop moisture over 28% w.b. the grain gets softer and is squeezed very fast, so the grain damages rise. There are differences in susceptibility to grain damages according to the grown varieties of maize [3].

Influence of the adjustment and settings
The throughput has a relative lesser influence on grain damage. At a grain moisture of 9% w.b. the damages got a bit lower, at higher grain moistures of 30% and 39% w.b. they stay nearly constant (*Fig. 3*).

The dependency of peripheral speed of the threshing unit is clearly cognizable. Already at a speed of 15 m/s there are very low threshing losses and a high grain separation at the concave. The peripheral speed is limited downwards by insufficient threshing and upward by grain damages too high.

Conclusions for practice

Grain damages are normally lower, as sooner the grain is separated in the threshing unit and detracted of further mechanical strain. But the strain must not pass a special maximum value at the beginning (too high peripheral speed of the threshing unit).

Because of a little influence of the concave clearance on grain damage, it should be adjusted as narrow as possible. The peripheral speed of the drum must be as high to attain a sufficient threshing result.

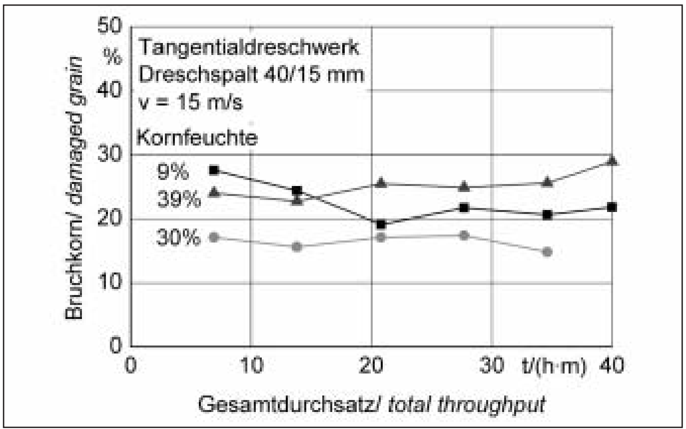

Fig. 3: Influence of total throughput on damaged grain at different grain moisture content

Literature

Books are identified by •

[1] • *Kustermann, M.*: Beanspruchung realer Körper durch Stoß - dargestellt am Beispiel des Schlages gegen ein Maiskorn. Forschungsbericht Agrartechnik MEG 245, Dissertation, Universität Hohenheim, 1994

[2] *Wacker, P.*: Einflüsse auf die Kornbeschädigung bei Axial- und Tangentialdreschwerken. Landtechnik 45 (1990), H. 6, S. 222-224

[3] *Hugger, H. und L. Laurenz*: Für Körnermais die richtige Sorte wählen. top agrar 32 (2003), H. 2, S. 58-62

[4] *Wacker, P.*: Testberichte des Lehrstuhls Grundlagen der Agrartechnik (unveröffentlicht)