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ON THE POSSIBILITIES OF UTILIZING THE RESULTS OF INVESTIGATIONS OF THE GRAIN-TO-EAR BINDING FORCE AT THE OPTIMIZATION OF THE REGULATION PARAMETERS OF HARVESTING-THRESHING MACHINES

Zbigniew Ślipek, Janusz Kolowca

INTRODUCTION AND THE PURPOSE OF THE WORK

Investigations of the grain-to-ear binding force are carried out, among others, with the thought of utilizing the results for the determination of the usability of varieties for mechanized harvesting. Interpretation of the results of these investigations is often based on a priori and at the same time rather obvious assumption that grains held in the ear the weakest can fall out at the action of the rake or the cutting system, while in the case of a strong grain-to-ear bond the used parameters of the threshing system are often not enough to extract grain from the ear [2, 3, 7, 8, 9, 10]. Obviously this assumption is based on the extreme values of distribution. Because, however, of the relatively high variability of the binding force it is possible to suppose that the effect of grain extraction during harvesting can also be influenced by the average values from the variability range determined for a given variety. This would be, of course, connected with the necessity of an exact determination of the distribution of the binding force, which was already mentioned in paper [6] analyzing the theoretical possibilities of unthreshed grain and grain damage occurence in the threshing system for the distributions of the binding force and grain resistance, differing as to assymetry and excess.

The above reasons influenced the carrying out of investigations, the purpose of which was an attempt at determining whether the increase rate of grain losses at a change of regulation parameters of the rake and the threshing drum is in any relation to the character of the binding force distribution.

METHODOLOGY AND CONDITIONS OF INVESTIGATIONS

The investigations were carried out in 1974 in the harvesting period of two wheat varieties

— Kaukaz — winter wheat,
— Carola — spring wheat,

cultivated in the Regional Experimental Station in Mydlniki.

For these varieties parallel measurements of the binding force and of the grain losses caused by fall-out and leaving unthreshed grains at harvesting with the „Bizon-Super" combined harvester were carried out.

For the determination of the grain-to-ear binding forces a centrifugal method was applied [4]. The application of this method, ensuring the rapid carrying out of measurements on a large population of ears, was justified by the purpose of the investigations. Thus the sample for the determination of the distributions of the binding force was 100 ears for each variety, which, in the opinion of the literature of the subject, constitutes a representative sample [7]. The distributions of the binding forces were approximated with Weibull's distribution, and for the estimation of the distribution parameters the graphic method was applied [5].

For the determination of fall-out and unthreshed grain leaving the generally used methods for investigations of combined harvesters and threshing machines were applied [1, 11]. Fall-out of grain was determined at the following angular velocities of the rake: 1.57, 2.09, 2.62, 3.14

Table 1

Properties of the harvested wheat varieties

Properties	Variety	
	Kaukaz	Carola
Grain moisture (%) (mean value from 5 measurements)	18.0	19.6
Straw moisture (%) (mean value from 5 measurements)	16.9	18.1
Crop yield (q/ha) (mean value from 5 measurements)	25.4	22.4
Relation of grain weight to straw weight (mean value from 5 measurements)	1 : 1.61	1 : 1.72
Mean length of stalks (m) (mean value from 30 measurements)	1.02	1.34
Mean length of ears (m) (mean value from 30 measurements)	0.092	0.087
Weed content (%) (mean value from 5 measurements)	2.0	0.9
Lodging of plants	standing	standing

rad/sec, the extreme values of which comprized the regulation range constructionally determinaed for this combined harvester.

Measurements of the unthreshed grain leaving were carried out at the following angular velocities of the threshing drum: 73.3, 83.7, 94.2, 104.7 rad/sec, and the highest value ω corresponded to the upper limit of regulation of angular velocity of the threshing drum constructionally determined. The size of the working slot between the drum and the concave was set so as to obtain the lowest possible quantity of unthreshed grain in the Kaukaz variety (for which the expected volue was higher than for the Carola variety) at the threshing drum value $\omega = 104.7$ rad/sec.

During the investigations the following parameters were recorded:

1) properties of the harvested varieties of wheat (Table 1),
2) atmospherical conditions (Table 2),
3) working parameters of the rake and the threshing system (Table 3)

Table 2

Atmospherical conditions during investigations

Conditions	Variety	
	Kaukaz	Carola
Relative air moisture (%)	71—77	80—83
Temperature (°K)	257.7—256.9	252.8—250.6
Cloudiness	little	little

Table 3

Technological working conditions of the rake and threshing system at the harvesting of the investigated varieties

Moving speed of the harvester	m/sec	0.49—0.65
Angular velocity of the rake	rad/sec	1.57—3.14 graded at every 0.52 rad/sec
Position of the rake	—	fronting-maximum to the front, before the cutting system, height--so that the boards hit ears
Position of the fingers of the rake	—	vertical
Angular velocity of the threshing drum	rad/sec	73.3—104.7 graded at every 10.48 rad/sec
Size of the working slot between the drum and the ccncave	mm	16/3 (inlet/outlet)
Feeding of the threshing system with cereal mass	kg/sec	1.0—1.52

RESULTS OF THE INVESTIGATIONS

Distributions of the grain-to-ear binding force in the investigated varieties were not statistically the same (this was established by verifying the agreement of the distributions with the λ test of Smirnov-Kolmogrov at the significance level $\alpha = 0.05$). Parameter values of the Weibull's distribution for the obtained distributions of the binding forces are presented in Table 4. The values of these parameters indicate that for the Kaukaz variety the distribution curve was lower and comprised a wider variability area than the Carola variety.

Table 4

Values of the Weibull's distribution parameters for the obtained distributions of the binding forces

Parameters	Variety	
	Kaukaz	Carola
Position parameter — x_o (N)	0.2	0.15
Shape parameter	1.6	2.0
Scale parameter	3.32	8.17

Thus, according to the posed hypothesis, if there is a relationship between the character of the distribution of the binding force and the effect of grain extraction at different regulation parameters of the rake and the threshing drum then for the Carola variety an increase of the action intensity of the rake should cause a faster increase of losses through fall-out. In turn a decrease of the angular velocity of the threshing drum (at the remaining working parameters of the threshing system unchanged) should cause a slower increase of unthreshed grain in the Kaukaz variety.

Table 5

Grain fall-out in relation to the kinetic coefficient of combined harvester

Variety			
Carola		Kaukaz	
	Grain fall-out (%) (mean values from 9 measurements)		Grain fall-out (%) (mean values from 9 measurements)
1.14	0.17	1.26	0.05
1.67	1.31	2.16	0.47
2.31	1.48	2.49	1.00
2.98	3.30	3.35	2.13

Table 6

Unthreshed grain in relation to the angular velocity of the threshing drum of combined harvester

rad/sec	Variety	
	Carola	Kaukaz
	unthreshed grain %	mean values from 3 measurements
73.3	4.37	3.36
83.7	1.37	1.80
94.2	0.28	0.83
104.7	—	0.04

It is possible to interpret in a similar way the obtained results of investigations of grain losses at the harvesting of these varieties. The volume of the losses is presented in Tables 5 and 6 — in the function of the kinetic coefficient of the rake and the angular velocity of the threshing drum respectively. It should then be stated that the investigations have confirmed the assumptions presented in paper [6] and thus make it possible to draw conclusions as to estimated grain losses (so far not yet in numbers) and about possibilities of diminishing them through appropriate regulations of the mentioned working elements of combined harvester.

CONCLUSION

The above presented results confirmed the assumed hypothesis, the authors however realize that the presented results of investigations of this type do not solve fully the problem of relating the laboratory results with harvesting technology. It will be necessary to state at what smallest differentiation of the distributions of the binding forces there occur significant differences in the volume of losses caused by fall-out and leaving unthreshed grains. This could have a vast significance in the working out of "scientific" principles of proper regulation of the particular working systems of harvesting machines.

REFERENCES

1. Brudnik T.: Metodyka badań młocarń. PIMR, Poznań 1958.
2. Burmistrowa M. F., Komolkowa T. K.: Fizyko-mechaniczeskije swojstwa sielkochozjajstwiennych rastienij. Gosudarstwiennoje izdatielstwo sielsko-chazjajstwiennoj litieratury. Moskwa 1956.

3. Ďuriš M., Havelka J., Turček J.: Možnosti lepšieho využitia mechanizačných prostiedkov pri zbere ibilnín. VSP Nitra 1968.
4. Gąska R., Ślipek Z.: Metoda wirówkowa badania siły wiążącej ziarno w kłosie. Rocz. Nauk rol. 1974, t. 72, s. C, z. 2.
5. Grzesiak K., Kołodziejski J., Metzel Z.: Badania trwałościowe obiektów technicznych. WNT 1968.
6. Haman J., Szot B.: Badania sił wiążących ziarno z kłosem. Rocz. Nauk rol. 1974, t. 71, s. C, z. 2.
7. Preininger M., Maleř J., Malšova M.: Pevnost spojeni zrna s klasem u pěstovanych odrud pšenica. Zemědělská Technika, nr 14, 1968.
8. Řezniček R.: On the Experimental Examination of Bond Strenght of Grain on the Ear. Journal of Agric. Engng. Res. 4, 1970.
9. Tomovčík J., Ďuriš M., Pisar E., Korejtko J.: Výskum agrofizikálnych a mechanických vlastnosti ozimých pšenic. Zemědělská Technika nr 9, 1963.
10. Wasilenko J. F., Awdiejew M. E., Morozow A. F., Sołowiew W. M.: Ziernowyje kombajny CCCP i zarubieżnych stran. Sielchozgiz 1958.
11. Zbiorowa. Metodyka badań kombajnów zbożowych dla SOSR. Zakład Maszyn Rolniczych II. IMER, Kłudzienko 1963.

Z. Ślipek, J. Kolowca

O MOŻLIWOŚCI WYKORZYSTANIA WYNIKÓW BADAŃ SIŁY WIĄŻĄCEJ ZIARNO W KŁOSIE DLA POTRZEB ZBIORU MECHANICZNEGO

Streszczenie

Przeprowadzono pomiary strat ziarna powodowanych przez osypywanie i niedomłot dla dwóch odmian pszenicy różniących się rozkładem siły wiążącej. Siłę wiążącą ziarno w kłosie wyznaczono metodą wirówkową.

Porównanie wyników badań laboratoryjnych (siły wiążącej) i polowych (osypywanie, niedomłot) wykazało, że tempo przyrostu strat ziarna przy różnych wartościach wskaźnika kinematycznego nagarniacza, jak również prędkości kątowej bębna młócącego nie było jednakowe u badanych odmian.

Tak więc metoda wirówkowa badania siły wiążącej ziarno w kłosie może znaleźć zastosowanie przy optymalizacji parametrów regulacyjnych niektórych zespołów roboczych maszyn żniwnych lub optymalizacji technologii zbioru zbóż.

З. Сълипек, Я. Колёвца

О ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ РЕЗУЛЬТАТОВ ИССЛЕДОВАНИЙ СИЛЫ СВЯЗЫВАЮЩЕЙ ЗЕРНО В КОЛОСЕ ДЛЯ ПОТРЕБНОСТЕЙ МЕХАНИЧЕСКОЙ УБОРКИ

Резюме

Провели измерения потерь зерна, вызванных осыпанием и недомолотом, для двух сортов пшеницы, отличающихся друг от друга распределением силы связывания. Силу связывания зерна в колосе определяли центрифугальным методом.

Сравнение результатов лабораторных исследований (сила связывания) и полевых (осыпание, недомолот) показало, что темп прироста потерь зерна при различных значениях кинематического показателя мотовила, как и угловой скорости молотильного барабана, не был одинаков у исследуемых сортов.

Таким образом центрифугальный метод исследования силы связывания зерна в колосе может найти применение при оптимализации регулировочных параметров некоторых рабочих органов уборочных машин или при оптимализации технологии уборки зерновых.

Address of the authors

Dr Ing. Zbigniew Ślipek, Dr Ing. Janusz Kolowca,
Institute of Agricultural Mechanization and Energetics, Agricultural Academy,
ul. Balicka 102, 30-149 Kraków, Poland