APPLICATION OF THE SHOCK METHOD FOR THE DETERMINATION OF THE GRAIN-TO-EAR BINDING FORCE

Jan Gieroba

INTRODUCTION

In the age of dynamically developing mechanization of processes in agriculture the getting to know the physical properties of agricultural materials is a very important matter. One of the more important properties, from the point of the course of threshing and the lowering of grain losses, is the "threshability" of cereals determined by the value of the grain-to-ear binding force. This force changes depending on the type and variety of cereal, level of maturity, moisture, and other factors.

The knowledge of the value of the grain-to-ear binding force is important in the breeding of varieties resistant to grain shedding during ripening, and for harvesting technologies and the course of the process of threshing. Varieties susceptible to grain shedding caused by the changing atmospheric conditions, and by the hitting of stalks and ears by the working elements of harvesting machines during harvesting, are the cause of considerable, and difficult to avoid, losses of grain.

For the determination of the force necessary to remove grain from ear several methods have been worked out, which can be divided into direct and indirect ones [5].

In the direct methods grain is removed from ears with the help of special apparati. Investigations with the application of tensometric apparatus were carried out by Řezniček [4] in Czechoslovakia. In the Institute of Agrophysics of Polish Academy of Sciences in Lublin a special electromagnetic micropicker [6] was constructed, with the help of which investigations of various varieties of winter wheat, spring wheat and rye were carried out. The extraction of single grains from ears were in this method done in two ways:

— the grain was held with precision pliers,

— to the grain a tiny steel wire was glued with a special mass, and the other end of it was fitted in the holder of the apparatus.

The mentionad apparati allow for the recording of the course of measurement of forces necessary to extract grain from ears.

The indirect methods, not requiring complicated apparati for investigations, can be divided into:

— centrifugal,
— vibrational,
— shock.

The enumerated methods allow for a relatively rapid making of measurements, though there is also the fault consisting in the difficulty of grasping the relationship between the weight of grain and the value of force necessary to extract in from ear [8].

One of the more interesting indirect methods, allowing for the rapid making of a large number of measurements both in field and laboratory conditions is the shock method with the application of Pustygin's apparatus, called the threshability classifier.

The purpose of the present work was to construct the mentioned apparatus on the basis of Pustygin's works [3] and to carry out investigations of different varieties of wheat and rye.

THE CONSTRUCTION OF THE APPARATUS AND THE COURSE OF INVESTIGATIONS

The investigation apparatus, constructed in the Institute of Mechanization of Agriculture of the Agricultural Academy in Lublin [1], presented in Fig. 1, allows for the extraction of grains from ear with the help of the action of inertia forces.

The apparatus consists of a base *1*, movable lever *2*, a container for grain *3*, a rack *4*, a screw for the fixing of ears *5*, and a spring *6*.

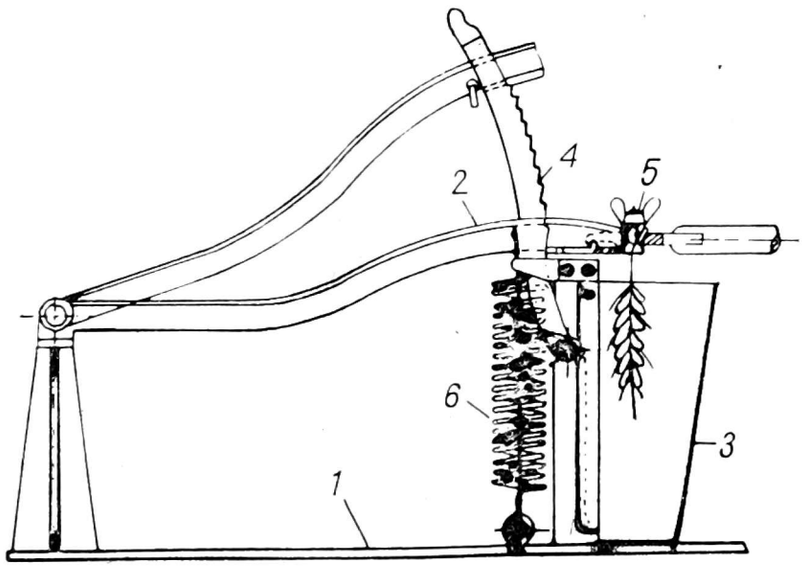

Fig. 1. Diagram of the threshability classifier

Single ears subjected to investigations were fixed in the screw of the lever giving them appropriate speed by utilizing the energy of the spring streched within certain limits.

The threshability classifier allows for the obtaining of the speeds of lever with ear in the range from 1 to 13 m/s, depending on the degree of streching the graded spring and on the position of the lever on an appropriate level of the rack. After the decline of the rack the lever hits the rubber bumper at a certin speed, is stopped abruptly with the ear, and the extrected grain falls down into the container. The extraction of grain occurs when the inertia force operating on the grain is higher than the force necessary to break the connection between grain and ear.

Every ear is subjected to shocks succesively on each level of the rack, up to complete threshing. Knowing the weight of grain and its speed the kinetic energy at the moment of grain extraction, used for the work for the extraction of grain, is calculated.

RESULTS OF INVESTIGATIONS

The investigations, carried out in the years 1969 and 1975, comprised 15 varieties of rye and *Triticale* and 13 varieties of wheat, cultivated in the Agricultural Experimental Station in Czesławice. Ears for measurements were taken in four terms:

— wax maturity,
— full maturity,

Table 1

Mean forces necessary to extract grain from ear for different varieties of wheat [2]

No.	Variety	Value of force (G) terms of investigations			
		I	II	III	IV
1	Heins	185.1	151.7	183.2	121.0
2	Szalejewska	210.0	184.3	183.9	152.1
3	Modzurowska	184.0	98.0	172.0	123.0
4	Eka Nowa	200.0	151.4	180.6	99.3
5	Olza	186.1	185.7	183.6	180.7
6	Małgorzatka Udycka	200.0	180.7	122.8	75.0
7	Wysokolitewka Sztywnosłoma	205.7	186.7	151.4	151.1
8	Leszczyńska Wczesna	126.8	96.6	123.4	73.3
9	Mironowskaja	185.4	122.6	75.0	95.6
10	Bezostnaja	207.1	177.3	97.7	75.0
11	Kutnowianka	185.0	149.1	123.2	121.7
12	Dańkowska Biała	184.3	151.6	96.4	122.0
13	Żelazna	183.3	149.4	149.3	120.6

Table 2

Mean forces necessary to extract grain from ear for different varieties of rye and *Triticale* [7]

No.	Type of cereal	Variety	Value of force (G) terms of investigations			
			I	II	III	IV
1	Rye	Dańkowskie Nowe	164.7	120.9	107.0	103.0
2		272	159.1	151.9	149.0	142.0
3		Dańkowskie Złote	157.0	151.6	109.1	105.9
4		Dańkowskie Selekcyjne	155.1	154.0	149.0	83.0
5		Pancerne	148.3	143.4	99.7	96.3
6		Dańkowskie Srebrne	160.6	166.3	112.6	100.1
7		Wojcieszyckie	156.3	109.8	100.1	140.8
8		AR-3	166.2	156.2	103.7	81.1
9		Tetra Lubelskie	175.8	164.0	159.7	152.4
10	*Triticale*	RC 275	162.6	155.6	149.0	147.3
11		RC 67	163.7	147.8	148.6	145.4
12		RC 294	175.8	163.2	153.3	132.0
13		RL 51	158.9	166.1	149.0	143.0
14		RC 6	156.8	143.3	147.3	142.4
15		RC 45	166.5	144.8	142.0	141.0

— 7 days after full maturity,

— 14 days after full maturity.

In the enumerated maturity stages 30 ears from each variety were taken, of which 20 were subjected to threshing on the apparatus and 10 served for the determination of moisture. The moisture of grain during investigations varied within the range from 14 to 26.8% for rye, and from 13 to 39% for wheats. The results of investigations are presented in Tables 1 and 2.

It can be seen from the Tables that the particular varieties are characterized by a differentiated value of the force binding grain with ear. The differences, slight in term I of investigations, increase with maturity and the drying of ears. In the stage of full maturity and at delayed harvesting the differences for the particular varieties are very clear. This indicates the possibility of making a conventional classification of cereal varieties according to their threshability.

CONCLUSIONS

1. The threshability classifier, simple in its construction and operation, allows for rapid making of measurements both in field and laboratory conditions.

2. Investigations of the threshability of all the varieties and types of cereals cultivated in Poland on a greater scale should be undertaken. Results of such investigations can be utilized for the working out of the working parameters and the regulation parameters of the threshing systems of combined harvesters, at the harvesting of cereals differing in their threshability.

3. On the basis of investigations of threshability we propose to make a classification of the types and varieties of cereals into groups easily, medium and hard threshable, differing significantly in the force required for releasing grain from ears.

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ZASTOSOWANIE METODY UDAROWEJ DO OKREŚLANIA SIŁY WIĄŻĄCEJ ZIARNO Z KŁOSEM

Streszczenie

W dobie dynamicznie rozwijającej się mechanizacji procesów w rolnictwie poznanie fizycznych właściwości materiałów rolniczych jest sprawą bardzo ważną. Jedną z ważnych cech, z punktu widzenia przebiegu procesu omłotu, jest określenie tzw. „zdolności omłotowej" zbóż, zmieniającej się zależnie od gatunku i odmiany zboża, stopnia dojrzałości, wilgotności i innych czynników.

Zdolność omłotowa określana wartością siły niezbędnej do zerwania połączenia

ziarna z kłosem jest oznaczana różnymi metodami. Jedną z ciekawych metod pozwalających na szybkie wykonywanie dużej ilości pomiarów, zarówno w warunkach polowych, jak i laboratoryjnych, jest zastosowanie metody udarowej.

Wykorzystując omawiany przyrząd przeprowadzono badania polowe i laboratoryjne różnych odmian pszenicy i żyta. W wyniku badań dokonano umownego podziału badanych zbóż na odmiany łatwo-, średnio- i trudnoomłotowe.

Я. Героба

ПРИМЕНЕНИЕ УДАРНОГО МЕТОДА ДЛЯ ОПРЕДЕЛЕНИЯ СИЛЫ СВЯЗЫВАНИЯ ЗЕРНА С КОЛОСОМ

Резюме

В период динамически развивающейся механизации процессов в сельском хозяйстве изучение физических свойств сельскохозяйственных материалов является очень важной проблемой.

Одним из важных свойств с точки зрения развития процесса обмолота является определение т.наз. „способности к обмолачиванию" зерновых хлебов, меняющейся в зависимости от вида и сорта культуры, спелости, влажности и других факторов.

Способность к обмолачиванию, определяемая величиной силы. необходимой для разрыва связи зерна с колосом, устанавливается различными методами. Одним из интересных методов, позволяющих быстро выполнять большое количество измерений как в полевых, так и в лабораторных условиях, является применение ударного метода посредством прибора, построенного в Институте механизации сельского хозяйства с/х академии в Люблине на основании труда Пустыгина.

Используя рассматриваемый прибор, провели полевые и лабораторные исследования различных сортов пшеницы и ржи. В их результате исследуемые зерновые хлеба были условно разделены на легко-, средне- и труднообмолачиваемые сорта.

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