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SOYBEAN GRAIN RESISTANCE TO FRACTURE

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A b s t r a c t. The investigation was aimed at testing the seed resistance to fracture.The seeds of the three outstanding varieties of soybean in Vojvodina (Corsoy, NS 16 and NS 106) were exposed to fracture during the simultaneous laboratory investigations. The results obtained explain which one of these three varieties is the most resistant to mechanical effect - that of the harvesting device in the first place.

K e y w o r d s: soybean, grain hardness, mechanical effects

INTRODUCTION

It is important for the designers of agricultural machines to be familiar with soybean seed physical-mechanical characteristics, as well as for the users of these machines in order to choose an adequate working regime; on the other hand, these characteristics are important to be known by the selection people too. There are many examples showing that the selection of particular crops resulted in their mechanized harvesting (picking) like a case, for example, with tomato or improvement of harvester performance quality (maize cobs on the even height).

Kutzbach [2] states that the output of the agricultural machines, and especially of corn harvesters, depends on the material properties very much. The properties of the agricultural materials are variable depending on the material condition [1]. The condition of material changes while the time is passing, especially by effect of meteorological factors. It is important to mention that knowledge of these properties is the foundation stone of the introduction of computer control in the scope of agricultural engineering.

Damage, and especially seed fracture, enables the development of harmful microflora. Fractured soybean seed means even its uselessness for sowing [3,5]. The seed resistance to mechanical effect depends on moisture and physical-mechanical properties of seed of the given variety. Some varieties as Corsoy, for example, have distinct resistance to mechanical effect. On the other hand, NS10 variety has weakly marked resistance [3].

The objective of investigation was to find out by comparative laboratory testing of three leading soybean varieties in Vojvodina, the grain resistance to fracture, and to find out which is the most suitable one for harvesting and which is the most resistant to mechanical effects of harvesting devices, and other working and transporting units, respectively.

MATERIALS AND METHODS

Measuring equipment

The determination of soybean grain resistance to fracture i.e., measuring of the force required

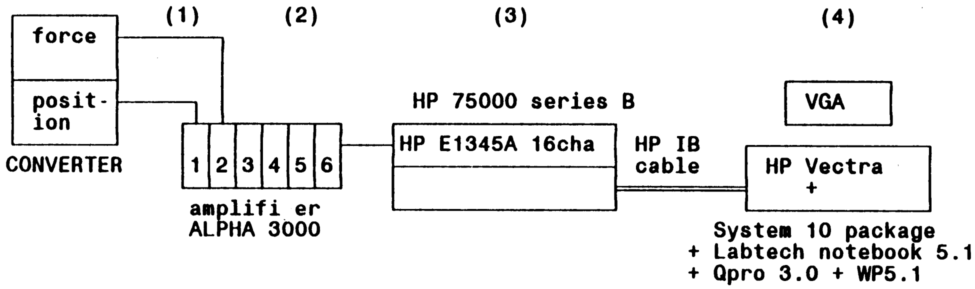

Fig. 1. Scheme of the measuring device for defining the soybean seed fracture force: 1 - force and position converters, 2 - measuring amplifier, 3 - converter of electric impuls into analogue signals for computer, 4 - PC computers.

for grain fracture, was accomplished in the laboratory by the tensiometric method. The method was based on measuring two non-electric values by an electric way. The measured values were the following: the force required for grain fracture and the deformation (bending) of grain. The apparatus used for this method consisted of the following (Fig. 1): the force and position converter (1), measuring amplifier (2), converter of electric impuls into analogue signals for computer (3) and PC computers (4).

Materials

In testing, three soybean seed varieties were used: Corsoy, NS 106 and NS 16. The samples of soybean were taken from the trial plots at Rimski Sancevi during the harvesting campaign, with 12 % moisture. The samples were handled manually, thus, avoiding the mechanical damage of soybean seed, which would, otherwise, effect the measuring results.

Defining the force was carried out in three characteristic positions of grain (I, II, III) as shown in Fig. 2.

Method

Defining the fracture force of grain in all three positions, is carried out in the way that the grain is placed under the piston on the base and is held by tweezers, by using the other hand a pressure is made on the grain by the piston via a system of arms until the moment of grain splitting. The moment of the grain splitting can be seen visually on the PC computer monitor.

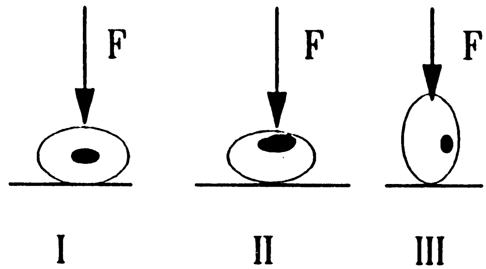

Fig. 2. Positions of the soybean seeds at which the fracture force was defined.

Data on the force and position are registered in the form of ASCII files in the computer, while simultaneously the orientation diagram of the movement of the force depending on the piston position is displayed on the monitor. In the further procedure from the work out of the laboratory, the data are processed statistically on the PC computer by the corresponding Application software programme.

RESULTS AND DISCUSSION

Mechanical effect (force) to the grain, results in its deformation until the moment of its fracture. A certain maximum force corresponds to this moment. The varieties vary by deformation (bending) until the moment of fracture and by a force required to cause it. In the scope of one variety depending on grain positions (three) on which the force is effecting, there are differences in the bend and value of the force at the moment of fracture.

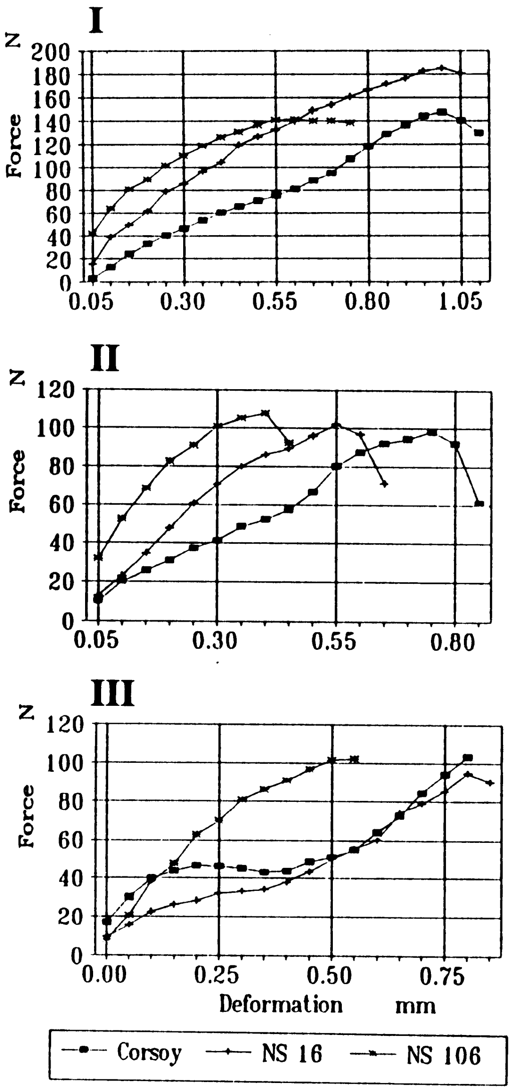

Fig. 3. Dependence of deformation force and the degree of deformation, for positions I, II and III.

On the basis of diagrams in Fig. 3 the following can be concluded: Hook's law, the basic law on the elastic deformation, which gives connection between the force of deformation and the value of every deformation, is noticeable only with Corsoy variety and so for all three positions. The proportion limit, elasticity limit and the definite deformation of segment resulting in fracture, are noticeable. At the NS 16 variety this dependence can be hardly seen and only for the grain positions II and III.

The greatest deformation (bending), until the fracture moment for all three varieties, appears in the first and byside grain position. It means that the grain is the most resistant to the fracture at that position. The least amount of bending until the grain fractures, for all three positions, can be seen with the NS 106 variety. It does not mean that even less force is required to cause the fracture, especially when position II and III are in question. The explanation of this should be looked for in the proposition that smaller elastic and plastic deformation occurred with this grain until the moment of fracture.

The greatest deformation occurred with the NS 16 and Corsoy varieties, while the last one, in the second position, had considerably greater deformation until the moment of grain fracture, at the nearly identical value of maximum force (Fig. 3b).

The third, i.e., upright grain position, is the most sensitive to the fracture. In comparison to the other positions (the first and second), the fracture force is the least. This refers to all varieties, excluding Corsoy variety from 1992. In comparison with the fracture force for the second position, fracture forces for the third grain position are slightly higher 3.65-10.08 %. Therefore, it can be said that the grain is sensitive to fracture in the second position, too (Table 1). This is justified on the diagrams in Fig. 4. The coefficient of variation of the maximum force, and the grain fracture force, is rather distinct (Table 1). The lowest value of variations is with the NS 16 variety, which in comparison to others, is the most sensitive to fracture, at the most sensitive position, i.e., at the third, upright position. However, this difference should not be exaggerated, since the values of other varieties are close to this one.

CONCLUSIONS

The quality of harvested soybean seed depends on the type and regime of work, primarily, on the harvesting unit, as well as on the physico-mechanical properties of the soybean seed. It is recommended that the seed of each

Table 1. Statistical data on maximal defomation force, for each variety and position of seed (1992)

Variety	Force (N)						
	Positions						
	I		II		III		w (%)
	$\bar{X}$	V (%)	$\bar{X}$	V (%)	$\bar{X}$	V (%)	
Corsoy	147.40	20.17	98.22	16.47	103.50	17.4	9.5
NS 16	185.12	17.45	101.80	13.28	94.82	16.5	9.5
NS 106	141.23	16.10	107.71	24.82	103.90	21.2	9.5

$\bar{X}$ - average value of maximal defomation force, V - coefficient of variation, w - moisture.

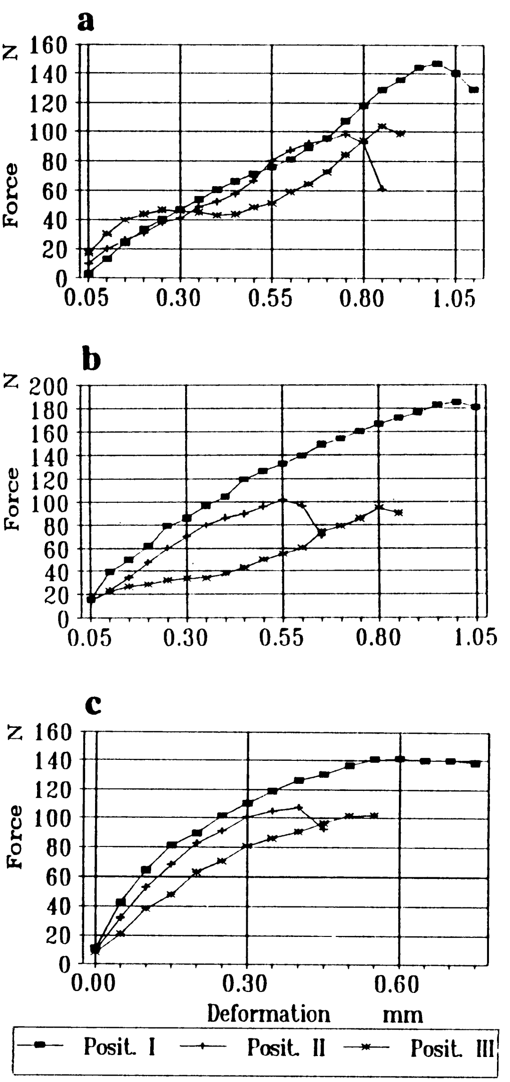

Fig. 4. Dependence of deformation force and the degree of deformation, for all three positions of the Corsoy (a), NS 16 (b) and NS 106 (c) seeds.

new soyben selection has to be tested to mechanical effect and the fracture, respectively, before being recognized as a new cultivar or simultaneously with the procedure of its recognition.

By laboratory testing of three leading varieties of Vojvodina: Corsoy, NS 16 and NS 106, it has been found that the seed in the upright position (III position), i.e., when the force acts on the length of seed, is most sensitive to fracture for the NS 16 and NS 106 variety as well as for Corsoy variety tested in 1987. Slightly lower sensitivity was found for the second position (II) of the seed when the seed navel is turned upward. The least sensitive to fracture and the greatest resistance to fracture, was found in the NS 106 variety, though the other two were not significantly far beyond it.

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