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MECHANICAL DAMAGE OF WHEAT GRAIN AND ITS HARDNESS

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A b s t r a c t. Authors present results of studies carried out so far, based on the Grain Vulnerability Index (GVI) and the Particle Size Index (PSI) methods, using the simple tests as a static loading of the bulk grain. It was stated that the level of wheat grain damage increase when the wheat grain hardness decreases. Studies carried out to date indicate the necessity of including the level of wheat grain damage in the evaluation of the technological value of wheat.

K e y w o r d s: wheat grain, mechanical damage, hardness

INTRODUCTION

The occurrence of mechanical damage is one of the most intangible phenomena related to wheat grain ever since its ripening stage under field conditions, through harvesting and post-harvesting treatment, until its processing. Mechanical damage can be defined as a state of disturbance of the natural continuity of particular tissues of the kernel. In cereal technology wheat grain hardness is taken as a variety or breeding effect in combination with environmental factors in the course of the plant growth and development. Determination of grain quality is often based on the estimation of hardness as a feature that distinguishes the endosperm texture.

Leaving aside the genetic connotations of grain hardness, or, to put in other words, of the resistance of wheat grain to mechanical loads, it seems to be interesting to determine the relation between the extent of mechanical damage of grain and its hardness. In order to verify this proposition, the authors determined the relation between the level of mechanical damage to grain - LD, as established according to the colorimetric method, and the hardness of wheat grain.

Grain hardness measurements were taken according to the standard method, determining the particle size index - PSI [1], and according to a method developed at the Institute of Agrophysics, Polish Academy of Sciences, Lublin, by determining the index of grain vulnerability to mechanical damage - GVI [4].

MATERIALS AND METHODS

The object of the study was Panda winter wheat grain from the harvest of 1992 at the Plant Breeding Station at Ulhówek (Zamość district). The initial sample of wheat grain, combine harvested, after the separation of contaminants and grain fraction below 2.0 mm in thickness, was divided into 21 samples of about 3.5 kg each.

Each of the samples were then subjected to a process of static loading within the range from 0.5 to 9.0 MPa, at 0.5 MPa increments, and up to 10 and 11 MPa, leaving one sample as control material. The moisture of the grain subjected to static loading was 12.5 %. The loading tests were performed using a strength tester type ZD-1 made in the former East Germany.

Grain samples were loaded under the conditions of uniaxial compression in a measuring cylinder of 0.3 dm^3 in volume and 0.025 dm^2 in section area. The rate of the movement of the piston exerting direct pressure on the grain sample was 0.8 mm/sec. When the required level of loading was reached, the grain layer was allowed 1 min of relaxation. The loading tests were made in 13 replications, and then the material used was put together and mixed.

Grain samples mixed together constituted input material for the assessment of the level of mechanical damage and of grain hardness. The assessment of mechanical damage was performed according to the colorimetric method using a tester of mechanical damage to grain (TMDG-2), following a method developed earlier [2,4] (Fig.1).

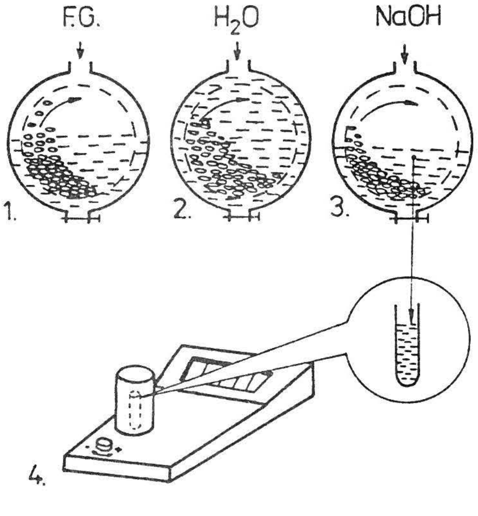

Fig. 1. Scheme of the colorimetric method: 1-soaking of the grain sample in the dye, 2-washing up of the dye excess, 3-resoaking (test solution), 4-the measuring of the optical density in the tested solution.

Every analysis was made using a 100 g grain sample of which test solution was prepared by means of a semiautomatic tester (SAT-2). Measurements were made in 4 replications. Through photometric measurements, for every test solution the level of dye concentration (ppm) was determined, which constituted the measure of the level of mechanical damage to grain (LD).

The assessment of grain hardness was performed according to two methods - PSI and GVI, the former of which is an AACC standard (No. 55-30). The determination of the latter hardness parameter - GVI - was made following the method described in a previous paper [4] (Fig. 2).

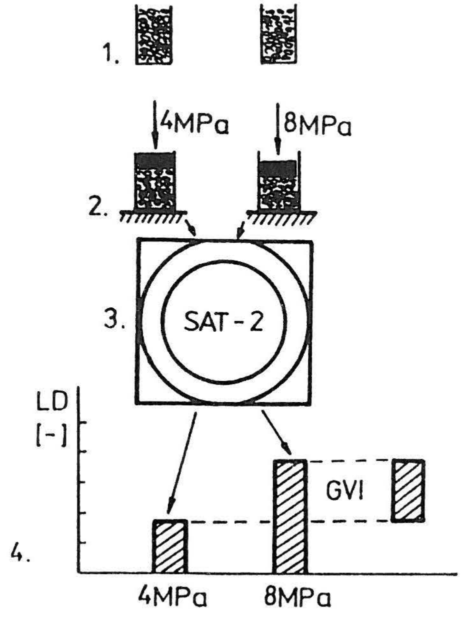

Fig. 2. Scheme of the determination of the GVI value: 1-two homogeneous grain samples, successively filling the measurement cylinder (SGD-2), 2-simulation of mechanical damage to grain (SDG-2), 3-colorimetric testing of the damage (SAT-2), 4-calculation of the GVI value.

RESULTS

Figures 3, 4 and 5 present mean values of LD, PSI and GVI, respectively. The value of the level of mechanical damage for the control sample (combine harvested but not subjected to static loading) was 1.36 ppm. Increase in the level of unit loads resulted in a gradual increase in the level of mechanical damage to grain (Fig. 3). First significant differences in LD values as compared to the value of 1.36 ppm (control sample) appeared only when the unit load of 4 MPa was reached.

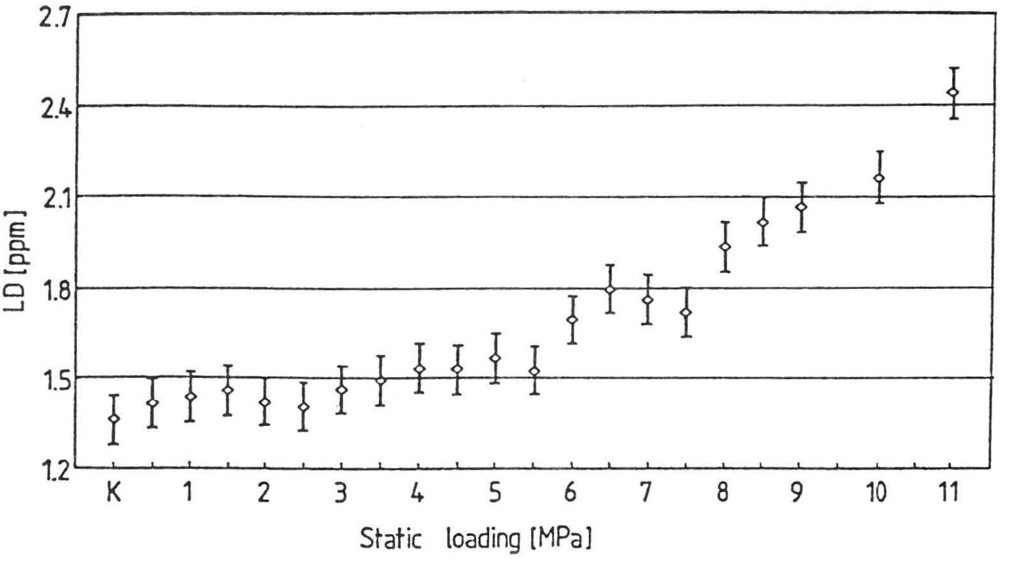

Fig. 3. Relationship between the static loading of the wheat grain samples and the value of its damage.

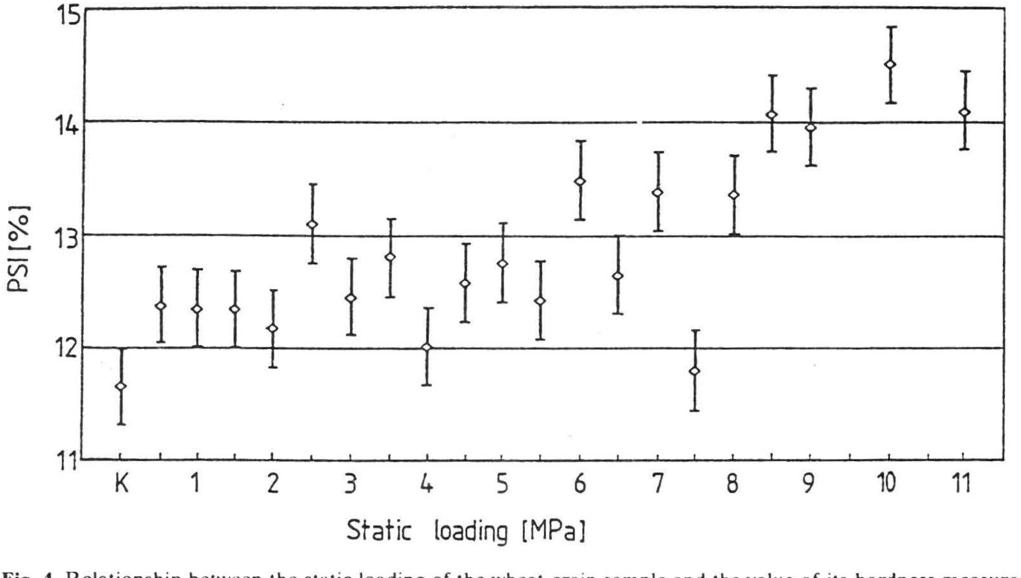

Fig. 4. Relationship between the static loading of the wheat grain sample and the value of its hardness measured by PSI.

Beginning with the unit load of 8 MPa the values of LD increased rapidly, reaching the level of 2.43 ppm at 11 MPa. The levels of static loading applied to the particular grain samples caused a similar character of changes in the parameters measured.

The value of PSI for the control material was 11.7 %. The values of PSI for successive grain samples subjected to increasing levels of static loading were characterized by considerable variability (Fig. 4). Only after the unit load of 7.5 MPa was exceeded, the

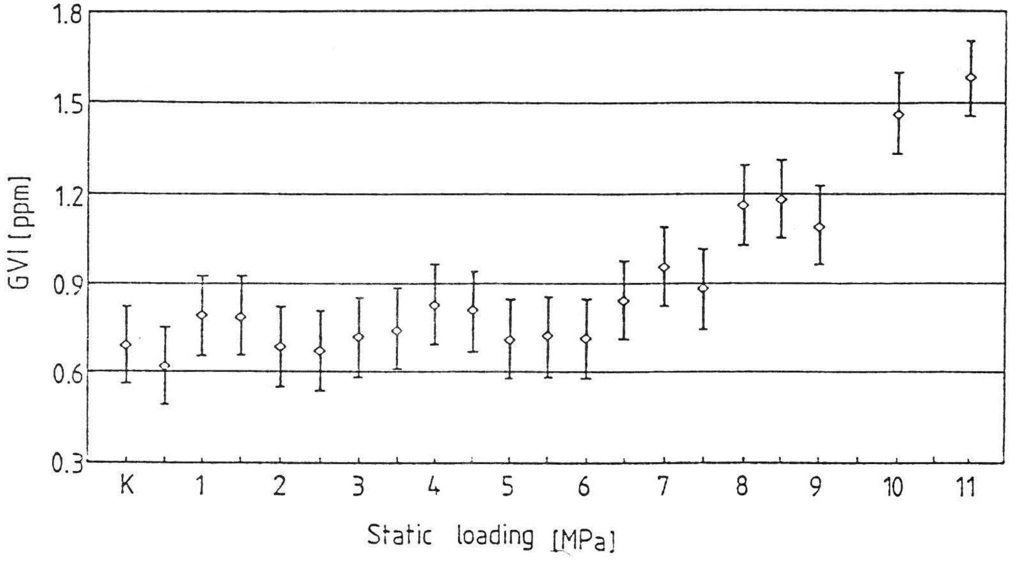

Fig. 5. Relationship between the static loading of the wheat grain sample and the value of its hardness measured by GVI.

values of PSI displayed a greater stability and a higher rate of increase. The maximum mean value of PSI=14.5 % was recorded at a load level of 10 MPa. The value of index of grain vulnerability - GVI - for the control sample was 0.70 ppm (Fig. 5). The character of changes in GVI values allowed for two ranges of unit loads to be distinguished: the first - up to 6.0 MPa, and the second - above 6.0 MPa. Within the range of loads up to 6 MPa the GVI values assumed levels similar to the GVI value for the control material. A distinct increasing tendency in the GVI values were observed only when the load level of 7.5 MPa was exceeded. The maximum value of GVI, obtained at 11 MPa, was 1.58 ppm.

The calculated values of coefficients of correlation (R^2), presented in Table 1, indicate that the relations between all the parameters tested are significant. Table 1 also shows that the highest correlation is that between the level of damage (LD) and the vulnerability of grain (GVI).

The coefficient of correlation for those two parameters was 0.94. The correlation between LD and PSI was lower at 0.82. Significant correlation was also observed between the parameters of PSI and GVI, the value of which was 0.76.

Table 1. Values of coefficients of correlation (R) for the parameters under study at number of grain samples n=21

Parameters	LD	PSI	GVI
LD	1.0000	0.8167	0.9454
PSI	0.8167	1.0000	0.7647
GVI	0.9454	0.7647	1.0000

CONCLUSION

Considering the character of changes in the GVI values within the range of grain sample loads up to 6.0 MPa it is possible to propose a permissible level of LD values as a criterion of grain hardness. This conclusion can provide valuable information indicating that the problem of assessment of mechanical damage to grain is significant for cereal technology and cannot be neglected in the qualitative evaluation of grain material.

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