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THE INFLUENCE OF GRAIN DAMAGE ON THE COMPONENTS OF CROP PRODUCTIVITY*

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A b s t r a c t. The influence of damaged grain on biological value has been the subject of research for many authors. Until now in most investigations the biological value of damaged grain was estimated during the beginning phases of growth - up to sprouting. It would be interesting to investigate further germ which was grown from grain with different types of damage up to the crop. The point of this paper was to state what the influence of wheat grain damage was on some chosen values of crop structure. The subject for investigation was wheat grain variety Grana. For the experiment 13 types of grain damage were selected. The damaged grain was sowed in soil in a completely randomized scheme. All seedlings were ensured optimum conditions for vegetation by applying the technique of field-crop production. After reaching peak the plants were harvested manually. It was possible to make measurements of certain components of the crop: number of plants, length of ears, height of plants, number of ears, weight of 1 000 grains, number of grains in an ear. The results after statistical analysis showed the influence of each type of damage on the crop structure. The group with the greatest amount of damage was determined.

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

INTRODUCTION

The investigation on the grain damage in the processes of its production has been performed on a large scale [1,3]. Effects of different factors on the quantity and kinds of mechanical damage of the grain are estimated. Those damages come up during harvesting and further treatments. Grain that has been damaged mechanically is very badly stored as the damage points are invaded by micro- organisms. It causes a decrease in the grain quality [5]. Similarly, while sowing grain we may expect that depending upon the extent of its damage both the germination and sprouting will be proportionally lower [3,4]. The study carried out has enabled to arrange various kinds of mechanical damages by their negative influences exerted upon the germination and sprouting ability [1]. However, it is necessary to follow up further vegetation of seedlings grown out of grain having different kinds of damage until the crop inclusive. It is yet more urgent to be done as in the references dealing with those problems one may find two opposite theories concerning the effect of grain mechanical damage upon the growth and development of plants. And thus, some papers explicitly confirm effects of even slight damage upon the crop [5]; instead, the other authors say that at the moment of giving out germinal rootlets any plant becomes totally independent of the caryopsis from which it has sprouted [2]. Therefore, this paper was aimed at finding the effect of the damage kinds upon futher growth and development of a plant coming up from a grain being damaged. The values of the crop components were taken as indexes for this growth and development.

MATERIALS AND PROCEDURES

The tests were conducted upon damaged grain of wheat variety Grana. The grain was

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collected from a harvester storage bin during harvest time. The humidity value of grain collected amounted to about 16 %, whereas the harvester control parameters were set according to the service manual. From such material prepared as above damaged grains were taken out. The grains were classified by the methods elaborated previously by distinguishing different damage kinds [1]. In consequence, the following groups of grain macro-damage have been accepted:

1) transverse losses (halves),
2) longitudinal losses (halves),
3) losses in the neighbourhood of the germ (about 1/4 of mass),
4) losses in the neighbourhood of the bit (about 1/4 of mass),
5) crushing towards the smallest dimension,
6) side crushings,
7) transverse cracks,
8) longitudinal cracks (through the germ),
9) longitudinal cracks (intact germ),
10) abrasions.

Grain micro-damage have been classified into the following kinds:

1/ germ micro-damage,
2/ micro-damage over the germ,
3/ cover micro-damage.

Additionally, grains for reference test 0 with no external damage, were taken out.

Thus, by regarding the classification above mentioned some samples for plot experiments containing for each combination exclusively grain with the determined kind of damage, were prepared. Those samples (500 pieces x 5 repetitions) were sown on some microplots completely randomized. Finally, 13 sample combinations containing damaged grain were arranged for a plot test. The seedlings were secured to be under optimum vegetation conditions according to the agricultural science indications. It was manual sowing and was realized in the second half of September. Seeds were arranged at regular 5 cm intervals, the rows being at 10 cm distances. It corresponds with the sow standards with the omission of the safety zone. The micro-plots said were sown with the same wheat variety. Mature plants were harvested by hand. That enabled execution of measuring the crop components, namely:

- number of plant (pieces/m^2),
- number of productive ears per plant (pieces),
- number of grains per ear (pieces),
- mass of 1000 grains (g).

Additionally grain crop from 1 m^2 (kg/m^2), and plants height (m) were determined.

The tests were performed in a three-year cycle.

RESULTS AND DISCUSSION

The measurement results are collected in Table 1. Those results were the base for performing six analyses of variance in the double classification by taking up the damage kind and the investigation year (Table 2) as the variability determining factors. Those analyses showed an appreciably effect of the damage kind upon:

- the number of plants that had sprouted,
- survived winter and yielded crops,
- the number of productive ears per plant - as an effect of the plant spread,
- the mass of 1 000 grains,
- yield.

For the remaining indexes, that is the number of grains per ear and the plant height, the effect of a damage kind was negligible. In the respective investigation years those results amounted to different values and this fact may be corroborated by the importance of the factor called 'investigation year' for such indexes like: the number of plants, number of ears, mass of 1 000 grains, yield from 1 m^2 and plant height. This variability is also confirmed by an importance of an interaction occurring between the investigation year and the damage kind in the case of the number of plants, ears and the yield.

For those yield components for which the variance analysis exhibited an important effect of the damage kind upon the variance values, Duncan test was carried out (Table 3). In the case of the number of plants, a considerable decrease in the values of this parameter

Table 1. Average values of some selected yield indexes in relation to the damage kinds of grains sown in a field experiment. The damage numbers correspond with those given in the text

Damage No.	Index					
	Number of plants (pcs/m^2)	Number of productive ears per plant (pcs)	Number of grains per ear (pcs)	Mass of 1 000 grains (g)	Yield from 1 m^2 (kg/m^2)	Plant height (m)
0	158	1.8	37.2	45.5	48.7	0.63
1	127	2.0	38.5	43.5	42.5	0.59
2	113	2.0	38.9	42.1	35.0	0.61
3	111	1.8	36.8	44.1	30.4	0.60
4	124	2.0	37.5	43.4	40.3	0.63
5	72	3.0	38.2	43.0	33.4	0.58
6	113	1.9	37.7	44.3	33.8	0.62
7	123	1.8	37.4	45.3	34.5	0.57
8	57	2.8	38.2	44.2	23.9	0.58
9	114	1.4	37.6	44.2	25.3	0.61
10	112	2.6	37.0	44.1	46.5	0.62
11	76	3.1	38.6	44.2	40.0	0.60
12	148	1.8	38.3	43.2	42.0	0.59
13	152	1.8	38.1	45.1	45.0	0.63

Table 2. Results of two-factor variance analyses for the performed plot experiment ($\alpha = 0.05$)

Index	Variability source	Significance level α	Difference significance
Number of plants	A damage kind	0.00	+
	B investigation year	0.01	+
	Interaction A x B	0.03	+
Number of productive ears per plant	A damage kind	0.01	+
	B investigation year	0.03	+
	Interaction A x B	0.00	+
Number of grains per ear	A damage kind	0.06	-
	B investigation year	0.11	-
	Interaction A x B	0.08	-
Mass of 1 000 grains	A damage kind	0.03	+
	B investigation year	0.05	+
	Interaction A x B	0.18	-
Yield from 1 m^2	A damage kind	0.01	+
	B investigation year	0.04	+
	Interaction A x B	0.03	+
Plant height	A damage kind	0.33	-
	B investigation year	0.04	+
	Interaction A x B	0.43	-

was found for the samples with damaged grain, comparing to the reference test. It may be supposed that fact was caused by a decrease in the germinating and sprouting ability, as well as by a lowered ability to survive winter time exhibited by the plants coming up from damaged grains.

As far as next parameter, viz. the number of productive ears, is concerned, it turned out that those samage kinds that had brought

Table 3. Difference significance for the average values of the evaluated yield components in a plot experiment

Index	Yield components													
Damage No.	8	5	11	3	10	6	2	9	7	4	1	12	13	0
Number of plants (pcs)	57	72	76	111	112	113	113	114	123	124	127	148	152	158
Damage No.	9	0	3	7	12	13	6	1	2	4	10	8	5	11
Number of productive ears per plant (pcs)	1.3	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.5	2.8	3.0	3.1
Damage No.	2	5	12	4	1	3	10	8	11	6	13	9	7	0
Mass of 1000 grains (g)	42.1	43.0	43.2	43.4	43.5	44.1	44.1	44.2	44.2	44.2	44.3	45.1	45.3	45.5
Damage No.	8	9	3	5	6	7	2	11	4	12	1	13	10	0
Yield from 1 m^2 (kg/m^2)	23.9	25.3	30.4	33.4	33.8	34.5	35.0	40.0	40.3	42.0	42.5	45.0	46.5	48.7

The unsignificance differences were underlined. The numbers correspond with those given in the text.

about a fall in the number of plants in a micro-plot engendered a better spread of the plants in comparison with the reference group. In turn, for the mass of 1000 grains three homogeneous groups were found. In the group having the highest values of this parameter there were: the reference sample and the samples having micro-damage in the covers and transversal cracks. The remaining damage kinds caused a considerable decrease in the mass of 1000 grains.

However, the values of the components given allow to calculate the theoretical yield. An extra found factor, i.e., the yield of crops, generalizes the micro-plot experiment results. The statistical analysis revealed for this factor an appreciable fall in the yield in the case of the plants grown out of damaged grains in comparison with the reference. As it can be seen in Table 3, the yield was particularly decreased by the following damage kinds: longitudinal cracks, of the grain and losses in the neighbourhood of the germ. In conclusion it can be said that the shown values of the yield component and the yield of crops show explicitly a negative effect of the grain mechanical damage. Yet, it must be stressed that the experiment comprised an evaluation of yield for the grain samples damaged in 100 %. Actually, during the harvesting by machine if great care of the grain quality (optimum humidity, proper control parameters) is taken, the fraction of damaged grains is relatively little. Therefore, while checking for damage, particular attention should be focused at those kinds of defects that, according to the experiments performed, reduce the yield of crops to the most extent.

CONCLUSIONS

1. A micro-plot experiment exhibited a considerable effect of the grain damage kind upon the decrease in the quality of the following yield components: the number of plants, mass of 1000 grains.

2. The grain mechanical damage may be ranged among the factors influencing wheat yield of crops.

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