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THE ATTACK OF THE WEEVIL *Sitophilus granarius* L. ON VARIETIES NEW WHEAT STORED

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Abstract
Stored cereal products suffer year after year from the attack of various insects, mainly due to the short period in which the grains are used. Instead, by delaying grain utilization, and especially in winter wheat, storage pests follow their biological cycle. This is also the case with the Sitophilus weevil whose attack causes a high level of damage every year. In this experiment, two series of batches of three varieties of winter wheat were analyzed. From the data obtained, it was found the existence of significant differences depending on the analyzed factor, namely, distinctly significant in the case of the group of varieties formed by Trivale, Ursita and Linia A4-10, significant in the variety FLD Caro, FDL Concurent, Șimnic 1619. At the same time, a significant connection was found between the first group of varieties with the four lots analyzed and insignificant in the case of the second group of winter wheat varieties

Keywords: wheat grain, storage, weevil, attack grade, new varieties.

1. INTRODUCTION

One of the common pests of stored products is the wheat weevil, *Sitophilus granarius* L. (pro. syn. *Curculio granarius* L., *Calandra granaria* L., grain weevil, granary weevil- Engl.) (Akol et al., 2011). The pest is known throughout the temperate climate and has a greater distribution in Europe, the Americas, Asia, Africa and Australia (Woodbury, 2008). They mainly prefer cereals such as wheat, barley, rice, corn, but also other plants (Germinara et al., 2008). The appearance of the pest showed adult lengths of 2.5-3.5 mm with a dark brown color, as well as anthers consisting of 10 segments. It also has a relatively long rostrum (Dinuță et. al., 2008), the body being covered with feathers. An adult female lays more than 200 eggs during half a year. The larvae are approximately the same size as the adult, being apodic, slightly curved, white in color and with a brown head. The larval period lasts two weeks in the attacked grains. White pupae develop within 7 days on the surface of the attacked grains. An entire biological cycle is completed in 35-36 days depending on the environmental temperature (Andersen, 1938). Because of this the weevil has several generations per year in a warehouse. The egg-laying period can last up to 6 months. After two weeks of incubation, the larvae appear and feed inside the grains (Bolivar-Silva et al., 2018). The larvae that reach maturity in about 15 days are implanted in the grain, and the new generation of adults appears

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after 7 days and the cycle starts again. From an ecological point of view for a whole life cycle, the weevil needs temperatures between 3-6 ℃ and a relative air humidity of 75%. The insect dies below -10 ℃ and above 40 ℃, and in very dry wheat with 9% humidity, it no longer reproduces (Hanses et. Al., 2011). The insect necessarily overwinters in the warehouse, both as an adult, as a pupa and as a larva. Apart from the mentioned stored grains, the pest infests in the adult stage and additionally feeds on bakery products, but without reproducing. Instead, the flour consumed has a bitter taste, a repulsive smell, thus becoming unsuitable for baking.

2. MATERIALS AND METHODS

The research was carried out in the warehouse of the Agricultural Pitesti Development Research Station of Pitesti, in which two groups of new varieties arranged according to the two-factor subdivided plots method. In the first group of varieties, the factor A had the following composition: the *Trivale* variety, the *Ursita* variety and *Lina A4-10*, each studied through the factor B, namely through four separate lots.

In the second experiment, factor A was composed of the varieties *FDL Caro, FDL Concurent* and *Șimnic 1619*, whose factor B was also composed of four separate lots. For each repetition, samples were collected in the amount of 800 g, from which they were separated by the method of quarters into 200 g grains. The degree of insect damage was determined on the respective samples, expressed as absolute and percentage values, GA%=FxI/100. From the point of view of the quality of the analyzed grains, two elements considered more important were determined, namely crude protein (%) and wet gluten content (%) with the help of the Inframatic IM 9500 Plus analyzer. In the statistical analysis of the values obtained, the analysis of variance (Anova test) was used, and between the two quality characters simple correlations were established using comparisons of rmax for the three levels of transgression probabilities. The results obtained refer to the first year of research.

3. RESULTS AND DISCUSSIONS

Trivale is a variety of autumn wheat, with a height of 70-100 cm, the grain has an oval shape, it shows good tolerance to aluminum ions, *Ursita* has a height between 90-100 cm, the grains are red in color, good resistance to frost, *Șimnic 1619, Line A4-10, Fdl Caro, Fdl Concurent*, wheat lines in testing, have good drought resistance. In the fall of 2022 and the beginning of 2023, it was found that in the warehouse where the determinations were made, the temperature values were positive, with very few exceptions of 0℃ and below 0℃ (table 1).

At the same time, air humidity recorded values between 60 and 100%. According to these data, it appears that the insect had favorable attack conditions on the wheat grains of the 6 analyzed varieties. From the determinations carried out, attack degrees were found at levels considered high, but with some differentiation in terms of the varieties analyzed and their batches respectively. Regarding the first group of wheat varieties (table 2), the *Trivale* variety, considered as a control, had a degree of attack of 23.5%.

Line A4-10 had approximately the same degree of attack (23.2%), while in the *Ursita* variety the degree of attack was much higher (28.9%), being statistically assured. Analyzing the four researched batches, the degree of attack oscillated between 21.8-26.6%, three of them being approximately equal and only batch C had a lower and statistically assured degree of attack. In the second group of varieties, the lowest degree of attack was found in *FDL Caro*, considered a control

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19.6% (table 3). The other two varieties studied had attack degrees of 145-162%, with the differences statistically ensured. In this group of varieties *FDL Concurent* and *Şimnic 1619* were more obviously attacked by the insect. The differences between the four lots analyzed were insignificant. From a value point of view, group B had a degree of attack of 38.3%, while in the other groups the degree of attack was approximately 40%, with no significant differences.

Table 1. Minimal temperatures evolution and air humidity from storage of wheat grains

Month. days	Low temperatures. tn^{0}C				Air humidity, %			
	Oct. 2022	Nov.	Dec.	Ian. 2023	Oct. 2022	Nov.	Dec.	Ian. 2023
1	13.3	8.2	0.1	3.1	90	90	93	91
2	15.2	9.3	1.1	5.2	94	88	97	91
3	8.3	9.4	1.2	3.1	77	79	97	93
4	8.1	8.2	1.1	4.2	84	91	96	91
5	6.2	8.1	1.2	4.1	89	82	93	95
6	6.0	12.2	3.1	2.2	90	66	98	77
7	8.1	9.3	1.3	**-2.1**	82	81	97	88
8	11.0	8.4	4.2	**-1.3**	87	92	99	94
9	9.1	5.0	3.2	0.1	97	97	100	94
10	11.1	4.1	5.1	4.3	83	98	98	90
11	11.3	7.3	3.2	5.2	76	83	93	96
12	10.2	5.1	1.1	1.3	92	93	89	97
13	10.3	1.2	**-4.2**	2.4	92	93	59	99
14	9.1	2.1	**-4.3**	1.3	95	92	76	96
15	8.2	4.0	0.0	2.1	81	97	98	98
16	5.2	4.0	0.3	1.1	98	94	95	90
17	4.1	5.1	5.1	3.2	93	97	98	89
18	4.2	3.2	1.3	4.1	97	98	100	92
19	4.0	8.1	**-3.3**	7.3	94	91	90	94
20	7.2	9.2	**-4.2**	1.2	87	95	93	95
21	4.1	6.1	**-4.4**	**-1.3**	65	100	96	97
22	5.2	1.2	**-3.2**	7.1	79	97	90	93
23	10.1	6.4	**-1.3**	2.2	74	83	92	92
24	8.2	4.0	0.2	**-1.2**	86	99	94	92
25	9.1	2.1	1.3	**-2.3**	89	87	85	90
26	9.3	**-1.2**	**-1.1**	**-3.2**	87	92	88	89
27	7.2	0.0	0.3	0.1	81	80	93	98
28	6.1	0.1	**-1.2**	0.2	90	95	72	100
29	4.3	0.3	**-3.4**	**-2.3**	85	94	93	100
30	8.2	2.2	**-1.3**	**-3.4**	83	91	87	98
31	10.3		2.1	**-5.0**	82		90	91
Mean	**8.22**	**5.09**	**0.21**	**1.46**	**86,6**	**90,5**	**91,7**	**93,2**

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Table 2. Attack percent by the two factors, first group with wheat varieties

Variety	AD %	%	Lot	AD %	%%
Trivale	23.5	100	A	26.5	100
Ursita	28.9**	123**	B	25.9	98
A4-10 line	23.2	99	C	21.8^0	82^0
			D	26.6	100
LSD 5 % =	*3.45*	*14.7*	*LSD 5 % =*	*3.70*	*14.0*
LSD 1 % =	*5.22*	*22.2*	*LSD 1 % =*	*4.99*	*18.8*
LSD 0.1% =	*8.40*	*35.8*	*LSD 0.1% =*	*6.65*	*25.1*

**-distinctly significantly, ^{0}-significantly negative

Table 3. Attack percent by the two factors, second group with wheat varieties

Variety	AD %	%	Lot	AD %	%%
FDL Caro	19.6	100	A	40.2	100
FDL Concurent	48.1*	245	B	38.3	95
Șimnic 1619	51.3*	262	C	40.1	100
			D	40.2	100
LSD 5 % =	*22.58*	*115.21*	*LSD 5 % =*	*6.48*	*16.1*
LSD 1 % =	*34.21*	*174.55*	*LSD 1 % =*	*8.75*	*21.8*
LSD 0.1% =	*54.99*	*280.56*	*LSD 0.1% =*	*11.65*	*29.0*

*-significantly positive

Regarding the interaction between the two factors, namely wheat varieties and batches, higher attack degrees are found in the case of the second group of wheat varieties (table 4). From a statistical point of view, in the first group of varieties and batches analyzed in a single batch (batch B, the *Ursita* variety), the degree of attack was 35.8%, being distinctly significant. In the rest, the other variants with varieties and batches were registered within the error limit. At *line A4-10* at lot C, a 20% attack degree was found, being significantly negative. Within the second group of varieties, the degree of attack was highly differentiated both for factor A and for factor B, thus the degree of damage between 42.3-54.5% was found in the varieties *FDL Concurent* and *Șimnic 1619*. In these varieties, all values were statistically different compared to the *FDL Caro* batch A variety.

Table 4. Attack percent by interaction of the two factors, wheat varieties x lots

Variety	Lot	AD %	AD %	Variety	Lot	AD %	AD %
Trivale	A	25.8	100	FDL Caro	A	18.8	100
	B	17.8^0	69^0		B	19.5	104
	C	22.3	86		C	20.8	111
	D	28.3	110		D	19.5	104
Ursita	A	29.3	114	FDL Concurent	A	47.3*	252*
	B	35,8**	139**		B	42.3*	225*
	C	25.0	97		C	50.8*	271*
	D	25.5	99		D	52.0**	277**
Linia A.4-10	A	24.5	95	Șimnic 1610	A	54.5**	291**
	B	24.3	94		B	53.0**	283**
	C	18.3^0	71		C	48.8*	260*
	D	26.0	101		D	49.0*	261*

**-distinctly significantly positive,*-significantly positive, ^{0}-significantly negative

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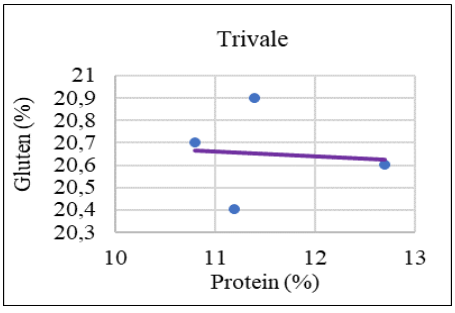
Regarding the dispersion analysis (table 5), it appears that the attack of the insect registered a lower variability in the first group of wheat varieties and a greater variability in the case of the second group of wheat varieties. After comparing the values of the variances of the two groups, it was found that the F Test in the case of factor A (the two groups of wheat varieties), the values obtained were statistically different in the case of both studied groups. Regarding factor B, the analyzed values did not differ statistically.
The AxB interaction, statistical differences were highlighted only in the case of the first group of wheat varieties, while in the second group of varieties the values obtained were insignificant.

Table 5. Results about the variance analysis of the two groups with the new wheat varieties and lots

Cause of variability	SP grup I	SP grup II	GL	S^2 grup I	S^2 grup II	Test F grup I	Test F grup II	Theoretical values
Repetition	7.75	2743.83	3					
Factor A	323.17	9724.54	2	161.59	4862.27	13.56**	9.51*	(5.14 10.92)
Error A	71.50	3066.29	6	11.92	511.05			
Large parcels	402.42	15534.67	11					
A x B	499.33	304.46	6	83.22	50.74	3.21*	0.64	(2.94 4.60)
Factor B	185.42	32.17	3	61.81	10.72	2.38	0.13	
Error B	700.75	2153.38	27	25.95	79.75			
Small parcels	1385.50	2490.00	36					
Total experience	1787.92	18024.67	47					

**-distinctly significantly positive, *-significantly positive

Correlations obtained between protein and wet gluten contents depending on the degree of insect attack. The relationships established between crude protein content and wet gluten among the six varieties analyzed revealed different situations. In the case of the first group of varieties, negative correlations were found in all three cases (figures 1-3). Thus, in the *Trivale* variety, the negative correlation coefficient was insignificant (r = -0.09), as in the case of *Line A4-10* whose correlation coefficient was also insignificant (r = -0.09). In the case of the *Ursita* variety, the correlation was more strongly negative (r = -0.830).



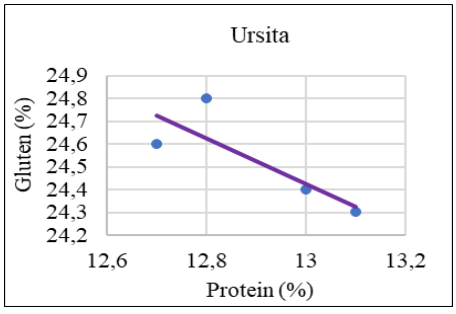


Figure 1. Correlation P x Gluten, Trivale var. ***Figure 2. Correlation P x Gluten, Ursita var.***

Regarding the second group of varieties, the correlations obtained between the two quality elements show in all cases positive situations, the correlation coefficients obtained being positive, in all cases they had insignificant values (figures 5-8).

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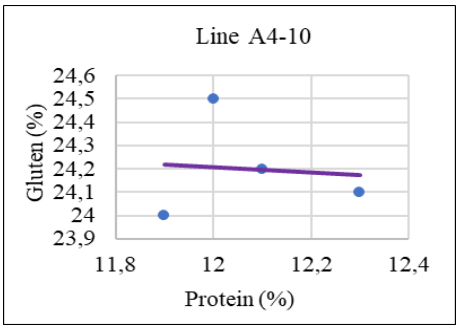
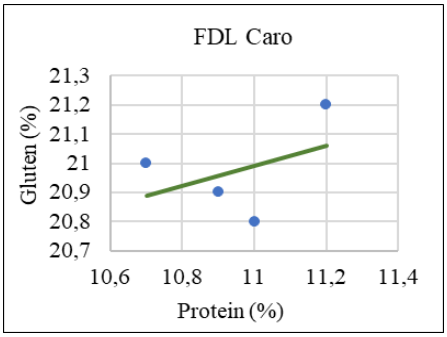


Figure 3. Correlation P x Gluten, Line A4-10

Figure 4. The stages of the wheat weevil



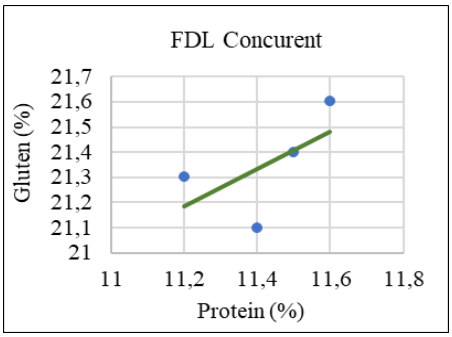


Figure. 5. Correlation P x Gluten, Caro var. Figure. 6. Correlation P x Gluten, Concurent var.

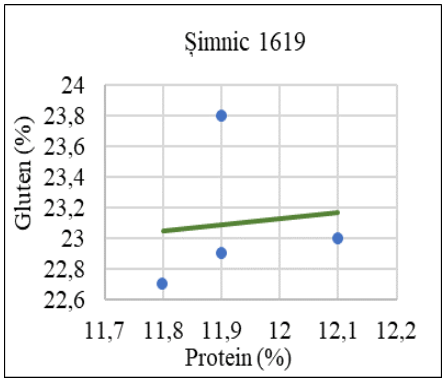


Figure 7. Correlation P x Gluten, Șimnic var.

Figure 8. The wheat seamples

4. CONCLUSIONS

Considering the groups of varieties and the lots on which the determinations were made, they are considered differentiated, especially between the varieties analyzed. The first group consisted of *Trivale, Ursita, Line A4-10*, of which only the *Ursita* variety had a higher degree of attack and with statistical assurance. The four lots of these varieties had relatively close attack degrees.

In the case of the second group formed by the varieties *FDL Caro, FDL Concurent, Șimnic 1619,* the attack degrees were much higher, respectively for *FDL Concurent* of 48%, and for *Șimnic 1619* of 51%, both with statistical assurance. And in the case of batches of the three varieties, the degrees of attack recorded values of 38-40%.

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Regarding the analyzed variety x lot interaction, a higher degree of attack was found in the *Ursita* variety, lot B, and in the second group of varieties, both *FDL Concurent* and *Șimnic 1619* presented much higher attack degrees in all lots analyzed.
Following the attack of the weevil, a deterioration in the quality of wheat grains was found, especially in the first group of varieties, *Trivale, Ursita, Line A4-10.* In the second group of varieties, the correlations have a positive trend, obtaining insignificant quality values between wheat lines.

5. REFERENCES

Akol, A. M., Chidege, M. Y., Talwana, H.A.L., Mauremootoo, J. R. (2011). *Factsheet - Sitophilus granarius (Linnaeus, 1875) - Granary Weevil. Bionet-Eafrinet.*

Andersen, K. T. (1938). Der Kornkäfer (*Calandra granaria* L.), Biologie und Bekämpfung. Monogr.ang.Ent., 13, 1-108 Berlin.

Bolívar-Silva, D.A., Guedes, N.M.P.& Guedes, R.N.C. (2018). Larval cannibalism and fitness in the stored grain weevils *Sitophilus granarius* and *Sitophilus Zea mais.* Journal of Pest Science, 91(2), 707- 716.

Dinuţă, A., Bunescu, H., Bodis, I., & Pop, O. (2008). Researches Concerning the Morphological aspects of sexual dimorphism in the granary weevil (*Sitophilus granarius*), major pest of the stored cereals. *Research Journal of Agricultural Science*, *40*(1), 379-384.

Germinara, G. S., De Cristofaro, A., & Rotundo, G. (2008). Behavioral responses of adult *Sitophilus granarius* to individual cereal volatiles. *Journal of Chemical Ecology*, *34*, 523-529.

Hansen, J. D., Johnson, J. A., & Winter, D. A. (2011). History and use of heat in pest control: a review. *International journal of pest management*, *57*(4), 267-289.

Woodbury, N. (2008). Infanticide avoidance by the granary weevil, *Sitophilus granarius* (L.) (*Coleoptera: Curculionidae*): the role of harbourage markers, oviposition markers, and egg-plugs. *Journal of insect behavior*, *21*, 55-62.

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