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THE BEHAVIOUR OF SOME WINTER WHEAT VARIETIES, CREATED AT ARDS TURDA AGAINST *Fusarium* sp. ATTACK, DURING 2015-2018

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ABSTRACT

Fusarium head blight (FHB) is a fungal disease of small grain cereals caused by pathogen fungi *Fusarium* sp. and has become a serious danger to the worldwide grain industry. Under favorable weather conditions (moist, warm conditions during flowering), the *Fusarium* spores are spread by wind to cereal spikelet, and then, infection expands within the whole ears. Wheat production can be reduced by up to 50-60%, and includes losses caused by flower abortion, elimination of damaged grains during threshing, decrease in grain size, and reduction in grain weight. In this paper we studied the behavior of some wheat varieties at the *Fusarium* sp., attack, under different infection conditions, between 2015-2018. The climatic conditions had a decisive role in the appearance and development of the disease, the percentage of infected ears and grains, in 2015 and 2016 recorded the highest values. Applying the vegetation treatments, at the optimum time, will lead to the reduction of the percentage of infected ears and kernels, even if there is a high pressure of infection. The yields obtained from the wheat varieties were influenced by the climatic conditions, the infection mode and the cultivated genotype. The lowest yields were obtained in 2017, a problematic year for the winter wheat crop; at the pressure of infection, without treatments, we obtained the lowest yields.

Keywords: wheat, natural and artificial infection, *Fusarium* sp.

INTRODUCTION

Fusarium head blight (FHB) is a fungal disease of small grain cereals caused by pathogen fungi *Fusarium* sp. and has become a serious danger to the worldwide grain industry. Under favorable weather conditions (moist, warm conditions during flowering), the *Fusarium* spores are spread by wind to cereal spikelet, and then, infection expands within the whole ears (Capouchová et al., 2017). Wheat yield can be reduced by up to 50-60%, and includes losses caused by flower abortion, elimination of damaged grains during threshing, decrease in grain size, and reduction in grain weight (Parry et al., 1995; McMullen et al., 1997). The concern of this disease is due to the reduction in grain yield and quality and the potential for contamination with mycotoxins, such as deoxynivalenol (DON) (Ittu et al., 2010; Palazzini et al., 2018).

In Transylvania, the most deterimental disease to winter wheat is Fusarium head blight, caused by the Fusarium fungi genus. The degree of the attack for this disease is influenced by the genotype under cultivation, climate conditions (Scala et al., 2016), inoculum source and technology applied. Climate change during the last decade has exerted its influence both on the plants, as well as the pathogens in an area. As such, either certain unknown pathogens have emerged or the existing ones have modified their traits under the influence of genetic or environmental factors (Popescu, 1998), thus leading to significant damage.

The aim of the paper was to study the behaviour of certain winter wheat varieties against the *Fusarium* sp. attack, in the ARDS Turda climate conditions, during the 2015-2018 period.

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MATERIAL AND METHODS

The biologic material employed in this experiment consisted of two wheat genotypes: Andrada and Codru, created by ARDS Turda.

Each genotype was assessed in the field with four treatments:

- control sample/natural infection conditions (C),
- infected with *Fusarium* sp., untreated (I),
- infected with *Fusarium* sp. and treated with fungicide (IT),
- natural infection condition and treated with fungicide (T) (Mastanjević et al., 2018).

Wheat genotypes were artificially field inoculated at anthesis (flowering stage) **(**Ittu et al., 2008; Martin et al., 2017; Capouchová et al., 2017; Spanic et al., 2018**)** by using the spraying method (Ceapoiu and Negulescu, 1983).

The treatment was completed in BBCH 49-59, with prothioconazole 125 g/l + tebuconazole 125 g/l – 0.9 l/ha (2015) and proquinazid 40 g/l + tebuconazole 160 g/l + prochloraz 320 g/l – 0.75-1 l/ha (2016-2018).

Determinations: **in the field**: the percentage of ears with *Fusarium*; **in the laboratory**: percentage of kernels with *Fusarium*, yield (kg/ha).

The data obtained were statistically processed using the POLIFACT and EXCEL programmes.

RESULTS AND DISCUSSION

The four experimental years were very different in terms of recorded temperatures and rainfall. The data presented in Figure 1A reveal that the temperatures recorded towards the end of the calendar year (September, October and November) exceeded the normal on 60, in all the four experimental years. In the winter months, the temperatures varied, but nevertheless above the average for the past 60 years. The year 2017 was an exception, as the month of January was very cold, which influenced productions registered in the same year. The second half of the agricultural year, for wheat cultivation, shows very high temperatures in March (three experimental years), a very cold month of April in 2017 and temperatures slightly above normal in June and July (Figure 1A).

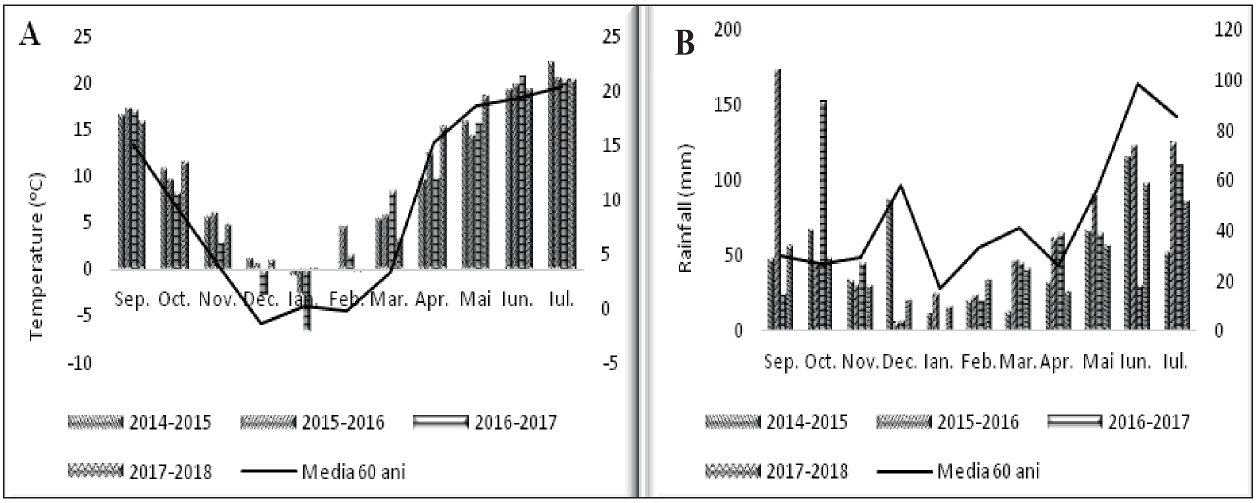

Figure 1. The temperatures (**A**) and the rainfall regime (**B**) at ARDS Turda, during 2015-2018
(Source: Weather Station Turda (longitude: 23°47; latitude 46°35; altitude 427 m)

The precipitations in the four experiments had an uneven distribution, most often these being below the average of the precipitations of the last 60 years (Figure 1B). Excess precipitation was recorded in September and October, during the four experimental years. Precipitation in the second part of the crop vegetation period (May, June) favored both the production and the manifestation of pathogens, especially in 2015 and 2016. The precipitation deficit in 2017 as well as the winter conditions, which determined high plant losses influenced the yields obtained that year (Kadar et al., 2017). In the year 2018, the rainfall in the spring was low, so that most of the 2nd and 3rd order plants dried up, the production obtained being the result of the main ears (Şimon, 2018).

The degree of fusariosis attack was expressed by the percentage of ears and fusaria grains. Environmental factors play an important role in the development of the disease which is favored by the prolonged humid weather during the anthesis. Particularly, excessive precipitation during the vegetation period and especially during the one to three weeks before the anthesis can lead to severe epidemics (Gilbert and Harber, 2013).

From the data presented in Table 1 one can observe the influence of climatic conditions on the percentage of ears and grains under *Fusarium* sp. attack.

Table 1. The influence of the climatic condition on the infected ears and kernels (average of the varieties and infection type)

No.	Year	Infected ears (%)	The difference to control	Infected kernels (%)	The difference to control
1.	Media	6.81	0.00	12.18	0.00
2.	2015	9.88	3.06***	20.75	8.57***
3.	2016	9.79	2.98***	23.25	11.07***
4.	2017	4.07	-2.75^{000}	1.56	-10.63^{000}
5.	2018	3.53	-3.29^{000}	3.18	-9.01^{000}
LSD (p 5%)			0.61		1.12
LSD (p 1%)			1.82		1.49
LSD (p 0.1%)			1.07		1.95

Compared to the experiment average, against the climatic conditions of 2015 and 2016, both the percentage of *Fusarium* ears and that of diseased grains was higher, with very positive statistically significant differences. Given the climatic conditions of 2017 and 2018, the percentage of the two parameters was reduced the differences from the control were distinctly significantly negative.

In case of infections with *Fusarium* sp. humidity is correlated with the severity and intensity of the disease, while precipitation and total radiation determine the levels of inoculation (Gilbert and Harber, 2013). Upon high pressure of infection (I) and without application of fungicides, the highest percentage of *Fusarium*-attacked grains and ears was registered, with very significant differences from the control. The application of treatments on vegetation significantly reduces the infections, the percentage of diseased ears and grains being very significantly reduced, compared to the control variant. Under natural conditions of infection, by applying a product to combat fusariosis, the lowest percentages of diseased ears and grains are recorded (Table 2).

Table 2. The influence of the infection condition on the infected ears and kernels (average of the varieties and years 2015-2018)

No.	Variant	Infected ears **(%)**	The difference to control	Infected kernels **(%)**	The difference to control
1.	C	7.88	0.00	14.71	0.00
2.	I	13.00	5.13***	20.38	5.67***
3.	IT	4.88	-3.00^{000}	9.92	-4.79^{00}
4.	T	1.51	-6.37^{000}	3.74	-10.97^{000}
LSD (p 5%)			0.92		2.20
LSD (p 1%)			1.39		3.33
LSD (p 0.1%)			2.23		5.35

Table 3. The behaviour of the wheat varieties on *Fusarium* sp. attack (average over 2015-2018 and infection type)

No.	Cultivar	Infected ears **(%)**	The difference to control	Infected kernels **(%)**	The difference to control
1.	Codru	8.58	0.00	12.18	0.00
2.	Andrada	5.05	-3.52^{00}	11.34	-0.84^{0}
LSD (p 5%)			0.70		1.49
LSD (p 1%)			1.03		2.17
LSD (p 0.1%)			1.54		3.26

Regarding the behavior of the studied cultivars, we can observe that the Codru variety displays a sensitivity to the *Fusarium* attack, both the percentage of diseased spices and grains was higher (8.58% and 12.18%). In the case of the Andrada variety, the percentages were reduced, with distinctly significant and significant differences from the Codru variety (Table 3).

Regarding the interaction between the climatic conditions, infection mode and the two varieties, in Figure 2 it can be observed that in the case of the percentage of diseased ears there were significant differences between the tested variants. The percentage of diseased ears was on average 8%. Compared to these average, the Andrada variety showed higher values, in conditions of artificial infection and without treatment, in all the experimental years (Figure 2), while the Codru variety showed lower values than the average in the variants where treatments were applied on vegetation, in the four years of experimentation (Figure 2), an aspect that confirms the efficiency of the treatments on the vegetation in diminishing the attack of the pathogen *Fusarium* sp.

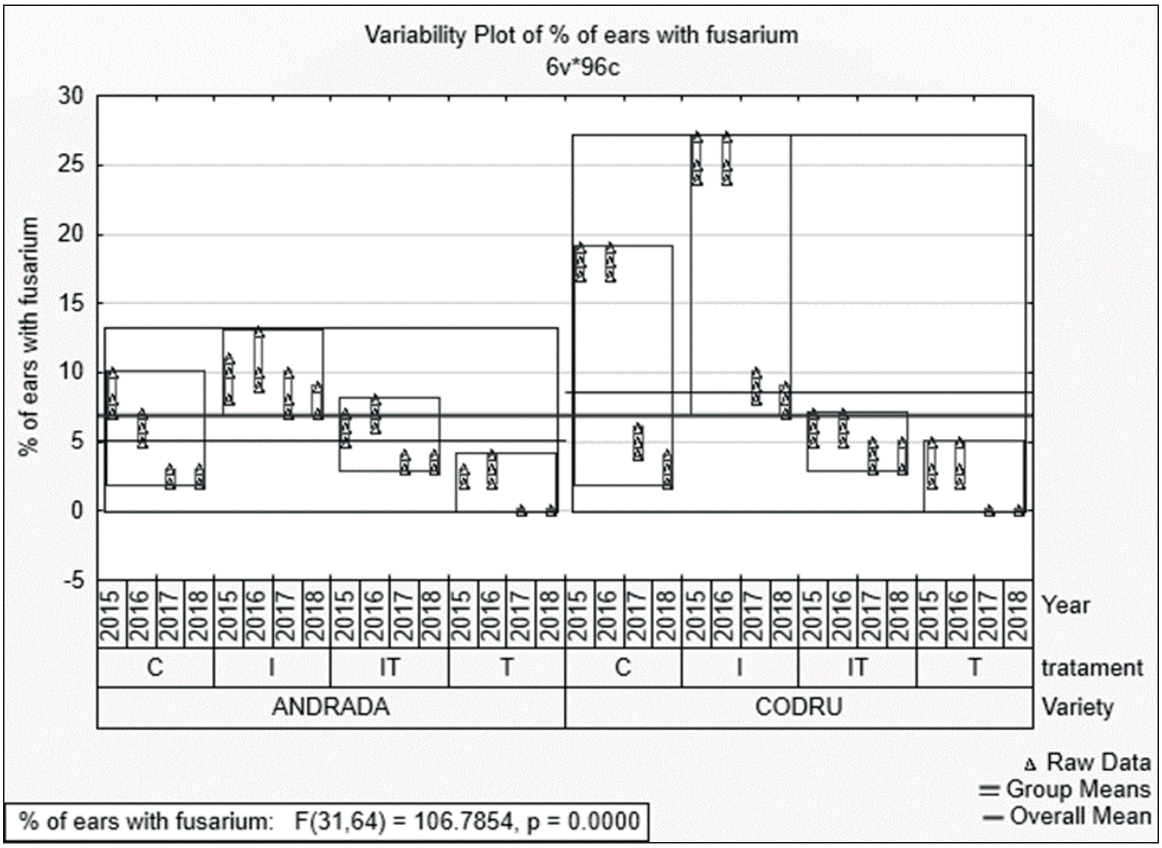

Figure 2. Interaction of climatic conditions and infection mode on the percentage of ears with *Fusarium* sp. (2015-2018)

Analyzing the interaction of climatic conditions, infection mode and varieties, on the percentage of disease kernels, we note that the differences between the variants are significant. The average percentage of disease kernels was 12% and compared to this, in both varieties under natural infection conditions and treatments on vegetation, the percentage of disease kernels was lower (Figure 3). At high pressure of infection and without treatments on vegetation, the percentage of disease kernels was higher, in both varieties, due to the climatic conditions of 2015 and 2016.

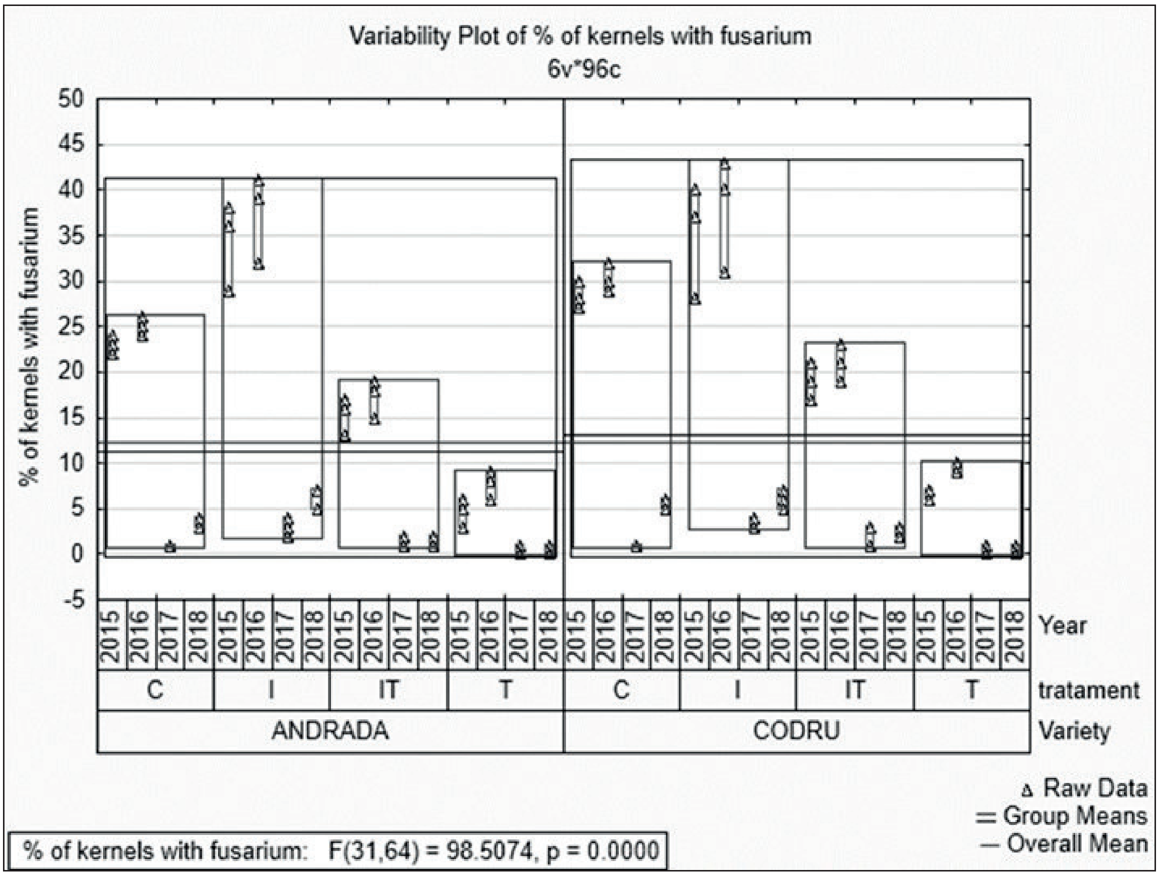

Figure 3. Interaction of climatic conditions and infection mode on the percentage of kernels with *Fusarium* sp. (2015-2018)

Analyzing the graph in Figure 4 one can observe a very significant positive correlation between the diseased ears and grains in the varieties Andrada and Codru, for the years 2015-2018.

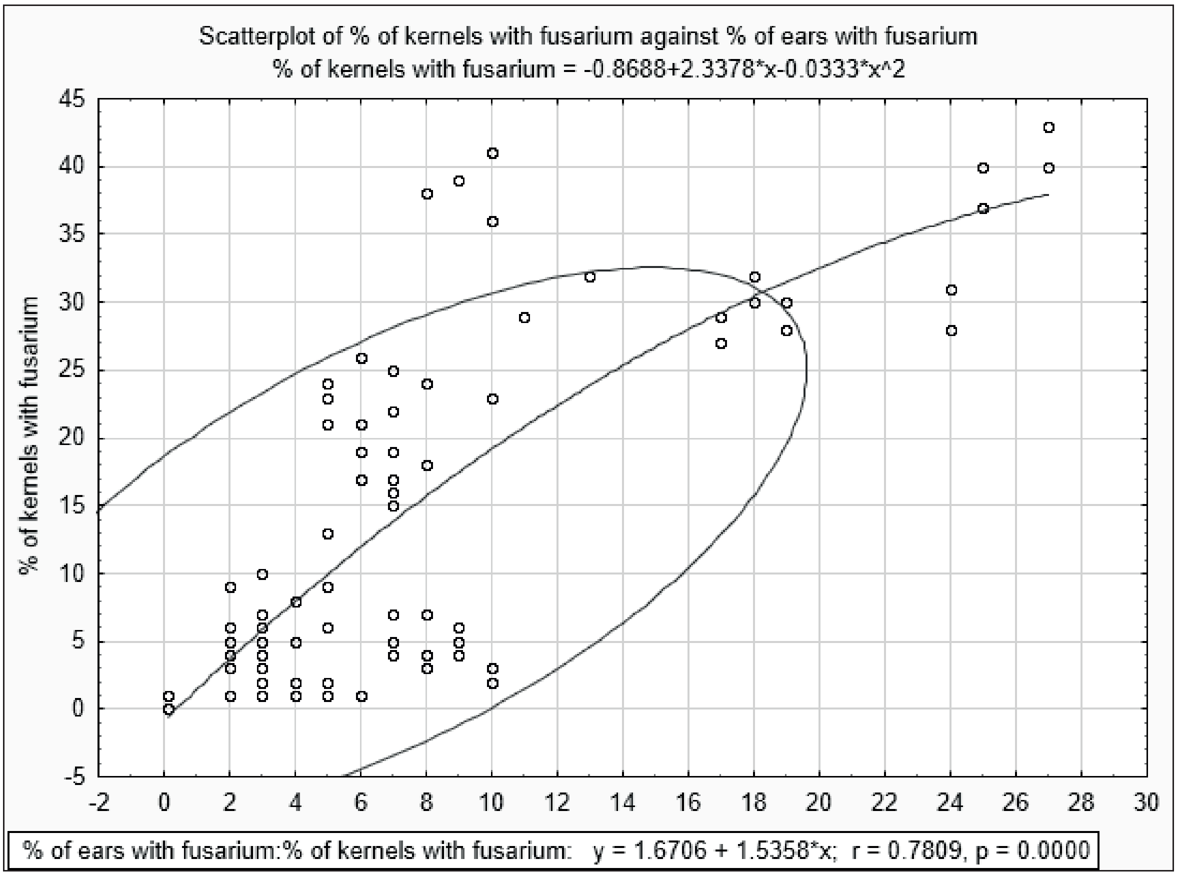

Figure 4. The correlation between ear and kernels with *Fusarium* sp.

The yield is a trait imparted by the genetics of the variety, but it can be influenced by the climatic conditions, the technology applied and the attack of diseases or pests. In the four years of experimentation, the average yields obtained were different, influenced largely by the climatic conditions. From the data presented in Table 5 one can see that the lowest yields were obtained because of the climatic conditions of 2017 (7132 kg) (Table 5), the 2017 winter causing significant plant losses.

At high pressure of infection with *Fusarium* sp. the smallest productions were obtained but the differences were not statistically ensured (Table 6).

The application of the treatments on the vegetation at the time of the infection results in obtaining production increases (278 kg), the differences from the control being distinctly significantly positive. In the variant where treatments were applied on vegetation, without artificial infections, the highest yields were obtained (Table 6).

Table 5. The influence of the climatic condition on yield (average of the varieties and infection type, 2015-2018)

No.	Year	Yield (kg/ha)	% to control	The difference to control
1.	Media	9114	100.0	0.00
2.	2015	9622	105.6	508*
3.	2016	9922	108.9	808**
4.	2017	7132	78.3	-1982[000]
5.	2018	9779	107.3	665*
LSD (p 5%)				490.14
LSD (p 1%)				742.21
LSD (p 0.1%)				1192.33

Table 6. The influence of the infection condition on yield (average of the varieties and years, 2015-2018)

No.	Variant	Yield (kg/ha)	% to control	The difference to control
1.	C	8924	100.0	0.00
2.	I	8809	98.7	-115
3.	IT	9202	103.1	278**
4.	T	9518	106.7	594***
LSD (p 5%)				196.68
LSD (p 1%)				262.63
LSD (p 0.1%)				342.67

Of the two varieties studied, Codru variety obtained the highest yields (Table 7), this variety being a productive variety, although in general it displays a sensitivity to the attack of *Fusarium* sp.

Table 7. The behaviour of the wheat varieties on *Fusarium* sp. attack (average over 2015-2018 and infection type)

No.	Genotype	Yield (kg/ha)	% to control	The difference to control
1.	Average	9113	100.0	0.00
2.	Andrada	8917	97.8	-196
3.	Codru	9309	102.2	196
LSD (p 5%)				239.69
LSD (p 1%)				348.63
LSD (p 0.1%)				522.95

The interaction of the three experimental factors on the yield is presented in Figure 5. From the data presented in figure 5 we can see that the Codru variety obtained the highest values of the yield, under natural infection conditions and with treatment in 2016. The lowest yields were obtained in 2017, in both varieties studied, in all the experimental variants.

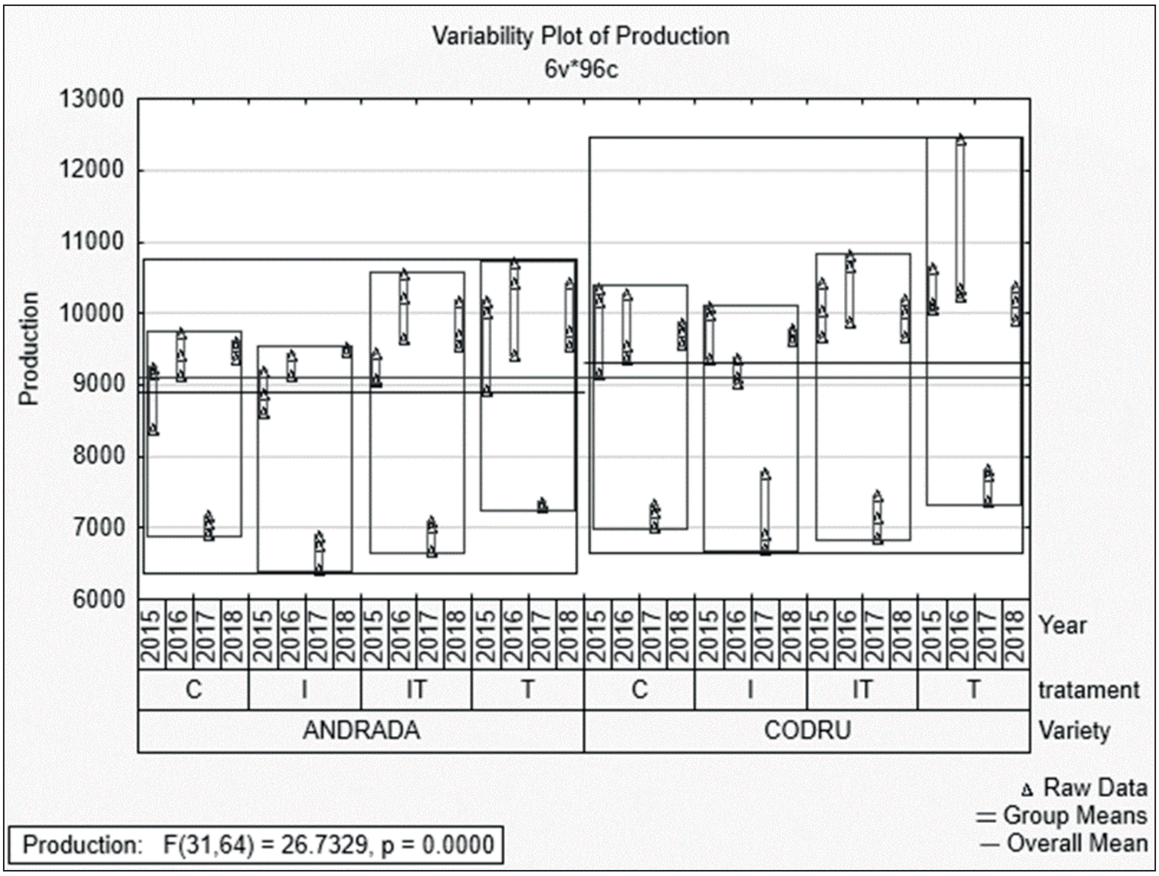

Figure 5. The influence of year, infection mode and variety on wheat yield (2015-2018)

CONCLUSIONS

The climate conditions have a decisive role in the emergence and development of the disease, the percentage of diseased ears and grains. The years 2015 and 2016 recorded the highest values, with very significant differences from the average of the experiment.

Treatment application on the vegetation, at the optimum time, reduced the percentage of grains and ears under attack, even if there was a high pressure of infection.

Cultivating a *Fusarium* resistant cultivar is one of the main measures used. In the years 2015-2018 the highest percentage of diseased ears and grains were registered in the Codru variety.

The yields obtained from the studied varieties were influenced by the climatic conditions, the manner of infection and the cultivated genotype. The lowest yields were obtained in 2017, a problematic year for the winter wheat crop. The lowest yields were obtained without the application of treatments.

Of the cultivated varieties, the highest yield was registered in the Codru variety, although it has a higher susceptibility to the attack of *Fusarium* sp.

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