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THE INFLUENCE OF THE NUMBER OF FUNGICIDE TREATMENTS UPON THE QUANTITY AND QUALITY OF WINTER WHEAT YIELD IN CLIMATIC CONDITIONS OF ARDS TURDA

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ABSTRACT

The effect of the number of fungicide treatments in vegetation on the quality and quantity of the autumn yield was studied in 2012-2014 at Agricultural Research & Development Station (ARDS) Turda, in the Phytopathology laboratory field. The study was conducted with three wheat varieties: Arieșan, Dumbrava and Andrada and the test variants were: no treatment (T0), one treatment, (T1) and two treatments (T2). The vegetation treatments were carried out with the products Nativo (1 l/ha) and Prosaro (1 l/ha). Since the Fusarium head blight, produced by different species of the genus *Fusarium*, is the most important disease in wheat crops and has a high impact on the quality and quantity of production, the percentage of diseased kernels was determined. Applying vegetation treatments with fungicides decreased the percentage of diseased grains compared to the control. The yield increased when treatments were applied. The gluten and the protein content recorded a slight decrease or increase, depending on the variant; the ash content decreased when the treatments were applied during the vegetation period. The application of fungicide treatment on the vegetation is an important link in the wheat crop management, ensuring higher quantitative and qualitative production.

Key words: wheat, fungicide, quality, yield.

INTRODUCTION

The winter wheat crops are affected by many diseases that cause significant quantitative and qualitative losses, damaging the food, feed and seed production.

Wheat yield varies from year to year, influenced by the climatic conditions, the variety grown and the presence of pathogens causing foliar and ear diseases. Production quality (e.g. protein and gluten content) is influenced by the soil environment, and climatic condition, but also by the diseases.

From the many diseases present in wheat crop, Fusarium ear blight, is responsible for reducing the yield and also contributes to its quality decrease. Along with the seed treatment, fungicide treatments on vegetation help to control pathogens like *Fusarium* spp., with the condition that fungicides are applied in the BBCH 61- BBCH 65 stage.

MATERIALS AND METHODS

The study of fungicide treatments in vegetation effects on the quantity and quality of winter wheat production was performed during 2012-2014 at ARDS Turda, in the Phytopathology laboratory. As biological material we used the wheat varieties: Arieșan, Dumbrava and Andrada. The test variants were: no treatment (T0), one treatment (T1), and two treatments (T2) (Table 1). The treatments carried out were with Nativo (1 l/ha), (tebuconazol 200 g/l + trifloxystrobin 100 g/l) at the flag leaf emergence and Prosaro (1 l/ha) (prothioconazole 125 g/l + tebuconazol 125 g/l) (Hershman et al., 2009; Welugo & Klein, 2013), at the end of flowering. Since Fusarium head blight produced by different species of the *Fusarium* genus, is the most important disease in wheat crop with a major impact on the quality and quantity of production, we determined the percentage of

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diseased kernels (%). Yield was measured in kg ha^{-1}. The quality parameters were determined using INSTALAB 600 and AGRICHEK analyser. The data obtained from the observations were processed using POLIFACT program.

Table 1. List of the field plot variants

Variant	Treatment
T0	Control variant with seed treatment
T1	Seed treatment and one vegetation treatment
T2	Seed treatment and two vegetation treatments

RESULTS AND DISCUSSION

The climatic conditions influence the growing and the developing of the plants, but also the emergence and the evolution of the pathogens. The year 2012 was a very warm year. The lack of water in soil, combined with the lack of rainfall in late 2011 led to the emergence of wheat only in the spring of 2012.

Even though the year 2012 was not normal in terms of climatic conditions, the varieties studied behaved well, being stable in terms of production and high capacity to adapt to different environmental conditions.

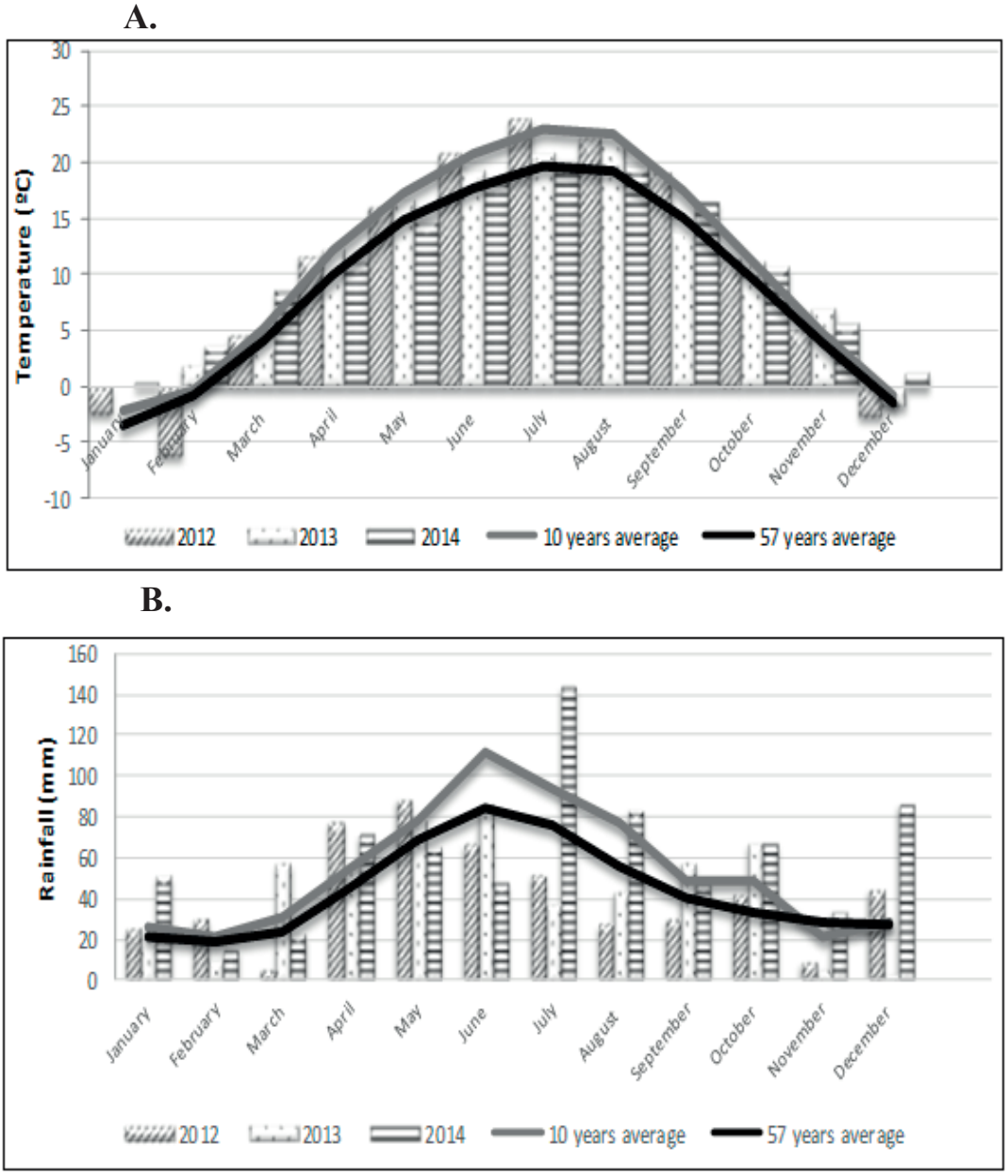

Figure 1. The temperatures (**A**) and the rainfall regime (**B**) at ARDS Turda, during 2012-2014 (Source: Weather Station Turda (longitude: 23° 47; latitude 46°35; altitude 427 m)

In terms of temperatures, the year 2013 was a hot year, with temperatures that were slightly above the average of 55 years (Figure 1A).

The temperatures recorded in 2014 were closer to the 57 years average, the year being characterized as normal in terms of temperatures, especially in the last period of the wheat growing season, May, June and July. The years 2012 and 2013 were characterized as normal in terms of rainfall. The rainfall in April, May and June (Figure 1B) in the two experimental years, influenced the emergence and development of the pathogens.

From the perspective of the climatic conditions the year 2014 was very rainy, but the rainfall was not evenly distributed, June was characterized as excessively dry and July as excessively rainy.

In order to determine the influence of the vegetation treatments on the quantity and the quality of the production of winter wheat varieties, we studied the percentage of diseased kernels in the three experimental years. The climatic conditions of the experimental years influenced the emergence and the manifestation of the diseases.

In 2013, the average percentage of diseased kernels in all varieties studied was higher, with a significant positive difference compared to the year 2012 taken as control (Table 2).

Regarding the influence of the number of vegetation treatments on the percentage of the diseased kernels, by applying one or two treatments the percentage of attacked kernels was lower than the untreated control, with significant negative differences (Table 3).

Table 2. The influence of the climatic condition on the diseased kernels (average of all varieties and treatments)

No.	Year	Diseased kernels %	Diseased kernels arcsin√%	% to control	The difference to control	The significance of the difference	Duncan Test
1	2012	12.54	20.13	100.0	0.00	Control	A
2	2013	22.41	28.08	178.6	10.23	***	C
3	2014	16.00	23.01	127.5	3.46	***	B
LSD (p 5%)						2.82	SD=2.82
LSD (p 1%)						4.67	
LSD (p 0.1%)						8.74	

Table 3. The influence of the number of treatments on the diseased kernels (average of over all varieties and years 2012-2014)

No.	Number of treatments	Diseased kernels %	Diseased kernels arcsin√%	% to control	The difference to control (T0)	The significance of the difference	Duncan Test
1	T0	23.41	28.82	100.0	0.00	Control	C
2	T1	16.61	23.77	71.1	-7.71	000	B
3	T2	10.92	18.63	46.6	-12.86	000	A
LSD (p 5%)						1.40	SD=1.40
LSD (p 1%)						1.87	
LSD (p 0.1%)						2.47	

Between the averages percentage of diseased kernels of all the variants, there were differences, but not statistically significant (Table 4). However, we notice that the variety Dumbrava recorded the highest percentage of diseased kernels (17.33%) and the variety Arieşan, recorded the lowest percentage of kernels attacked by *Fusarium* spp. (16.44%).

In the year x variety x treatments number interaction it can be observed that application of vegetation treatments contributes to very significant reduction of the percentage of diseased grains, in all three experimental years (Table 5). A more accurate picture of

the effects of the tested factors on the percentage of diseased kernels is offered by the Duncan Test.

As shown in Table 5, the lowest percentage of *Fusarium* damaged kernels was recorded when two treatments were applied to the Arieşan and Andrada varieties in the year 2012. The application of the fungicide treatments on vegetation, contributes alongside with the crop management measures (crop rotation, sowing period, balanced fertilization, cultivation of resistant varieties) to obtaining high yields.

Table 4. The behaviour of the three varieties on *Fusarium* spp., attack (averaged over 2012-2014 and treatments)

No.	Variety	Diseased kernels %	Diseased kernels arcsin√%	% to control	The difference to control	The significance of the difference	Duncan Test
1	Arieşan	16.44	23.08	100.0	0.00	Control	A
2	Dumbrava	17.33	24.25	105.4	0.89	-	A
3	Andrada	17.18	23.89	104.5	0.74	-	A
LSD (p 5%)						1.25	SD=1.52
LSD (p 1%)						2.13	
LSD (p 0.1%)						3.01	

Table 5. The influence of the climatic conditions and the number of treatments on the diseased kernels, during 2012-2014

No.	Year	Variety	No. of treat.	Diseased kernels %	Diseased kernels arcsin√%	% to control (T0)	The difference to control	The significance of the difference	Duncan Test
1	2012	Arieşan	T0	20.63	26.97	100.0	0.00	Control	GHIJ
			T1	9.57	17.98	46.4	-11.07	000	BC
			T2	4.77	12.60	23.1	-15.87	000	A
		Dumbrava	T0	23.00	28.63	100.0	0.00	Control	HIJK
			T1	14.10	22.03	61.3	-8.90	000	CDEF
			T2	3.90	13.66	17.0	-19.10	000	AB
		Andrada	T0	20.10	26.48	100.0	0.00	Control	FGHIJ
			T1	12.20	20.42	60.7	-7.90	000	CD
			T2	4.63	12.42	23.1	-15.47	000	A
2	2013	Arieşan	T0	28.00	31.89	100.0	0.00	Control	K
			T1	25.33	30.15	90.5	-2.67	000	IJK
			T2	19.00	25.66	67.9	-9.00	000	EFGHI
		Dumbrava	T0	23.67	29.08	100.0	0.00	Control	HIJK
			T1	22.00	27.95	93.0	-1.67	000	GHIJK
			T2	14.00	21.91	59.2	-9.67	000	CDEF
		Andrada	T0	26.33	30.80	100.0	0.00	Control	JK
			T1	23.33	28.88	88.6	-3.00	000	HIJK
			T2	20.00	26.40	75.9	-6.33	000	FGHIJ
3	2014	Arieşan	T0	18.00	25.08	100.0	0.00	Control	DEFGH
			T1	14.00	21.94	77.8	-4.00	000	CDEF
			T2	8.67	15.41	48.1	-9.33	000	AB
		Dumbrava	T0	28.33	32.14	100.0	0.00	Control	K
			T1	13.33	21.34	47.1	-15.00	000	CDE
			T2	13.67	21.51	48.2	-14.67	000	CDE
		Andrada	T0	22.67	28.34	100.0	0.00	Control	HIJK
			T1	15.67	23.21	69.1	-7.00	000	DEFG
			T2	9.67	18.10	42.6	-13.00	000	BC
LSD (p 5%)								4.19	DS=4.20
LSD (p 1%)								5.61	
LSD (p 0.1%)								7.40	

Under the experimental conditions from ARDS Turda the application of fungicide treatments during the vegetation resulted in yield increases in all the studied varieties.

In the climatic conditions of the year 2014, by applying two treatments on vegetation, the yield increase in all varieties ranged between 1600 kg and 1900 kg; the highest yield was recorded in the case of Andrada variety (Table 6).

Protein, gluten and ash content can be influenced by the infection with *Fusarium* spp. The protein content can increase, decrease or remain constant as a result of the *Fusarium* attack. Boyacioğlu and Hettiarachchy in 1995 recorded an increase in protein content after infection with *Fusarium* spp. Other authors (Dexter et al., 1997; Gartner et al., 2008) observed a slight decrease in the protein content and Kreuzberger, in 2011, stated that the *Fusarium* infections did not affect the protein content.

The environmental conditions (year x location) the previous crop and the cultivar type might influence the protein content.

Table 6. The influence of the climatic conditions, varieties and the number of treatments on yield

No.	Year	Variety	No. of treatments	Yield (kg/ha)	% to control (T0)	The difference to control	The significance of the difference
1	2012	Arieşan	T0	7816.00	100.0	0.00	Control
2			T1	8264.00	105.7	448.00	-
3			T2	8341.67	106.7	525.67	-
4		Dumbrava	T0	8153.67	100.0	0.00	Control
5			T1	8819.33	108.2	665.67	-
6			T2	8891.33	109.0	737.67	*
7		Andrada	T0	7677.00	100.0	0.00	Control
8			T1	8090.67	105.4	413.67	-
9			T2	8342.33	108.7	665.33	-
10	2013	Arieşan	T0	7830.67	100.0	0.00	Control
11			T1	7851.00	100.3	20.33	-
12			T2	7936.00	101.3	105.33	-
13		Dumbrava	T0	7984.67	100.0	0.00	Control
14			T1	8447.00	105.8	462.33	-
15			T2	9184.00	115.0	1199.33	**
16		Andrada	T0	7666.33	100.0	0.00	Control
17			T1	8512.33	111.0	846.00	*
18			T2	8626.00	112.5	959.67	*
19	2014	Arieşan	T0	9909.67	100.0	0.00	Control
20			T1	10016.67	101.1	107.00	-
21			T2	10157.67	102.5	248.00	-
22		Dumbrava	T0	9082.67	100.0	0.00	Control
23			T1	9768.33	107.5	685.67	-
24			T2	10519.67	115.8	1437.00	***
25		Andrada	T0	9612.33	100.0	0.00	Control
26			T1	9790.67	101.9	178.33	-
27			T2	10308.67	107.2	696.33	-
LSD (p 5%)						718.98	
LSD (p 1%)						962.90	
LSD (p 0.1%)						1269.92	

In our experiment, in the variant without treatments the amount of gluten was higher than in the treated variants and this was correlated with a lower yield. A slight decrease or even the same values were observed when applying the vegetation treatments (Figure 3). Due to the fact that in 2014 the highest yields were obtained, the protein and gluten content of the studied varieties was lower (Figure 2 and Figure 3); between yield and the protein and gluten content a negative correlation was recorded.

The ash content in the flour obtained from *Fusarium* infected grains increased in a

study made by Kreuzberger (2011). Papoušková et al. (2011) also noted an increase in ash content in the flour obtained from wheat infected with *Fusarium*.

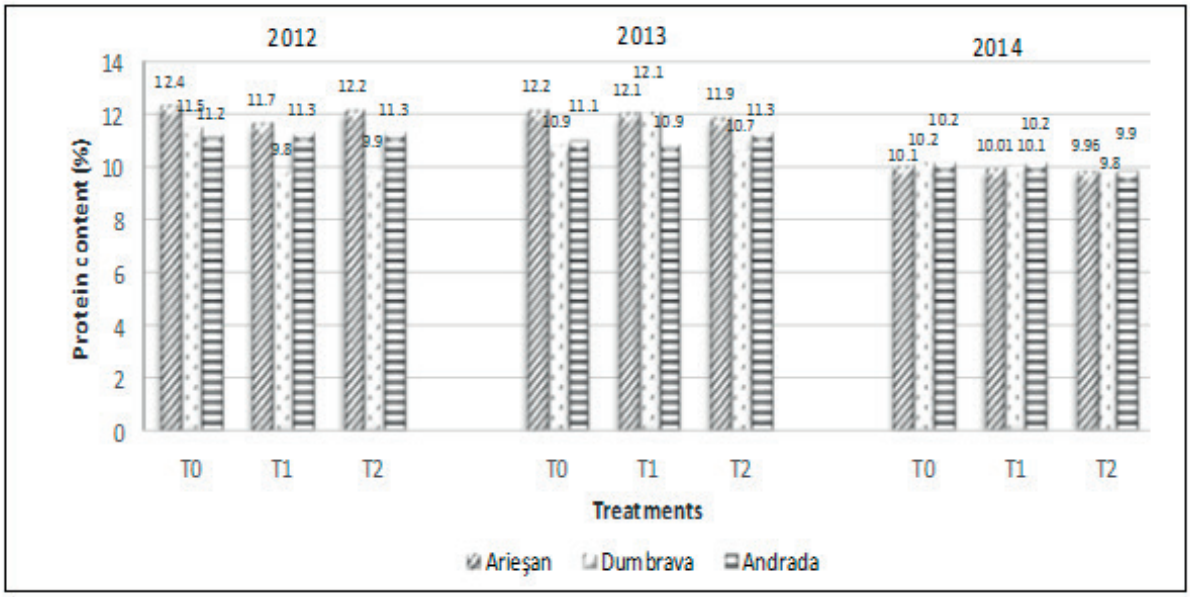

Figure 2. The protein content of tested wheat varieties at different treatments during 2012-2014

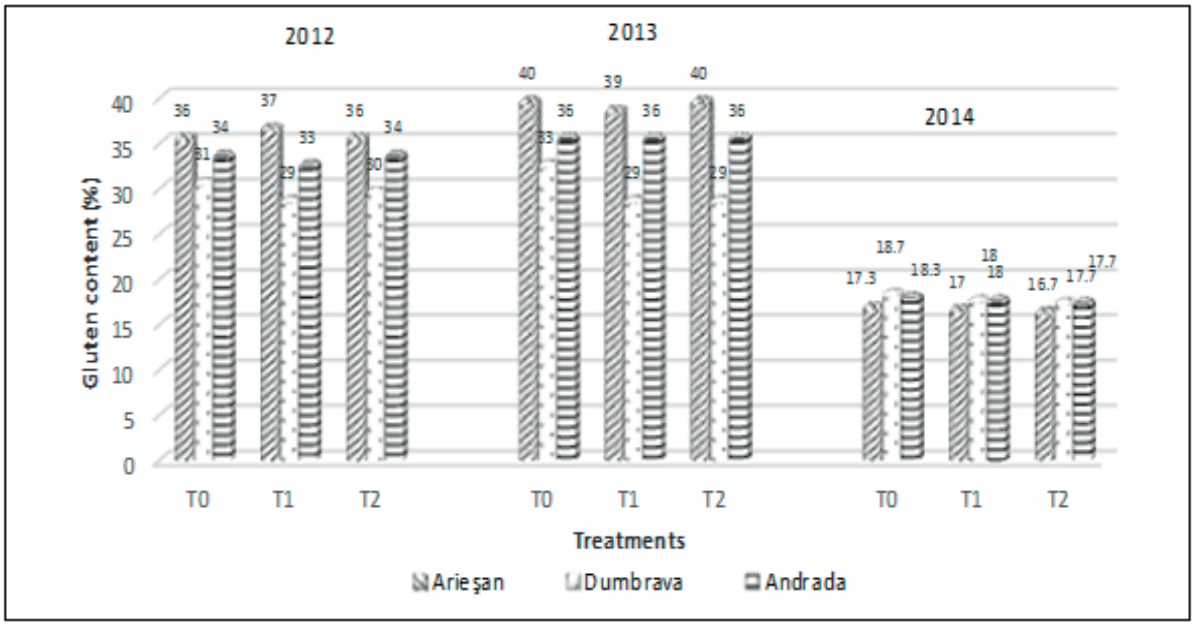

Figure 3. The gluten content of tested wheat varieties at different treatments during 2012-2014

In our experiment, the ash content was higher in the variant without vegetation treatments, correlated with a higher percentage of diseased kernels.

The application of vegetation treatments lead to the decreasing of the ash content in flour obtained from the studied varieties (Figure 4).

To highlight the influence of the fungicide vegetation treatments on the quantity and quality of production, we calculated the average yields per hectare in the three experimental years and the average amount of protein per hectare for all the varieties.

It can be seen in Table 7 that the highest amount of protein per hectare was obtained in the variant where two vegetation treatments were applied, although in this variant the protein content was slightly lower than in the untreated variant.

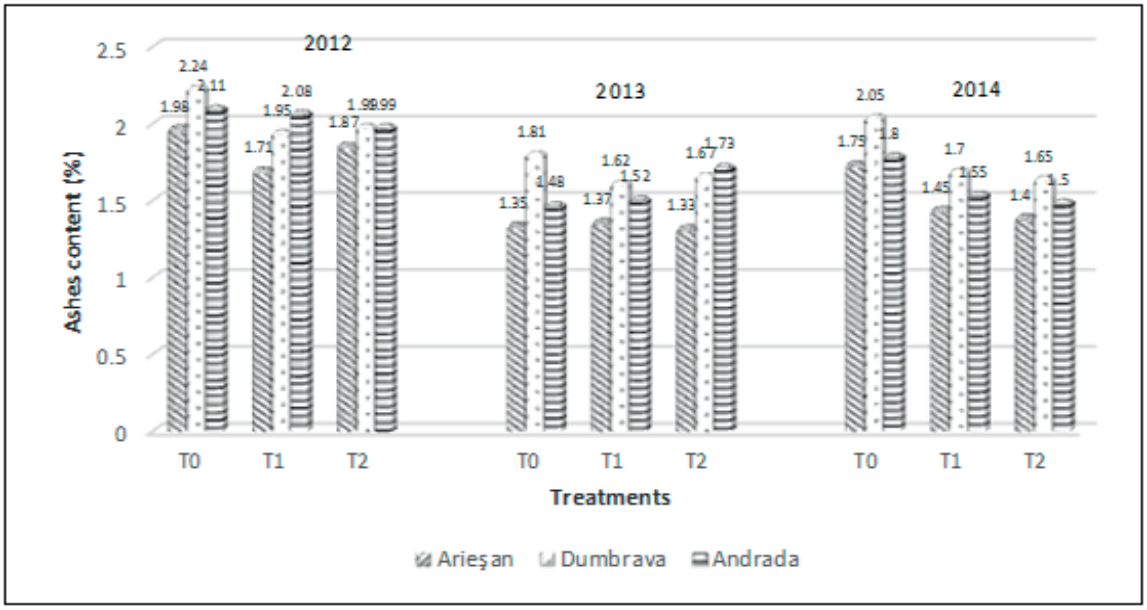

Figure 4. The ashes content of tested wheat varieties at different treatments during 2012-2014

Table 7. The protein yield (kg ha^{-1}) during 2012-2014

No.	Variety	Number of treatments	Yield average 2012-2014 (kg ha^{-1})	Average protein content 2012-2014 (%)	Average protein yield 2012-2014 (kg ha^{-1})
1.	Arieşan	T0	8519	12.1	1031
		T1	8710	12.0	1045
		T2	8811	11.9	1049
2.	Dumbrava	T0	8407	11.2	942
		T1	9011	10.6	955
		T2	9532	10.5	1001
3.	Andrada	T0	8318	11.4	948
		T1	8798	11.3	994
		T2	9092	11.2	1018

CONCLUSIONS

The climatic conditions influenced the percentage of kernels attacked by *Fusarium* spp.; in 2013 the percentage of diseased kernels was higher in all studied varieties.

The number of vegetation treatments with fungicides influenced the percentage of diseased kernels; by applying a single treatment or two treatments on vegetation the percentage of diseased kernels decreased very significantly compared with the untreated control variant.

In the experimental conditions from Turda, applying of vegetation treatments lead to increased yields between 15 and 1967 kg ha^{-1}, depending on the number of treatments applied.

The application of vegetation treatments lead to a slight decrease in the protein percentage with a single treatment and to a slight increase after the application of two treatments, but the values did not exceed the protein content recorded in the untreated control.

In case of applying vegetation treatments the amount of gluten recorded a slight decrease compared to the amount of gluten obtained without treatments.

The ash content was higher in the variant without vegetation treatment correlated with a higher percentage of diseased kernels; the

application of treatments in vegetation decreased the ash content.

The highest amount of protein per hectare was obtained in the variant where two treatments were applied on vegetation and it can be said that the application of two treatments on vegetation contributed to a higher production in terms of quantity and quality.

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