

THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON BARLEY HARVEST, DONAU VARIETY, IN 2021 PEDOCLIMATIC CONDITIONS OF THE EASTERN BARAGAN

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Abstract

This study aims at monitoring the dynamics of the occurrence and evolution of the attack of some pathogens to barley, among which we mention: mildew (*Blumeria graminis* f.sp. *hordei*), leaf stripe (*Pyrenophora graminea*) and barley's rust (*Puccinia hordei*). Also, the influence of applying these fungicides on the harvest, as well as of the number of treatments/ha as compared to the untreated control variant, has been monitored. For this study, an experiment with 6 treatment variants was created, being used the following phytosanitary products: EVALIA (azoxystrobin 250 g/l), EVOLUS (prochloraz 320 g/l, tebuconazole 160 g/l, proquinazid 40g/l); FALCON PRO (prothioconazole 53 g/l, spiroxamine 224 g/l, tebuconazole 148 g/l). The treatment variants were the following: V1- EVALIA 1.00 L/HA 2 treatments (the first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021, V2 - EVOLUS 0.75 L/HA 2 treatments (the first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021), V3- FALCON PRO – 0.6 L/HA 2 treatments (the first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021), V4 - EVALIA 1.00 L/HA 1 treatment applied in "bellows" - earing phase – 7.05.2021, V5- EVOLUS 0.75 L/HA 1 treatment applied in "bellows" - earing phase – 7.05.2021, V6 - FALCON PRO – 0.8 L/HA 1 treatment applied in "bellows" - earing phase – 7.05.2021, V7- untreated control variant. The experiment was placed in Latin square, the 7 variants being placed in 7 repetitions. The year 2021 had rainy spring and beginning of summer, favorable to the attacks of some pathogens. The first two leaves under the ear had been analyzed, in order to determine the attack of the pathogens. Among the pathogens monitored, relatively strong attacks produced by the *Pyrenophora graminea* fungus (producing, in barley, the disease known as leaf stripe disease) had been observed. The yields of the variants were the following: V1 – 6.748 to/ha, V2 – 6.536 to/ha, V3 – 7.103 to/ha, V4 – 6.834 to/ha, V5 – 7.049 to/ha, V6 – 7.440 to/ha and V7 – 5.704 to/ha.

Key words: *Pyrenophora* spp., *Blumeria* spp., latin square

Hordeum vulgare barley is attacked by many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe-*Pyrenophora graminea*, leaf blotch - *Rhynchosporium secalis*, rust - *Puccinia hordei* (Iacob Viorica, Hatman, M., Ulea, E., Puiu, I. 1998). The first half of the year 2021 was very favorable for barley, for obtaining high yields. Heavy rainfall had been recorded, unlike the previous year which had been dry. For example, in April the average recorded temperature was 10.9°C and rainfalls totaled 33.6 l/m². In May, rainfalls totaled 28 l /m². March was relatively rich in rainfalls (40.6 l/m²) with the average temperature being 6° C. The emergence of barley in the fall of 2020 was good. The winter between 2020 and 2021 was quite warm, as was the previous winter,

which allowed the plants not to frostbite, barley being a species more sensitive to cold than wheat. The rainfalls that fell between March and May, in 2021, was much higher than those that fell in the previous year. These led to a much higher production of barley compared to the production obtained in the previous year. Among the pathogens that have appeared, we mention the *Pyrenophora graminea* (figure 1) fungus which produces, in barley, the disease called leaf stripe. This pathogen attacks barley cultures every year at attack intensities that vary from year to year. The other pathogens mentioned were not signaled in the barley experience even though very favorable conditions existed for the occurrence of their attack.

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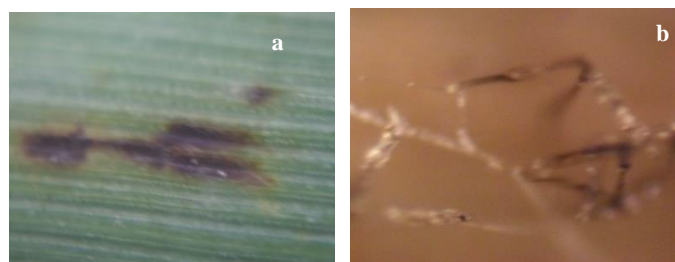


Figure 1 - Barley's leaf stripe, *Pyrenophora graminea* (beginning of the attack): a – attack on leaves, b – conidia (original).



Figure 2 - Aspects from the experiment field (original)

Table 1

The results of the experiment with fungicide products (6 variants of treatment + 1 untreated control variant) in what concerns the attack (D.A. %) of *Pyrenophora graminea* fungus on barley (“flag” leaf and the next leaf). The observations were performed on the date of 26th May 2021

Variant	The “flag” leaf			The second leaf		
	D.A%	Difference as compared to the control variant	Significance	D.A%	Difference as compared to the control variant	Significance
V1 - EVALIA 1.00 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021)	10.71	21.29	**	39.30	14.70	**
V2 - EVOLUS 0.75 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021 the second treatment applied at the end of blooming - 19.05.2021)	14.28	17.72	**	47.30	6.70	Not significant
V3 - FALCON PRO – 0.6 L/HA - 2 treatments (first treatment applied at straw's extension 17.04.2021, the second treatment applied at the end of blooming 19.05.2021)	16.14	15.86	**	47.10	6.90	Not significant
V4 - EVALIA 1.00 L/HA-1 treatment applied in “bellows” - earing phase - 7.05.2021	5.28	26.72	**	32.40	21.60	**
V5 - EVOLUS 0.75 L/HA-1 treatment applied in “bellows” - earing phase - 7.05.2021	10.14	21.86	**	42.70	11.30	*
V6 –FALCON PRO – 0.8 L/HA - 1 treatment applied in “bellows”-earing phase - 7.05.2021	11.00	21.00	**	39.20	14.80	**
V7 – Untreated control variant.	32.00	–	–	54.00	–	–

LD D.A.% for the „flag” leaf
LD 5% =5.87%

LD D.A.% for the second leaf:
LD 5% = 9.80%

LD 1% =7.92%

LD 1% =13.22%

Table 2

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the yield (t/ha) obtained at the treated variants as compared to the untreated control variant

Variant	Yield (to/ha)	Difference as compared to the control variant (to/ha)	Significance
V1 - EVALIA 1.00 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming – 19.05.2021)	6.748	1.044	*
V2 - EVOLUS 0.75 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021 the second treatment applied at the end of blooming – 19.05.2021)	6.536	0.832	Not significant
V3 - FALCON PRO – 0.6 L/HA - 2 treatments (first treatment applied at straw's extension 17.04.2021, the second treatment applied at the end of blooming 19.05.2021)	7.103	1.399	*
V4 - EVALIA 1.00 L/HA - 1 treatment applied in "bellows" - earing phase – 7.05.2021	6.834	1.130	*
V5 - EVOLUS 0.75 L/HA - 1 treatment applied in "bellows" - earing phase – 7.05.2021	7.049	1.345	*
V6 - FALCON PRO – 0.8 L/HA - 1 treatment applied in "bellows" - earing phase – 7.05.2021	7.440	1.736	**
V7 - Untreated control variant.	5.704	–	–

LD 5% = 0.990 to/ha

LD 1% = 1.350 to/ha

MATERIAL AND METHOD

For performing the observations, an experiment with 7 study variants was conceived. This experiment comprised 6 variants of phytosanitary treatment (fungicide products, their combinations, number of treatments) and a control variant not treated. The variants of the experiment were the following (table 1):

-V1: EVALIA 1.00 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021);

-V2: EVOLUS 0.75 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021);

-V3: FALCON PRO - 0.6 L/HA - 2 treatments (first treatment applied at straw's extension 17.04.2021, the second treatment applied at the end of blooming 19.05.2021);

-V4: EVALIA 1.00 L/HA - 1 treatment applied in "bellows" - earing phase - 7.05.2021;

-V5: EVOLUS 0.75 L/HA - 1 treatment applied in "bellows" - earing phase - 7.05.2021;

-V6: FALCON PRO – 0.8 L/HA - 1 treatment applied in "bellows" - earing phase - 7.05.2021;

-V7: Untreated control variant.

The experiment was placed in Latin square. These 7 variants were placed in 7 repetitions. Each experimental plot had an area of 21 m² (7 x 3 m). The total area of the experiment was of 49. The area of an experimental variant was of 21 m² x 7 repetitions = 147 m². The total area of the experiment was of 147 m² x 7 = 1029 m². The treatments were performed manually, with a machine of "Vermorel" type. "Trend" adjuvant product, in concentration of 0.03%, was

added to the sprinkling solution. Weeds control was done with the help of Mustang herbicide (6.25 g/l florasulam + 300 g/l acid 2,4-D EHE) in a dosage of 0.5 l/ha, applied separately with Vermorel. The experiment had as purpose establishing the efficiency of the mentioned phytosanitary products, reported to their price, as well as the efficiency and respectively the lucrativeness of applying one or two phytosanitary treatments during barley's vegetation period.

The evaluation of the attack's frequency (F%), of the attack's intensity (I%) and respectively, of the degree of attack (D.A.%) was done separately, on each and every experimental plot, analyzing 10 plants / experimental plot. Their degree of affectation (the intensity of the attack I %) of the last 2 leaves, especially of the "flag" leaf which has the biggest contribution to the ear's yield at cereals, had been assessed. The phytosanitary analyses of the plant's samples were done with the help of the stereomicroscope and optic microscope at Brăila Phytosanitary Office's laboratory – Phytosanitary National Authority, institution subordinated to the Ministry of Agriculture and Rural Development. These analyses had revealed the presence of *Pyrenophora graminea* fungus in the samples analyzed, which produces the barley's leaf stripe.

In order to assess the yield of each variant under study, kernel samples from each experimental plot, 5 samples / plot, had been analyzed by sampling. Each sample comprised 10 plants, so, from each experimental plot, 50 plants were taken over, from which the yield was manually weighted. The demarcation of each sample was performed with a metric frame with the area of 0.25 m² (0.5/0.5m). The average of the experimental plot samples had served for calculating the production of each and every experimental plot. The statistic interpretation had been done with the help of the limit differences (LD %) (Săulescu N).

Donau variety was used. This is a new German variety of barley for beer, traded by Soufflet French Company. The variety is early-flowering. It has a good resistance to falling, cold and barley's specific diseases (Soufflet. Agro Romania 2020).

Assessing the pest attack can be done with the help of the following values (Prognosis and Warning Methods, 1980):

- Attack frequency (F %);
- Attack intensity (I %);
- Degree of attack (D.A %).

-Attack frequency represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of plants or organs observed (N). The value of the frequency is established through direct observations on a number of plants or organs, according to the case and to the conditions, existing different methods of collecting the samples and of performing the observations. In the case of our observations regarding the foliar diseases, the number of attacked plant organs from the total of observed plant organs (leaves) had been taken into consideration, establishing thus the frequency of the attack expressed in percentages %. In case of blights, the number of attacked ears reported to the total number of observed ears had been used. The frequency was calculated with the help of the $F\% = \frac{n \times 100}{N}$ formula.

-Attack intensity represents the degree or percentage where a plant or an organ of the plant is attacked and how much from the area of the plant or of the organ analyzed (leaf, fruit) is covered by the disease under study.

The assessment of the area attacked had been done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. The damage percentage can be recorded or grades can be awarded for each plant or organ attacked by the disease or/and by the pest. Grades usage can ease up greatly data summarizing. It can be used a scale with 6 degrees of intensity, as follows:

- Grade 0 no attack
- Grade 1 attack 1 – 3%
- Grade 2 attack 3 – 10%
- Grade 3 attack 11 – 25%
- Grade 4 attack 26 – 50%
- Grade 5 attack 51 – 75%
- Grade 6 attack 76 – 100%

After summarizing the data, the attack intensity had been determined with the following formula:

$$I\% = \frac{\sum (i \times f)}{N}$$

Where:

I% – Attack intensity (in %);

i – The intensity according to the grade awarded to the organ or plant attacked;

f – The number of cases (plants, organs) attacked;

n – The number of plants attacked.

In our experiment, grades from 1 to 6 had been separately awarded to the “flag” leaf and to the next leaf situated below it.

-The Degree of Attack is the expression of the attack severity's extension on the crop or of the total number of plants for which we are making the observations. D.A.'s value expression is given by the ratio:

$$D.A (\%) = \frac{F \times I}{100}$$

In most of the cases, there is a negative correlation between the degree of attack of a pathogenic agent or pest and the quantitative and/or qualitative level of a crop's yield.

RESULTS AND DISCUSSIONS

The agricultural year 2020 – 2021 was favorable for barley crop. It must be underlined the very important fact that barley (*Hordeum vulgare*) is a variety more sensitive to disease attack and to wintering than wheat. As compared to last year, March, April and May months were richer in rainfalls compared to 2020. Those months were cooler compared to the same months in 2020. The autumn of 2020 had sufficient rainfalls, the plants emerging in time in order to go through the winter of 2020-2021.

In what concerns the occurrence dynamic of the pathogens' attacks on barley, we mention the following aspects: - *Pyrenophora graminea* had affected barley in a higher extent, as compared to previous years. This fact has led to the conclusion that a second treatment might be necessary in certain situations. The degree of attack (D.A. %) was of only 32.00% at V7 variant - untreated control variant, at the “flag” leaf - on the date of 26th May 2021. This high degree of attack on this leaf has led to the appearance of yield differences between the variants with treatment (V1...V6) and the untreated control variant V7. It should be noted that this pathogen is proven to be more dangerous in years with rainy and cool springs.

Even though favorable weather conditions had been present, no other attacks of other pathogens specific to barley had been present – fungi of *Blumeria* and *Puccinia* genera.

If we analyze the data from Table 1, we observe that the degree of attack of *Pyrenophora graminea* fungus was differentiated, as follows:

-V1: EVALIA 1.00 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021 has determined a degree of attack of *Pyrenophora graminea* fungus of 10.71% on the flag leaf and of 39.30% on the second leaf, so smaller by 21.29%, and, respectively, by 14.70% as compared to the untreated control variant (V7).

-V2: EVOLUS 0.75 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021

the second treatment applied at the end of blooming - 19.05.2021) has determined a degree of attack of *Pyrenophora graminea* fungus of 14.28% on the flag leaf and 47.30 % on the second leaf, so smaller by 17.72 %, and respectively by 6.70% as compared to the untreated control variant (V7).

-V3: FALCON PRO - 0.6 L/HA 2 treatments (first treatment applied at straw's extension 17.04.2021, the second treatment applied at the end of blooming 19.05.2021) has determined a degree of attack of *Pyrenophora graminea* fungus of 16.14% on the flag leaf and of 47.10% on the second leaf, so smaller by 15.86% and respectively by 6.90% as compared to the untreated control variant (V7).

-V4: EVALIA 1.00 L/HA - 1 treatment applied in „bellows” - earing phase - 7.05.2021 has determined a degree of attack of *Pyrenophora graminea* fungus of 5.28% on the flag leaf and of 32.40% on the second leaf, so smaller by 26.72% and respectively by 21.60% as compared to the untreated control variant (V7).

-V5: EVOLUS 0.75 L/HA 1 treatment applied in “bellows” - earing phase - 7.05.2021 has determined a degree of attack of *Pyrenophora graminea* fungus of 10,14% on the flag leaf and of 42.70% on the second leaf, so smaller by 21.86% and respectively by 11.30% as compared to the untreated control variant (V7).

-V6: FALCON PRO – 0.8 L/HA 1 treatment applied in “bellows” - earing phase - 7.05.2021 has determined a degree of attack of *Pyrenophora graminea* fungus of 11.00% on the flag leaf and of 39.20% on the second leaf, so smaller by 21.00% and respectively by 14.80% as compared to the untreated control variant (V7).

-V7: The untreated control variant was affected by *Pyrenophora graminis* with values of the degree of attack (D.A.%) of 32.00% on the “flag” leaf and 54.00% on the second leaf.

From the analysis of Table 2 production differences as compared to the untreated control variant, V7, can be observed, as follows:

-V1: EVALIA 1.00 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021, achieved a yield of 6.748 to/ha, respectively an increase of 1.044 to/ha as compared to the untreated control variant (V7).

-V2: EVOLUS 0.75 L/HA - 2 treatments (first treatment applied at straw's extension - 17.04.2021, the second treatment applied at the end of blooming - 19.05.2021), achieved a yield of 6.536 to/ha, respectively an increase of 0.832 to/ha as compared to the untreated control variant (V7). However, this yield increase has no statistical assurance and cannot be taken into consideration.

-V3: FALCON PRO – 0.6 L/HA - 2 treatments (first treatment applied at straw's extension 17.04.2021, the second treatment applied at the end of blooming 19.05.2021), achieved a yield of 7.103 to/ha, respectively an increase of 1.399 to/ha as compared to the untreated control variant (V7).

-V4: EVALIA 1.00 L/HA - 1 treatment applied in “bellows” - earing phase - 7.05.2021, achieved a yield of 6.834 to/ha, respectively an increase of 1.130 to/ha as compared to the untreated control variant (V7).

-V5: EVOLUS 0.75 L/HA - 1 treatment applied in “bellows” - earing phase - 7.05.2021, achieved a yield of 7.049 to/ha, respectively an increase of 1.345 to/ha as compared to the untreated control variant (V7).

-V6: FALCON PRO - 0.8 L/HA - 1 treatment applied in “bellows” - earing phase - 7.05.2021, achieved a yield of 7.440 to/ha, respectively an increase of 1.736 to/ha as compared to the untreated control variant (V7).

-V7: The untreated control variant achieved a yield of 5.704 to/ha.

From a practical point of view, the variants with phytosanitary treatment, in the climatic conditions of 2021, achieved higher yields than the untreated control. We underline, however, that the yield increase of V2 variant (0.832 t/ha) has no statistical assurance.

CONCLUSIONS

The observations performed in the spring of the year 2021 on barley crop, in the pedoclimatic conditions of the Eastern Baragan, had led to the following conditions and recommendations:

1-The attack of *Pyrenophora graminea* fungus which produces the disease known under the popular name of “leaf stripe” has made its presence known also in 2021. The attack of this fungus was much stronger than in the previous years. This fact was caused by the higher quantity of rainfall during spring and in June. The yield differences between the treated variants and untreated control variant were higher as compared to the experiments performed in the previous years. These differences are statistically assured.

2-No attacks of *Blumeria* and *Puccinia* fungi on the untreated control variant were observed, even though very favorable conditions for the attacks of these two pathogens had been present.

3-Donau barley beer variety has proven to be quite productive in the climatic conditions of the spring of the year 2021, the rainfalls from spring mainly contributing to this aspect. This variety had a good behavior, in terms of resistance to the attack of *Pyrenophora graminea* fungus. Thus, the untreated

control variant (V7) achieved a yield of 5.704 t/ha, while very favorable conditions for *Pyrenophora Graminea* fungus attacks had been present.

4-The price of barley for beer is approximately 0.85 lei (0.17 €) / kg in 2022.

5-The yields obtained in the variants studied were significantly higher compared to those achieved in previous years. In 2021, the untreated control variant (V7) achieved lower yields compared to the variants where treatments were applied. As regards the costs/ha of some plant protection products, they vary in 2022 as follows: EVOLUS costs 200 lei/l - 40 €/l, 0.75 l/ha is applied (150 lei/ha - 30 €/ha), FALCON PRO lei/l costs 200 lei/l (40 €/l), 0.8 l/ha is applied (180 lei/ha - 36 €/ha), EVALIA product costs 267 lei/l - 53.4 € /l, 1 l/ha is applied (267 lei/ha -53.4 €/ha).

6-The variants where a single treatment was applied (V4, V5 and V6) achieved substantially equal yields to those where 2 treatments were performed (V1, V2 V3). In their case, the economic return is very clear.

7-A single treatment with fungicides can be applied in rainy and cooler years. It seems that the optimal moment of application of this treatment is

when the plants are in the “bellows” – earing phase.

8-In terms of profitability, the V6 FALCON PRO variant stands out very well – 0.8 L/HA - 1 treatment applied at the “bellows” – earing phase. This variant provided a yield increase of 1.736 t/ha as compared to the untreated control variant, V7.

9-The leu/€ exchange rate for the first 6 months of 2022 was 4.9455 lei/€1, according to the website of the National Bank of Romania.

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