

THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON BARLEY HARVEST, DONAU VARIETY, IN 2022 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), RETENGO (200 g/l pyraclostrobin) and NATIVO PRO 325 SL (prothioconazole 175 g/l + trifloxystrobin 150 g/l). The treatment variants were the following: V1- RETENGO 0.8 l/ha, 1 treatment was applied on 13th April + 1 treatment on 17th May; V2 – EVALIA 0.75 l/ha, 1 treatment was applied on 13th April + 1 treatment on 17th May; V3-NATIVO PRO 0.6l/ha, 1 treatment was applied on 13th April + 1 treatment on 17th May; V4- RETENGO 0.8 l/ha, 1 treatment was applied on 22nd May, V5- EVALIA 1.0 l/ha, 1 treatment was applied on 22nd May, V6- NATIVO 0.7 l/ha, 1 treatment was applied on 22nd May, V7 - Untreated Control Variant. The experiment was placed in Latin square, the 7 variants being placed in 7 repetitions. The year 2022 was a year where the spring and the beginning of summer were very dry, totally unfavorable to pathogen attacks. The experiment was not irrigated. Among the pathogens monitored, very weak attacks by the fungus *Pyrenophora graminea*, which produces, in barley, the disease known as leaf stripe, were observed. This led to very uniform yields in the variants studied. Basically, no significant yield differences occurred in the climate conditions of 2022 between the untreated control variant and the variants that were treated with fungicides. The variant's yields were: V1 – 5,276 to/ha, V2 – 5,292 to/ha, V3 – 5,451 to/ha, V4 – 5,184 to/ha, V5 – 5,601 to/ha, V6 – 5,585 to/ha and V7 – 5,508 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* (Jacob Viorica *et al*, 1998). The first half of 2022 was very unfavorable for obtaining good barley yields. Few rainfalls were recorded, unlike the previous year which was rich in rainfalls. For example, in January, the average temperature was 2.6°C and the rainfall totaled only 7.3 l/m². In February, the average temperature was 5.1°C and the rainfall totaled 11.6 l / m². In March, the average temperature was 4.1°C, the rainfall totaled only 8.9 l/m² and the average relative humidity of the air was only 54%. In April, the average temperature recorded was 12.7°C, the rainfall totaled 28.5 l/m² and the average relative humidity of the air was only 50.7%. In May, the average temperature was 19.7°C, the rainfall totaled 26.5

l/m² and the average relative humidity of the air was only 47%. The emergence of barley in the fall of 2021 was relatively good. The winter between 2021 and 2022 was quite warm, as it was the previous winter, which allowed the plants not to freeze, barley being a species more sensitive to cold than wheat. The rainfall between January and May in 2022 had been totally insufficient to those that fell in the previous year. These led to a lower yield in barley compared to the yield obtained in the previous year. Among the pathogens that have appeared, we mention the *Pyrenophora graminea* 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 experiment.

We emphasize that the experiment was established in monoculture conditions. In the previous agricultural year, the barley area where the experiment was established was also cultivated

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with barley, the variety being the same – Donau.



Figure 1 Aspects from the experiment field (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 21st May 2022

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-RETENGO 0.8 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	0.17	0.83	**	4.97	40.24	**
V2-EVALIA 0.75 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	0.00	2.00	**	5.27	33.94	**
V3-NATIVO PRO 0.6 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	0.23	1.77	**	4.94	40.27	**
V4-RETENGO 0.8 l/ha 1 treatment applied on 22 nd May	0.31	1.69	**	5.84	39.27	**
V5-EVALIA 1.0 l/ha 1 treatment applied on 22 nd May	0.15	0.85	**	8.75	36.71	**
V6-NATIVO PRO 0.7 l/ha 1 treatment applied on 22 nd May	0.26	1.74	**	7.42	37.79	**
V7 – Untreated control variant.	2.00	–	–	45.21	–	–

LD D.A.% for the „flag” leaf
 LD 5% = 0.43%
 LD 1% = 0.58%

LD D.A.% for the second leaf:
 LD 5% = 3.08%
 LD 1% = 4.15%

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-RETENGO 0.8 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	5.276	-0.232	Not significant
V2-EVALIA 0.75 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	5.292	-0.216	Not significant
V3-NATIVO PRO 0.6 l/ha 1 treatment applied on 13 th April + 1 treatment applied on 17 th May	5.451	-0.057	Not significant
V4-RETENGO 0.8 l/ha 1 treatment applied on 22 nd May	5.184	-0.324	Not significant
V5-EVALIA 1.0 l/ha 1 treatment applied on 22 nd May	5.601	+0.093	Not significant
V6-NATIVO PRO 0.7 l/ha 1 treatment applied on 22 nd May	5.585	+0.077	Not significant
V7 – Untreated control variant.	5.508	-	-

LD 5% = 0.499 to/ha

LD 1% = 0.605 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: RETENGO 0.8 l/ha 1 treatment applied on 13th April + 1 treatment applied on 17th May
- V2: EVALIA 0.75 l/ha 1 treatment applied on 13th April + 1 treatment applied on 17th May
- V3: NATIVO PRO 0.6 l/ha 1 treatment applied on 13th April + 1 treatment applied on 17th May
- V4: RETENGO 0.8 l/ha 1 treatment applied on 22nd May
- V5: EVALIA 1.0 l/ha 1 treatment applied on 22nd May
- V6: NATIVO PRO 0.7 l/ha 1 treatment applied on 22nd May
- 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 manual sprayer type "Vermorel" type. Weed control was achieved with the help of Mustang herbicide (6.25 g / l florasulam + 300 g / l 2,4-D EHE acid) at a dosage of 0.5 l / ha applied, separately, with the vermorel. The experiment has shown the effectiveness of these phytosanitary products, in relation to their price, as well as the efficiency and, respectively, the profitability of

applying one or two phytosanitary treatments during barley's growing season.

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* in the samples analyzed, fungus which produces 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., 1967).

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 for 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 $F\% = n \times 100 / N$ 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 2021 – 2022 was not 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. Contrary to last year, March, April and May months were poorer in rainfalls compared to 2021. Those months were also warmer compared to the same months in 2021. The autumn of 2021 had few rainfalls. Even in these conditions, the plants emerged in time in order to go through the winter of 2021-2022 in good conditions. This winter was warmer compared to the previous winter (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 lower extent in 2022, as compared to previous years. The degree of attack (D.A.%) was of only 2.00% at V7 - untreated control variant, at the “flag” leaf - on the date of 21st May 2022. This very low degree of attack on this leaf of the untreated control variant resulted in its yield being practically equal to that of the treated variants. It should be noted that this pathogen is of no concern to barley in years with draughty and warm winters and springs.

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

-V1 determined a degree of attack of the *Pyrenophora graminea* fungus of 0.17% in the “flag” leaf and 4.97% in the second leaf, thus lower by 0.83% and by 40.24% respectively, compared to the untreated control variant (V7).

-V2 determined a degree of attack of the *Pyrenophora graminea* fungus of 0.00% in the “flag” leaf and 5.27% in the second leaf, thus lower by 2.00% and by 33.94% respectively, compared to the untreated control variant (V7).

-V3 determined a degree of attack of the *Pyrenophora graminea* fungus of 0.23% in the “flag” leaf and 4.94% in the second leaf, thus lower by 1.77% and by 40.27% respectively, compared to the untreated control variant (V7).

4 determined a degree of attack of the *Pyrenophora graminea* fungus of 0.31% in the

“flag” leaf and 5.84% in the second leaf, thus lower by 1.69% and by 39.27% respectively, compared to the untreated control variant (V7).

-V5 determined a degree of attack of *Pyrenophora graminea* of 0.15% in the “flag” leaf and 8.75% in the second leaf, thus lower by 0.85% and by 36.71% respectively, compared to the untreated control variant (V7).

V6 determined a degree of attack of *Pyrenophora graminea* of 0.26% in the “flag” leaf and 7.42% in the second leaf, thus lower by 1.74% and by 37.79% respectively, compared to the untreated control variant (V7).

-V7, the untreated control variant, was affected by *Pyrenophora graminis* at D.A. attack values of 2.00% in the “flag” leaf and 45.21% in second leaf.

By analyzing table 2, we can see the yield differences compared to the untreated control variant, V7, as follows:

-V1 achieved a yield of 5.276 to/ha, which is lower by 0.232 to/ha compared to the untreated control variant (V7).

-V2 achieved a yield of 5.292 to/ha which is lower by 0.216 to/ha compared to the untreated control variant (V7).

-V3 achieved a yield of 5.451 to/ha, which is lower by 0.057 to/ha compared to the untreated control variant (V7).

-V4 achieved a production of 5.184 to/ha, which is lower by 0.324 to/ha compared to the untreated control variant (V7).

-V5 achieved a yield of 5.601 to/ha which is higher by 0.093 to/ha compared to the untreated control variant (V7).

-V6 achieved a yield of 5.585 to/ha, which is higher by 0.077 to/ha compared to the untreated control variant (V7).

-V7, the untreated control variant, achieved a yield of 5,508 to/ha.

From a practical point of view, the variants with phytosanitary treatment in the climatic conditions of 2022 achieved almost similar yields compared to the untreated control variant (V7).

CONCLUSIONS

The observations performed in the spring of the year 2022 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 2022. The attack of this fungus was much weaker than in the previous years. This fact was caused by the smaller quantity of rainfall, higher average temperatures and very

low average air humidity, recorded in the first 5 months of the year 2022. The yield differences between the treated variants and the untreated control variant were very small as compared to the experiments performed in the previous years. These differences have no statistical assurance.

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 2022, especially that the experiment was performed in non-irrigation conditions.

4. The experience was placed on a plot that was also cultivated with barley in the previous year. The inoculum reserve of the *Pyrenophora graminea* fungus remained in the soil from the previous year was high. However, the degree of attack of this phytopathogenic fungus was very small in the untreated control variant (V7).

5. The price of barley for beer, in mid-2023, is around 0.90 lei (0.18 €/kg).

6. The yields obtained in the studied variants were slightly lower than those made in previous years. In 2022, the untreated control variant (V7) achieved almost similar, practically equal yields, compared to the variants where treatments were applied. In terms of costs/ha of some plant protection products, they vary in 2023, as follows:

-RETEGO costs 240 lei/l – 46.654 €/l. A single treatment was applied with 0.8 l/ha (192 lei/ha – 38.92 €/ha) at V4. At V1, 2 treatments were applied with 0.8 l / ha, i.e., a total of 1.6 l / ha (384 lei / ha – 77.83 € / ha).

-EVALIA costs 270 lei/l - 53.4 €/l, 1 l/ha was applied (270 lei/ha -53.4 €/ha/) to V5. For V2, 2 treatments were applied with 0.75 l / ha, i.e., a total of 1.5 l / ha (405 lei / ha – 82.10 € / ha/);

-NATIVO PRO costs 230 lei / l - 46.62 €/l. 2 treatments were applied to V3, with 0.6 l/ha (138 lei - 27.97 €), i.e., a total of 1.2 l/ha (165.60 lei / ha - 35.56 €/ha).

7. The analysis of economic profitability shows that in the climatic conditions of 2022, which was very dry and hot in the first 5 months, the most profitable turned out to be V7 – the untreated control variant. This variant achieved a yield very close to the yields obtained by the variants that received phytosanitary treatments with products that have fungicidal effect. However, we do not recommend, even in very dry and hot years, the cultivation of barley without applying any treatment during growth, with a phytosanitary product with fungicidal action. For barley, in very

dry and hot years, we recommend applying a single treatment with a fungicide product, usually cheaper. Among them we mention ORIUS 25 EW (SALVATOR 25 EW - second trade name) applied in a dosage of 0.5 l / ha

8. When, for various reasons, barley is grown after barley on the same area, great attention will be paid to the occurrence of attacks of foliar diseases even in very dry and hot years.

9. The leu/€ exchange rate for the first 6 months of 2023 was 4.9335 lei/1€, according to the website of the National Bank of Romania.

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