

THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON BARLEY HARVEST, DONAU VARIETY, IN 2020 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 pathogenic agents 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 production was monitored, as compared to the untreated control variant. For this study, an experiment with 6 treatment variants was created, in which the following phytosanitary products were used: AMISTAR (azoxystrobin 250 g/l), EVOLUS (prochloraz 320 g/l, tebuconazole 160 g/l, proquinazid 40g/l); FALCON PRO (prothioconazol 53 g/l, spiroxamine 224 g/l, tebuconazole 148 g/l), TOPSIN 500 SC (thiophanate-methyl 500 g/l), ORIUS 25 EW (250 g/l tebuconazole) and DITHANE M 45 (mancozeb 80%). The treatment variants were the following V1- AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020, V2- EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020, V3- FALCON PRO 0.6 L/HA 1 treatment applied at spike's release - 13.05.2020, V4- TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020, V5- ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020, V6 - ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1.0 L/HA - 1 treatment applied at spike's release - 13.05.2020, V7 - Untreated control variant. The experiment was placed in Latin square, the 7 variants being placed in 7 repetitions. The experiment was performed in the absence of irrigation. 2020 had been one of the draughtiest years in the last 3 decades, this fact leading to a poorer presence of the attack of the pathogenic agents specific to barley. The first two leaves placed under the spike had been analysed for the above. Among the pathogenic agents under monitoring, poor attacks produced by *Pyrenophora graminea* fungus which produces barley leaf stripe disease were observed. No attacks by *Blumeria* and *Puccinia* fungi were observed.

Key words: *Pyrenophora*, cyproconazole, 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, Hatman, M., Ulea, E., Puiu, I. 1998). The first half of the year 2020 was unfavourable to barley. For example, in April, the average temperature registered was 12.8°C and the rainfalls summed up to 2.1 l/m². In May, the average temperature registered was 17°C, and the rainfalls summed up to 36.6 l/m². They have fallen diffusely, not quite influencing the barley production and the degree of attack of

Pyrenophora graminea. Also, March was extremely poor in rainfalls (2.1 l/m²). However, rainfalls were present in the autumn of the year 2019. Barley's springing in the autumn of the year 2019 was good. The winter between the years 2019 and 2020 was relatively warm, fact which allowed the plants not to freeze, barley being a variety sensitive to cold as compared to wheat.

Among the emerging pathogenic agents, we mention *Pyrenophora graminea* (fig. 1) fungus which produces the disease called leaf stripe at barley. This pathogenic agent attacks barley crops each year, at attack intensities which vary each and every year. The other mentioned pathogenic agents did not occur in barley's experiment.

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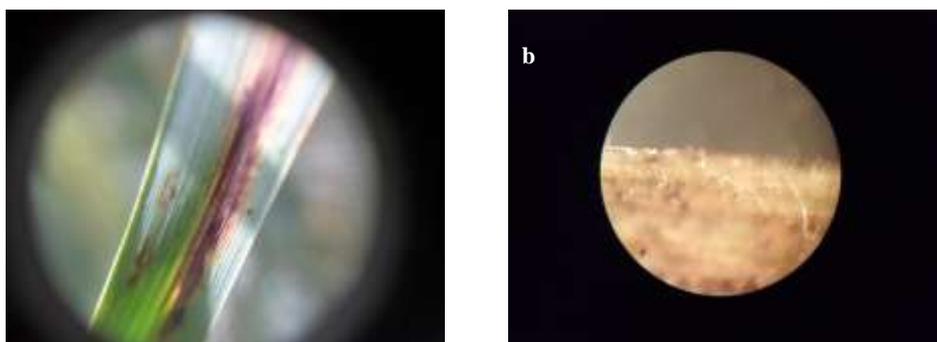


Figure 1 - Barley's leaf stripe, *Pyrenophora graminea* (beginning of the attack):
a – attack on leaves, b – conidia (original).



Figure 2 - Aspects from the experiment field (original)

Table 1

The results of the experiment with fungicide products (6 variants of treatment + untreated control variant) in what concerns the attack (D.A. %) of *Pyrenophora graminea* fungus at barley (“flag” leaf and the next leaf). The observations were performed on the date of 19st May 2020

Variant	“flag” leaf			The second leaf		
	D.A%	Difference as compared to the control variant	Signif.	D.A%	Difference as compared to the control variant	Signif.
V1- AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020	0.26	5.08	**	13.00	45.80	**
V2- EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020	0.93	4.41	**	20.60	38.20	**
V3- FALCON PRO 0.6 L/HA - 1 treatment applied at spike's release - 13.05.2020	1.11	4.23	**	15.30	43.35	**
V4- TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020	1.10	4.24	**	18.00	40.80	**
V5- ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020	0.39	4.95	**	19.00	39.80	**
V6- ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1.0 L/HA - 1 treatment applied at spike's release -13.05.2020	0.96	4.38	**	19.30	39.50	**
V7 -Untreated control variant.	5.34	–	–	58.80	–	–

LD D.A.% for the „flag leaf”

LD 5% = 1.18%

LD 1% = 1.59%

LD D.A.% for the second leaf:

LD 5% = 1.26%

LD 1% = 1.70%

Table 2

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

Variant	Prod. (to/ha)	Difference as compared to the control variant (to/ha)	Significance
V1 - AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020	2.788	-0.058	Not significant
V2 - EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020	2.834	-0.012	Not significant
V3 - FALCON PRO 0.6 L/HA - 1 treatment applied at spike's release - 13.05.2020	2.811	-0.035	Not significant
V4 - TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020	2.799	-0.047	Not significant
V5 - ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020	2.823	-0.023	Not significant
V6 - ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1,0 L/HA - 1 treatment applied at spike's release -13.05.2020	2.870	0.024	Not significant
V7 - Untreated control variant.	2.846	-	-

LD 5% = 0.42 to/ha

LD 1% = 0.57 to/ha

MATERIAL AND METHOD

For performing the observations, an experiment with 7 study variants was conceived (fig.2). 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 - AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020;
- V2 - EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020;
- V3 - FALCON PRO 0.6 L/HA - 1 treatment applied at spike's release - 13.05.2020;
- V4 - TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020;
- V5 - ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020;
- V6 - ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1,0 L/HA - 1 treatment applied at spike's release -13.05.2020;
- V7 - Untreated control variant.

The experiment was placed in randomized blocks. These 7 variants were placed in 7 repetitions. Each experimental plot had an area of 15 m² (5 x 3m). The total number of experimental plots was of 49. The area of an experimental variant was of 15 m² x 7 repetitions =105 m². The total area of the experiment was of 105 m² x 7 = 735 m². The treatments were executed manually, with a machine of "vermorel" type. "Trend" adjuvant product, in concentration of 0.03%, was added to the irrigation 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 the barley's vegetation period.

The evaluation of the attack's frequency (F%), of the intensity of the attack (I%) and respectively, of the degree of attack (D.A.%) was done separately, on each and every experimental plot, analyzing 10 plants / experimental plot. To them it was assessed the 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 production of a spike at cereals. The phytosanitary analyses of the plant's samples were done with the help of the stereomicroscope and of the 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 harvest of each variant under study, kernel samples from each experimental plot, 5 samples / plot, had been analysed on a percentage sample basis. Each sample comprised 10 plants, so, from each experimental plot, 50 plants were taken over, from which the harvest 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 2019).

Assessing the attack of a damaging agent can be done with the help of 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 organs of plants attacked from the total of organs of plants observed (leaves) had been taken into consideration, establishing thus the frequency of the attack expressed in percentages %. In case of blights, the number of spikes attacked, reported to the total number of spikes observed, had been used. The frequency was calculated with the help of the formula $F\% = \frac{n \times 100}{N}$.
- Attack intensity represents the degree or percentage in which a plant or an organ of the plant is attacked and how much from the area of the plant or of the organ analysed (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 “flag” leaf and to the next leaf situated below it.

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

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

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 production.

RESULTS AND DISCUSSIONS

The agricultural year 2019 – 2020 was a complicated year for barley. It must be underlined the very important fact that barley (*Hordeum vulgare*) is a variety more sensitive to the attack of the diseases and to overwintering than wheat. As we already mentioned, March, April and May months were poor in rainfalls and the average temperatures recorded in these months were higher than in previous years. However, the autumn of the year 2019 had sufficient rainfalls, the plants emerging on time to get through the winter of 2019-2020.

In what concerns the dynamic of the occurrence of the pathogenic attacks at barley, we mention the following aspects:

- *Pyrenophora graminea* had affected the barley in a lower extent, as compared to previous years. Accordingly, one single treatment was necessary. The degree of attack (D.A. %) was of only 5.34% at V7 variant - untreated control variant - on the date of 19th May 2020, at the “flag” leaf. This low degree of attack on this leaf did not lead to the appearance of differences in production between the variants with treatment (V1...V6) and the V7 variant - untreated control variant. It should be noted that this pathogen is found to be present in barley crops also in dry years, which are usually less favourable to other cereal diseases.
- No attacks of other barley-specific pathogens, such as fungi of *Blumeria* and *Puccinia* genera, have been reported.

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

- V1 - AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 0.26 % to the flag leaf and of 13.00% to the second leaf, so smaller by 5.08%, and respectively by 45.80% as compared to untreated control variant (V7);

- V2 - EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 0.93 % to the flag leaf and of 20.60% to the second leaf, so smaller by 4.41%, and respectively by 38.20% as compared to untreated control variant (V7);
 - V3 - FALCON PRO 0.6 L/HA - 1 treatment applied at spike's release - 13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 1.11% to the flag leaf and of 15.30% to the second leaf, so smaller by 4.23%, and respectively by 43.35% as compared to untreated control variant (V7);
 - V4 - TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 1.10% to the flag leaf and of 18.00% to the second leaf, so smaller by 4.24%, and respectively by 40.80% as compared to untreated control variant (V7);
 - V5 - ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 0.39 % to the flag leaf and of 19.00% to the second leaf, so smaller by 4.95%, and respectively by 39.80% as compared to untreated control variant (V7);
 - V6 - ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1,0 L/HA - 1 treatment applied at spike's release -13.05.2020 has determined a degree of attack of *Pyrenophora graminis* of 0.96 % to the flag leaf and of 19.30% to the second leaf, so smaller by 4.38%, and respectively by 39.50% as compared to untreated control variant (V7);
 - V7 - The untreated control variant was affected by *Pyrenophora graminis* with values of the degree of attack (D.A.%) of 5.34% for the “flag” leaf and 58.80% to 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 - AMISTAR 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020 has obtained a production of 2.788 to/ha, respectively a negative increase of - 0.058 to/ha as compared to untreated control variant (V7).;
 - V2 - EVOLUS 0.75 L/HA - 1 treatment applied at spike's release - 13.05.2020 - has obtained a production of 2.834 to/ha, respectively a negative increase of -0.012 to/ha as compared to untreated control variant (V7).;
 - V3 - FALCON PRO 0.6 L/HA - 1 treatment applied at spike's release - 13.05.2020 - has obtained a production of 2.811 to/ha, respectively a negative increase of -0.035 to/ha as compared to untreated control variant (V7).;
 - V4 - TOPSIN 500 SC 1.0 L/HA + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020 - has obtained a production of 2.799 to/ha, respectively a negative increase of -0.047 to/ha as compared to untreated control variant (V7).
 - V5 - ORIUS 25 EW 0.5 L/HA 1 + DITHANE M 45 2 KG/HA - 1 treatment applied at spike's release - 13.05.2020 - has obtained a production of 2.823 to/ha, respectively a negative increase of -0.023 to/ha as compared to untreated control variant (V7).;
 - V6 - ORIUS 25 EW 0.5 L/HA + TOPSIN 500 SC 1,0 L/HA - 1 treatment applied at spike's release - 13.05.2020 - has obtained a production of 2.870 to/ha, respectively an increase of 0.024 to/ha as compared to untreated control variant (V7);
 - V7-The untreated control variant has achieved a harvest of 2.846 kg/ha.
- The production increase did not present statistical assurance. From practical point of view, all variants, in the difficult climatic conditions of 2020, have obtained similar productions.

CONCLUSIONS

The observations performed in the spring of the year 2020 on the 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 under the popular name of “leaf stripe” has made its presence known also in 2020. The attack of this fungus was much lower than in the previous years.

The production differences between the treated variants and the untreated control variant were quite small (under 0.06 t/ha). In fact, all variants (including the untreated control variant) obtained very similar productions, not statistically assured. This means that these differences were caused by random factors and not by the studied factors (variants with phytosanitary treatment + untreated control variant).

2. No attacks of *Blumeria* and *Puccinia* were observed.
3. Donau barley beer variety has proved to be quite productive in the climatic conditions of the spring of the year 2020, considering the excessive drought in this year. This variety seems to have a fairly good tolerance to barley-specific diseases, a fact demonstrated in 2019 that was rainy and cool, so favorable to barley-specific diseases.
4. The price of barley for beer, in 2021, is approximately 0.85 lei (0.17 €) / kg. At an average production of the treated variants (V1-V6) of approximately 2.8 t / ha, a gross income per ha of 2380 lei (485.7 €) / ha was obtained.
5. The productions obtained for the studied variants were much lower than those obtained in previous years. In 2020, even the untreated control variant (V7) obtained lower yields (2,846 t / ha) compared to the untreated control variants (V7) from the experiments of previous years (e.g. 5.506 t / ha in 2019 or even 7.365 t / ha in 2018). Regarding the costs / ha of some plant protection products, they vary as follows: AMISTAR 350 lei/l - 0.75 l/ ha is applied (262.5 lei / ha), EVOLUS 198 lei / l - 0.75 l / ha is applied (149 lei / ha), FALCON PRO 155 lei / l - 0.6 l/ ha is applied (93 lei / ha), ORIUS 25 EW 80 lei / l - 0.5 l /

ha is applied (40 lei / ha). The combination TOPSIN 500 l/ha + DITHANE M5 2 kg / ha costs 120 lei / ha. It is observed that the most expensive variant is AMISTAR 0.75 l / ha (262.5 lei/ha) and the most economically efficient is the ORIUS 25 EW 0.5 l / ha variant (40 lei / ha) .

6. For a secure protection against the attack of the pathogenic agents specific to barley, it is recommended the application, in the droughty years, of 1 phytosanitary treatment with fungicides homologated products for barley. Even if the year is very dry and the yields will be lower, we do not recommend the cultivation of barley in conditions of 0 phytosanitary treatments with fungicidal products - this is because barley is a species more susceptible to disease than wheat.
7. We emphasize the fact that the experiment was carried out in the absence of irrigation.
8. The exchange currency lei/€ for the first 7 months of the year 2021 was 4.9093 lei/1€, according to the National Bank of Romania's website.

REFERENCES

- Iacob Viorica, Hatman M., Ulea E., Puiu I., 1998** – "Ion Ionescu de la Brad" Publishing House, *Agricultural phytopathology*, p. 37-39.
- Săulescu N. 1967** - *Experiment field*, Agro- Sylvan Publishing House, Bucharest, p. 217, 311
- Velichi E. 2012** - *General and special phytopathology*, University Publishing House, Bucharest, p. 151 - 153.
- *** *National Bank of Romania* (web page).
- *** *Methods of Prognosis and Warning*, 1980 M.A.I.A., Bucharest, p. 7-9.
- *** *Pest – Expert*, Ministry of Agriculture and Rural Development, the National Phytosanitary Authority (web page).
- *** *Soufflet Agro Romania*, 2019 (web page).