

THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON BARLEY HARVEST, DONAU VARIETY, IN 2019 PEDOCLIMATIC CONDITIONS OF THE EASTERN BARAGAN

Eugen VELICHI¹

e-mail: Eugen_velichi@yahoo.com

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 harvest 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, as follows: ACANTO PLUS (picoxystrobin 200 g/l + cyproconazole 80 g/l); MYSTIC 250 EC (tebuconazole 250 g/l); FALCON PRO (prothioconazole 53 g/l+tebuconazole 148 g/l + spiroxamine 224 g/l); CAPALO (fenpropimorph 200g/l, epoxiconazole 62.5 g/l, metrafenon 75g/l). The treatment variants were the following: V1 - ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019); V2 - ACANTO PLUS 0.5 L/HA, 1 treatment applied in "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019); V3 - CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019); V4 - MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied in "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019); V5 - FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019); V6 - ACANTO PLUS 0.5 L/HA +- FALCON PRO 0.5 L/HA, 1 treatment applied in "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019), V7 – Untreated control variant. The experiment was placed in Latin square; the 7 variants being placed in 7 repetitions. The first two leaves placed under the spike had been analysed for the above. Among the pathogenic agents under monitoring, the greatest attacks were produced by *Pyrenophora graminea* fungus which produces barley leaf stripe disease. The harvests of the variants were the following: V1 - 5634 kg/ha, V2 - 5951 kg/ha, V3 - 5669 kg/ha, V4 - 5658 kg/ha, V5 - 5494kg/ha, V6 - 5704 kg/ha and V7 (untreated control variant) - 5506 kg/ha.

Key words: *Pyrenophora*, cyproconazole, latin square

Hordeum vulgare barley is under attack of many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *hordei*, leaf stripe - *Pyrenophora graminea*, leaf blotch - *Rhynchosporium secalis*, rust - *Puccinia hordei* (Jacob V. *et al*, 1998). The first half of the year 2019 was very good for barley. For example, in April, the average temperature registered was 10.4°C and the rainfalls summed up to 60.0 l/m². In May, the average temperature registered was 17.7°C, and the rainfalls summed up to 100.6 l/m². Also, March was very rich in rainfalls (60 l/m²). However, the autumn of the year 2018 was poor in rainfalls. Barley's springing in the autumn of the year 2018 was difficult due to this cause and it took place after the date of 15th November. The winter between the years 2018 and 2019 was relatively warm, fact which allowed the plants not

to freeze, barley being a variety sensitive to cold as compared to wheat.

Among the pathogenic agents which emerged, we mention *Pyrenophora graminea* 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 pathogenic agents mentioned had occurred sporadically in the year 2019 in barley's experiment.

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.

¹ "Dunărea de Jos" University of Galati

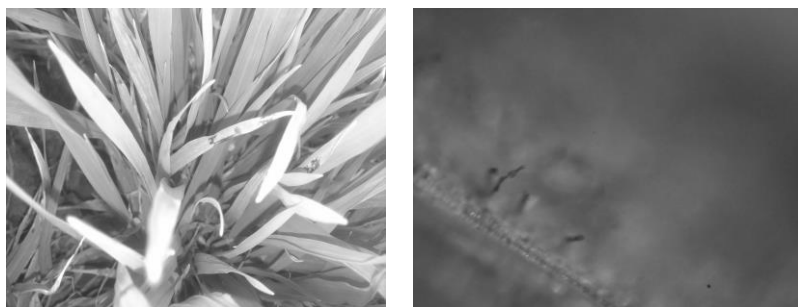


Figure 1 – Barley's leaf stripe, *Pyrenophora graminea* (beginning of the attack): a – attack on leaves, b – conidia (original)

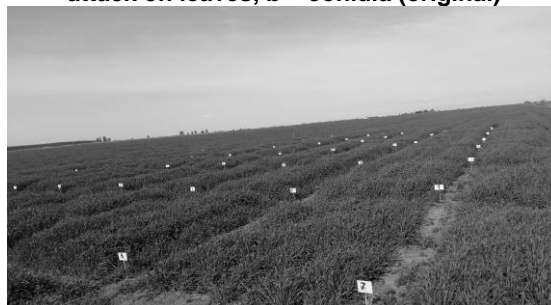


Figure 2 – Aspects from the experiment field (original)

The variants of the experiment were the following (tab.1):

- V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release – blooming (5.05.2019);
- V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019);

- V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0,5 L/HA treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019);
- V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019);
- V7 Untreated control variant.

Tabel 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 May 21st 2019

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 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	2.10	41.70	**	5.95	8.15	**
V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04 2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	7.20	36.60	**	3.57	10.53	**
V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	8.80	35.00	**	2.65	11.45	**
V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	8.40	35.40	**	4.34	9.76	**
V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	3.00	40.80	**	3.92	10.18	**
V6 ACANTO PLUS 0.5 L/HA + -FALCON PRO 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5.30	38.50	**	2.91	11.19	**
V7 -Untreated control variant.	43.80	-	-	14.10	-	-

LD D.A.% for the „flag leaf”

LD 5% = 0.75%

LD 1% = 1.02%

LD D.A.% for the second leaf:

LD 5% = 4.85%

LD 1% = 6.54%

Table 2

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

Variant	Harvest (kg/ha)	Difference as compared to the control variant (kg/ha)	Significance
V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5634	128	Not significant
V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5951	445	**
V3 CAPALO 1.0 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5669	163	*
V4 MYSTIC 250 EC 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at "bellows" phase (20.04.2019) + 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5658	152	Not significant
V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike's release - blooming (5.05.2019)	5494	-12	Not significant
V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at "bellows" phase (20.04.2019), 1 treatment applied at the beginning of kernel's filling (27.05.2019)	5704	198	*
V7 Untreated control variant.	5506	-	-

LD 5% = 159.60 kg/ha

LD 1% = 215.16 kg/ha

We mention that FALCON 460 EC product is homologated for barley in a dosage of 0.6 l/ha. For V6, a smaller dose of 0.5 l/ha was used, due to the fact that it was tried a combination with ACANTO PLUS product in a dosage of 0.5 l/ha.

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 was added in the irrigation solution, in concentration of 0.03%. Weeds control was done with the help of Rival Star 75 GD herbicide, in a dosage of 15 g/ha. 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 plants 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., 1967).

Donau variety was used. This is a new German variety of barley for beer, traded by Soufflet French Company. The variety is forward, of small size. It has a good resistance to fall, 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, there had been taken into consideration the number of organs of plants attacked from the total of organs of plants observed (leaves), 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 $F\% = nx100/N$.

- 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:

$$I\% = \frac{\sum (i \cdot xf)}{n}$$

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 the case of our experiment, grades from 1 to 6 had been awarded, separately, 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 DA 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 the production of a crop.

RESULTS AND DISCUSSIONS

The agricultural year 2018 – 2019 was a complicated year for barley’s crop. 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 rich in rainfalls and the average temperatures recorded in these months were favorable to the attack of some pathogenic agents specific to barley. However, the autumn of the year 2018 was very droughty, the plants emerging after the date of 15th November.

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 higher extent, fact which made necessary the application of phytosanitary treatments. The degree of attack (D.A. %) was of 43.8% at variant V7 - untreated control variant on the date of 21st May 2019, at the “flag” leaf. It must be underlined the fact that this pathogen had proven to be the most dangerous pathogenic agent of barley, like in the previous years.

- *Rhynchosporium secalis* (leaf scald) and *Blumeria (Erysiphe) graminis* f. sp. *Hordei* (mildew) had not significantly affected the barley in the spring of the year 2019 (D.A. < 0.9%).

- Barley’s rust (*Puccinia hordei*) was not signaled in the experiment.

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

- V1 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 2.10% to the “flag” leaf and 5.95% to the second leaf, so smaller by 41.70% and respectively by 8.15% as compared to the untreated control variant (V7).

- V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel’s filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 7.20% to the “flag” leaf and 3.57% to the second leaf, so smaller by 36.60% and respectively by 10.53% as compared to the untreated control variant (V7).

- V3 CAPALO 1.0 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 8.80% to the “flag” leaf and 2.65% to the second leaf, so smaller by 35.00% and respectively by 11.45% as compared to the untreated control variant (V7).

– V4 MYSTIC 250 EC – 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel’s filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 8.40 % to the “flag” leaf and 4.34% to the second leaf, so smaller by 35.40% and respectively by 9.76% as compared to the untreated control variant (V7).

– V5 FALCON PRO 0.6 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 3.00% to the “flag” leaf and 3.92% to the second leaf, so smaller by 40.80% and respectively by 10.18% as compared to the untreated control variant (V7).

– V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019), 1 treatment applied at the beginning of kernel’s filling (27.05.2019) had determined a degree of attack of *Pyrenophora graminis* fungus of 5.30% to the “flag” leaf and 2.91% to the second leaf, so smaller by 38.50% and respectively by 11.19% 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 43.80% for the “flag” leaf and 14.10% 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 ACANTO PLUS 0.5 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019), has achieved a harvest of 5634 kg/ha, respectively an increment of 128 kg/ha as compared to the untreated control variant (V7).

– V2 ACANTO PLUS 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel’s filling (27.05.2019) has achieved a harvest of 5951 kg/ha, respectively an increment of 445 kg/ha as compared to the untreated control variant (V7).

– V3 CAPALO 1.0 L/HA, 1 treatment applied at spike’s release - blooming (5.05.2019) has achieved a harvest of 5669 kg/ha, respectively an increment of 163 kg/ha as compared to the untreated control variant (V7).

– V4 MYSTIC 250 EC – 0.5 L/HA + 1 CAPALO 0.5 L/HA treatment applied at “bellows” phase (20.04.2019) + 1 treatment applied at the beginning of kernel’s filling (27.05.2019) has achieved a harvest of 5658 kg/ha, respectively an increment of 152 kg/ha as compared to the untreated control variant (V7).

– V5 FALCON PRO 0.6 L/HA 1 treatment applied at spike’s release - blooming (5.05.2019)

has achieved a harvest of 5494 kg/ha, respectively a negative increment of -12 kg/ha as compared to the untreated control variant (V7).

– V6 ACANTO PLUS 0.5 L/HA + FALCON PRO 0.5 L/HA, 1 treatment applied at “bellows” phase (20.04.2019), 1 treatment applied at the beginning of kernel’s filling (27.05.2019) has achieved a harvest of 5704 kg/ha, respectively an increment of 198 kg/ha as compared to the untreated control variant (V7).

– V7 The untreated control variant has achieved a harvest of 5506 kg/ha.

The harvest differences presented statistical assurance distinctly significant in V2 (**) and significant in V3 and V6 (*). The harvest increments achieved by V1 (128 kg/ha) and V4 (152 kg/ha) has no statistical assurance, minimally accepted by the experimental technique and must not be taken into consideration. V5 achieved a harvest practically equal to control variant V7, the negative difference of only -12 kg/ha being very small.

CONCLUSIONS

The observations performed in the spring of the year 2019 on the barley crop, in the pedoclimatic conditions of the Eastern Baragan had led to the following conditions and recommendations:

1. The most dangerous pathogenic agent of barley had proven to be in 2019 the *Pyrenophora graminea* fungus which produces the disease under the popular name of “leaf stripe”. The attack of this fungus was higher than in the previous years. The harvest differences between the treated variants and the untreated control variant were quite small (maximum 445 kg/ha at V2).

2. Insignificant attacks of the fungi which attack the foliage, such as *Blumeria graminis* f.sp. *hordei* fungus, producing barley’s mildew, were observed. *Puccinia hordei* fungus, producing barley’s rust had not been observed in the barley experiment performed in 2019.

3. Donau barley beer variety has proved to be quite tolerant to the diseases specific to barley in the climatic conditions of the spring of the year 2019. In conditions of 0 treatments with fungicides (V7), this variety achieved in 2019 a good harvest of 5506 kg/ha. However, due to late emergence (after 15th November 2018), the plants entered the spring poorly entwined, the harvests being relatively small (below 6000 kg/ha) as compared to the potential of the variety. This variety seems to have a better tolerance to the diseases specific to barley as compared to other varieties. It has obtained a better harvest, in conditions of zero

phytosanitary treatments, the differences up against the treated variants V1, V3, V4, V5 and V6 being small or even quite equal (V5).

4. For a secure protection against the attack of the pathogenic agents specific to barley, it is recommended the application, in the difficult years (rainy and chilly), of 2 phytosanitary treatments with fungicides homologated products for barley. Combinations of fungicide products can be used, such as the one between FALCON PRO (prothioconazole 53 g/l+tebuconazole 148 g/l + spiroxamine 224 g/l) in a dosage of 0.5 l/ha and MYSTIC 250 EC (tebuconazole 250 g/l) in dosage of 0.5 l/ha. The application of a single treatment, in difficult years, is not recommended, because the barley is a more sensitive variety to the attack of specific pathogenic agents than wheat.

5. In the years with rainy springs, favourable to the attack of the disease, like 2019, the application of two phytosanitary treatments is recommended. In the conditions where in 2020 it is foreseen a price of 0.75 lei/kg of barley for beer, the increments of 163 kg/ha and 198 kg/ha achieved by the variants V3 and especially V6 (two phytosanitary treatments) are not justified from economic point of view. For example, the price of a liter of FALCON PRO is approx. 180 lei/l and is applied in dosages of 0.6 – 0.7 l/ha. It can be used in a dosage of 0.5 l/ha, in combination with another fungicide which has at basis a single active substance, such as, for example,

tebuconazole. Mystic 250 EC Product (250 g tebuconazole/l) costs 120 lei/l and a dosage of 0.5 l/ha is applied. CAPALO Fungicide costs in the year 2019 approximatively 190 lei/l and a dosage of 1 l/ha is applied, so the cost per ha/treatment is 190 lei. Unfortunately, ACANTO PLUS product, which has given the best results (V2 - 2 treatments) in the experiment performed in 2019, cannot be traded and used in Romania any longer, starting with December 2018.

6. The exchange currency Leu/€ for the first 7 months of the year 2020 was 4.8180 lei/1€, according to the Romanian National Bank's website.

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