THE INFLUENCE OF TREATMENTS WITH VARIOUS PHYTOSANITARY PRODUCTS (FUNGICIDES) ON THE ATTACK OF SOME PHYTOPATHOGENIC FUNGI ON WHEAT HARVEST – GLOSA VARIETY - IN 2023 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 Glosa Romanian wheat variety, among which we mention: *Puccinia recondita* f. sp. tritici (sin. *Puccinia triticina*) which produces wheat's brown rust and *Septoria* sp. which produces wheat's brown leaf spotting (septoriosis). The influence of applying these fungicides on the harvest, as compared to the untreated control variant, has also been monitored. One experiment with 5 variants (4 variants with phytosanitary treatment, plus one control variant not treated) was taken into consideration for this study, for which the following phytosanitary products were used, as follows: NATIVO PRO 325 SC (prothioconazole 175 g/l + trifloxystrobin 150 g/l) and RETENGO (Pyraclostrobin 200 g/l). The treatment variants were the following: V1 – NATIVO PRO 325 SC 0.7 L/HA, 1 treatment applied at booting – flowering phase; V2 - RETENGO 0.5 /L/HA, 1 treatment applied at booting – flowering phase, V3 - NATIVO PRO 325 SC – 0.7 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling; V4 - RETENGO 0.5 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling and V5 – Control variant not treated. The experiment was placed in Latin square, the 5 variants being placed in 5 repetitions. The year 2023 was a year with a relatively wet spring and early summer. The experiment was irrigated in the spring of 2023 with the norm of 600 m^2 of water / ha. The experiment was established after rapeseed. The climatic conditions were favorable to the attacks of some wheat pathogens, at higher values than in 2022, year which was very dry. The yields of the variants were as follows: V1 – 7,056 t/ha, V2 – 7,287 t/ha, V3– 6,783 t/ha, V4 – 6,783 t/ha and V5 (control variant not treated) – 6,720 t/ha.

Key words: *Puccinia*, *Septoria*, Latin square

The wheat, *Triticum aestivum*, is attacked by many pathogenic agents, such as: mildew - *Blumeria graminis* f.sp. *tritici*, brown rust - *Puccinia recondita* f. sp. *tritici*, brown leaf spotting - *Septoria tritici*, *Septoria nodorum*, stem's fusariosis and ear's rot *Giberella zeae*, *Giberella avenacea* (Iacob V. *et al*, 1998). The first half of 2023 was, for wheat, more favorable in terms of climatic conditions, compared to the first half of 2022. The first half of 2023 was richer in rainfall than the similar period of 2022. During this period, rainfall was recorded in relatively moderate quantities. Average temperatures were lower than in the same period of 2022. In February, the average temperature was 2.5^0C and rainfall totaled 9.3 l/m² and the average relative humidity was 71%. In March, the average temperature was 9^0C, the average relative humidity was 60% and rainfall totaled 24 l/m². In April, the average temperature was 14.5^0C, precipitation totaled 53 l/m² and the average relative humidity was 70%. In May, the average temperature recorded was 16.5^0C, precipitation totaled 41 l/m² and the average relative humidity was 59%. In June, the average temperature recorded was 21^0C, rainfall totaled 20.5 l/m^2 and the average relative humidity was 46%. Under these conditions, *Septoria* sp. fungus, which produces, in wheat, diseases known as brown leaf spotting (septoriosis), made its presence felt. We emphasize that this phytopathogenic fungus has made its appearance in some years with rainier and cooler springs to a greater extent than the *Puccinia recondita* f. sp. *tritici* phytopathogenic fungus. The attack of the *Gibberella* genus fungi was practically absent, probably due to the fact that June came with high temperatures and an air humidity of only 46%. The 20.5 l/m^2 of rainfall accumulated in June resulted from light rains of 2-5 l/m^2, which were staggered during this month.

The experiment received a watering in May 2023 to complete the amount of water from rainfall. This watering contributed substantially to obtaining a good wheat production, especially since June turned out to be poorer in rainfall than April and May 2023.

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Table 1

The results of the experiment with fungicide products (4 variants of treatment + 1 untreated control variant) in what concerns the attack (D.A.%) of *Septoria* sp. fungus ("flag" leaf and the next leaf). The observations had been made on 12th June 2023

	"Flag" leaf			Second leaf		
Variant	D.A. %	Difference as compared to the control variant	Significance	D.A. %	Difference as compared to the control variant	Significance
V1 - NATIVO PRO 325 SC 0.7 L/HA, 1 treatment applied at booting – flowering phase	34.76	38.24	**	90.00	7.50	**
V2 - RETENGO 0.5 L/HA, 1 treatment applied at booting – flowering phase	35.76	37.24	**	85.50	12.00	**
V3 - NATIVO PRO 325 SC – 0.7 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling	36.26	36.74	**	89.00	8.50	**
V4 - RETENGO 0.5 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling	34.00	39.00	**	89.50	8.00	**
V5 - Untreated control variant	73.00	-	-	97.50	-	-

LD D.A. % for "flag" leaf
LD 5%= 5.68%
LD 1%= 7.83%

LD D.A. % for the second leaf
LD 5%= 5.26%
LD 1%= 7.24%

Table 2

The results of the experiment with fungicide products (4 variants of treatment + 1 untreated control variant) in what concerns the yield (t/ha) obtained at the treated variants, as compared to the untreated control variant

Variant	Yield (t/ha)	Difference as compared to the control variant (t/ha)	Significance
V1 - NATIVO PRO 325 SC 0.7 L/HA, 1 treatment applied at booting – flowering phase	7.056	0.420	*
V2 - RETENGO 0.5 /L/HA, 1 treatment applied at booting – flowering phase	7.287	0.567	**
V3 - NATIVO PRO 325 SC – 0.7 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling	6.783	0.063	Not significant
V4 - RETENGO 0.5 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling	7.035	0.315	Not significant
V5 - Untreated control variant	6.720	-	-

LD 5% =0.345 t/ha
LD 1% =0.475 t/ha

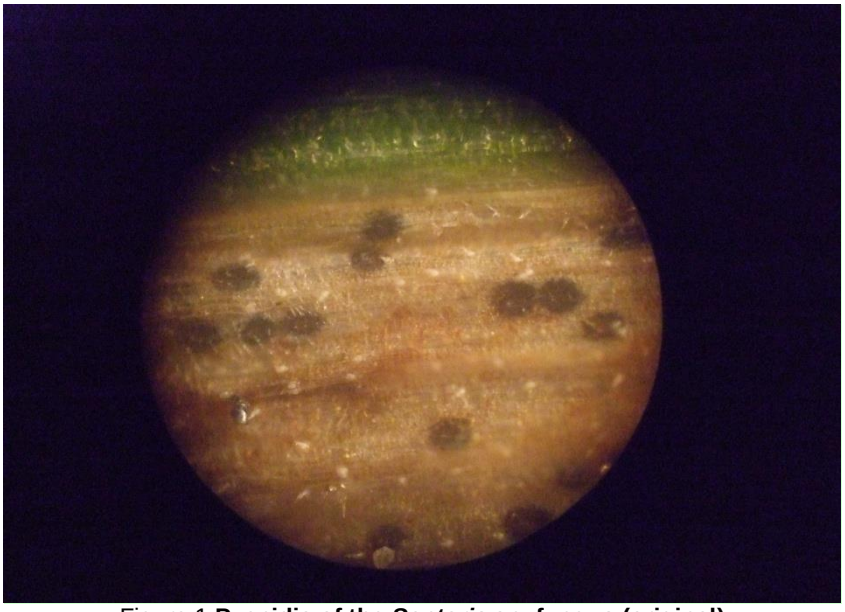

Figure 1 **Pycnidia of the *Septoria* sp. fungus (original)**

Figure 2 **Aspects from the experimental field (original)**

MATERIAL AND METHOD

1 experiment with 5 study variants each had been conceived for performing the observations. This experiment comprised 4 phytosanitary treatment variants (fungicide products containing various active substances) and one untreated control variant. The variants of the experiment were the following:

- V1: NATIVO PRO 325 SC 0.7 L/HA, 1 treatment applied at booting – flowering phase;
- V2: RETENGO 0.5 /L/HA, 1 treatment applied at booting – flowering phase;
- V3: NATIVO PRO 325 SC – 0.7 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling;
- V4: RETENGO 0.5 L/HA, 1 treatment applied at straw's extension + 1 treatment applied at kernel filling;
- V5: Untreated control variant.

The experiment was placed in Latin square; the 5 variants were placed in 5 repetitions. Each experimental plot had an area of 15 m^2 (5 x 3m). The total number of experimental plots was 25. The surface of an experimental variant was of 15 m^2 x 5 repetitions = 75 m^2. The total area of the experiment was of 75 m^2 x 5 = 375 m^2. The treatments had been performed manually, with a "Vermorel" type of equipment. 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 0.6 l / ha applied, separately, with the vermorel. The experiment has shown the effectiveness of the above-mentioned phytosanitary products in relation to their price. The efficiency and, respectively, the profitability of applying a single treatment to a product with a fungicidal effect or two phytosanitary treatments with a product with a fungicidal effect were also monitored during wheat's vegetation period. It was taken into account that the spring of 2023 was rainier and cooler than the spring of 2022.

The assessment of the attack's frequency (F%), of attack's intensity (I%) and respectively of the degree of attack (D.A.%) was done separately, on each and every experimental plot, being analyzed 10 plants / experimental plot. The degree of affectation (attack intensity, I%) of the last two leaves was assessed, especially of the "flag" leaf which has the greatest contribution to the ear's production at strawy cereals. The phytosanitary analyses on the plants' samples had been done with the help of the stereo-microscope and of the optic microscope at the laboratory of Braila's Phytosanitary Office – National Phytosanitary Authority, institution subordinated to the Ministry of Agriculture and Rural Development. These analyses have revealed in the analyzed samples the presence of *Septoria* fungus which produces in wheat the disease known as septoriosis. Other pathogenic agents specific to wheat (*Blumeria* sp. *Puccinia* sp.) were signaled in the climatic conditions of the first half of the year 2023, but in a smaller percentage.

For assessing the yield of each variant under study, samples of kernels from each experimental plot, 5 samples each / plot, had been analyzed by spot check. Each sample contained 20 plants, so 100 plants had been taken from each experimental plot, for which the yield was weighted manually. The delimitation of each sample was done with a metric frame with an area of 0.25 m^2 (0.5/0.5m). The average of the samples from the experimental plots was used for calculating the yield of each experimental parcel. The statistic interpretation was executed with the help of limit differences (LD %) (Săulescu N., 1967).

The used variety, Glosa, is a Romanian variety created by the Fundulea National Agricultural Research & Development Institute. Glosa variety is an early variety. It has good

resistance to falling, resistance to wintering, drought and heat and it has a good resistance at sprouting into ear. It has average resistance to brown rust and is resistant to mildew and to the actual strains of yellow rust (Fundulea Seeds Company, 2021).

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

- Frequency of attack (F%);
- Intensity of attack (I %);
- Degree of attack (D.A %).

- The frequency of attack represents the relative value of the number of plants or organs of the plant under attack (n) reported to the number of observed plants or organs (N). The value of the frequency is established by direct observation on a number of plants or organs, according to the case and to the conditions, existing different methods of sample taking and for performing the observations. In the case of our observations, for the foliar diseases, the number of attacked plant organs out of the total of observed plant organs (leaves) was taken into consideration, being thus established the attack's frequency expressed in percentages %. In the case of blights (*Ustilago* sp), it is used the number of wheat's attacked ears, as reported to the total number of observed ears. The frequency is calculated with the formula F%= nx100/N.

- The intensity of the attack represents the degree or percentage whereby a plant or a plant's organ is attacked and how much from the surface of the plant or of the organ analyzed (leaf, fruit) is covered by the disease under study.

- The assessment of the surface under attack is done with the naked eye or with the magnifying glass, assessing the percentage occupied by spots or burns caused by the pathogenic agent. The affectation percentages can be noted or grades can be given for each plant or organ attacked by the disease and/or by the pest. The usage of grades can make easier data summarization in a great extent. It can be used a scale with 6 degrees of intensity, as follows:

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

After data's summarization, the attack's intensity is determined by the formula:

$$I\% = \frac{\Sigma (i \times f)}{n}$$

Where:

I% – attack's intensity (in %);

i – intensity according to the grade given to the organ or plant under attack;

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

n – number of plants attacked.

Grades from 1 to 6, separately, to the "flag" leaf and to the next leaf situated beneath it, had been awarded in our experiment.

- The degree of attack is the expression of the extension of the severity of the attack onto the crop or onto the total number of plants on which we perform the observations. The following relation gives the value expression of D.A.:

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

In most 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 first half of 2023 was more favorable to the onset of the attack of the wheat-specific pathogen complex compared to the similar period of 2022, which was particularly dry. Unlike the previous year, the months of February, March, April and May were richer in rainfall than in 2022. These months were also a little cooler than in 2022. In the autumn of 2022, relatively richer rainfall fell than in the autumn of 2021. Under these conditions, the plants sprang up in time to get through the winter of 2022-2023. This winter was relatively warm compared to the average of previous years. The crop was irrigated in the spring of 2023 with 600 m^2 of water per ha.

Regarding the dynamics of the occurrence of pathogen attacks on wheat, we mention that the pathogen that appeared in the experiment in 2023 was the *Septoria* sp. fungus which produces wheat septoriosis at values of the degree of attack (D.A%) much higher than in 2022.

If we analyze the data in table 1, we notice that the degree of attack of the pathogens monitored, on each treatment variant, was as follows:

- V1 determined a degree of attack (D.A.) of the *Septoria* sp fungus of **34.76**% in the "flag" leaf, and 90.00% in the second leaf, therefore lower by **38.24**% and, respectively, by **7.50**% than the untreated control variant (V5).
- V2 determined a degree of attack (D.A.) of the *Septoria* sp fungus of **35.76**% in the "flag" leaf, and 85.50% in the second leaf, therefore lower by **37.24**% and, respectively, by **12.00**% than the untreated control variant (V5).
- V3 determined a degree of attack (D.A.) of the *Septoria* sp. fungus of **36.26**% in the "flag" leaf, and of 89.00% in the second leaf,

therefore lower by **36.74**% and, respectively, by **8.50**% than the untreated control variant (V5).

- V4 determined a degree of attack (D.A.%) of the *Septoria* sp. fungus of **34.00**% for the "flag" leaf, and 89.50% for the second leaf, therefore lower by **39.00**% and, respectively, by **8.00**% than the untreated control variant (V5).
- V5 untreated control variant showed a degree of attack (D.A.%) of the *Septoria* sp. fungus of **73.00**% on the "flag" leaf, and 97.50% on the second leaf.

All differences in the degree of attack (D.A.%) are statistically assured, according to Table 1.

From the analysis of table 2, the yield differences compared to the untreated control variant V5 can be observed, as follows:

- V1 achieved a yield of 7.056 t/ha, so 0.420 t/ha lower than the control variant.
- V2 achieved a yield of 7.287 t/ha, so 0.567 t/ha higher than the control variant.
- V3 achieved a yield of 6.783 t/ha, so 0.063 t/ha higher than the control variant.
- V4 achieved a yield of 7.035 t/ha, so 0.315 t/ha lower than the control variant.
- V5 - The untreated control variant achieved a yield of 6,720 t/ha.

The yield increases of the variants V1 NATIVO PRO 325 SC 0.7 L/HA 1 treatment applied to booting – flowering phase and V2 RETENGO 0.5 L/HA, 1 treatment applied to the booting – flowering phase present statistical assurance, compared to the V5 - untreated control variant.

CONCLUSIONS

The observations made in the summer of 2023 on the experiment with the Romanian wheat-variety Glosa, led to the following conclusions and recommendations:

1 - The attacks of some pathogens were higher than in 2022. Among these, *Septoria* sp, which produces, in wheat, diseases known as septoriosis, has mainly appeared. The values of the degrees of attack of this phytopathogenic fungus, both in the "flag" leaf and in the second leaf had significantly higher values than in the untreated control variant.

2 - For a good protection of the wheat crop, in case of using the Romanian variety Glosa, we recommend performing, especially in years with moderately humid and cool springs, a single treatment with fungicides, applied in the booting - flowering phase of the wheat plants.

3 – In the years with springs with rainfalls, higher atmospheric humidity and lower temperatures, we recommend performing two treatments with fungicidal plant protection products.

4 - The prices (2024) of the products with fungicide effect used in 2023 are as follows:

- NATIVO PRO 35 SC costs about 212 lei/l (42.5 €/l)
- RETENGO costs about 200 lei/l (40 €/l)

For the V1 variant, 1 treatment with NATIVO PRO 35 SC 0.7 l/ha was applied, i.e. the total cost with the phytosanitary product/ha was 148 lei/ha (approx. 29.6 €/ha)

For the V2 variant, 1 treatment with RETENGO 0.5 l/ha was applied, i.e. the total cost with the phytosanitary product/ha was 100 lei/ha (approx. 20€/ha).

For the V3 variant, 2 NATIVO PRO 325 SC 0.7 l/ha treatments were applied, the total cost with the fungicide product/ha was 296 lei/ha (approx. 59.2 €/ha)

For the V4 variant, 2 treatments with RETENGO 0.5 l/ha were applied, the total cost with the fungicide product/ha was 200 lei/ha (approx. 40 €/ha)

The differences in yield, expressed value wise (lei) compared to the untreated control variant (V5), were as follows:

- For V1, the difference was of 0.420 t/ha, amounting to 420 lei/ha (84 €/ha);
- For V2, it was of 0.567 t/ha, amounting to 567 lei/ha lei/ha (113 €/ha);
- For V3, it was of 0.063 t/ha, amounting to 63 lei/ha (12.6 €/ha);
- For V4, it was of 0.315 t/ha, amounting to 315 lei/ha (63€/ha);

The yield of the untreated control variant was 6,720 t/ha.

We emphasize that the V3 and V4 variants do not present statistical assurance.

4 - From the analysis of the economic profitability, in the climatic conditions of 2023, which was rainier and cooler in the first half, compared to the similar period of 2022, the most cost-effective turned out to be the variants V1 NATIVO PRO 325 SC 0.7 L/HA, 1 treatment applied to the booting - flowering phase and V2. RETENGO 0.5 L/HA, 1 treatment applied to the booting – flowering phase. Under these conditions, we recommend, in years with relatively wet and cool springs, to carry out a single treatment, in the wheat's vegetation phase of booting - flowering, a treatment with a more performant fungicidal product, such as one of those used in this experiment. In the years with springs when rainfall

falls above the multi-year average of the area and temperatures are lower than usual, we recommend two treatments with more performing fungicide products.

5 – In the years with dry and hot winters and springs, a single treatment with products with a fungicidal effect, cheaper, such as those based only on tebuconazole, can be applied to wheat. Here we mention: ARMADA (250 g/l tebuconazole) at a dosage of 0.5 l/ha, ORIUS 25 EW (SALVATOR 25 EW - second trade name) 0.5 l/ha, MYSTIC GOLD -1.0 l/ha according to the Pest-Expert website of the National Phytosanitary Authority, a structure subordinated to the Ministry of Agriculture and Rural Development of Romania.

6- The price of wheat, quoted for export, was, in Romania, on 1st August 2024, about 1.0 lei/kg - about 200€/to (Cereal Exchange 2024).

7-The average leu/€ exchange rate, in the months of April, May and June of 2024 was 4.9751 lei/€1, according to the National Bank of Romania's website.

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