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# THE INFLUENCE OF BIOTIC FACTORS ON THE PRODUCTION AND QUALITY OF SOME NEW WHEAT LINES IN THE 2023-2024 AGRICULTURAL YEAR

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***Abstract***

*Powdery mildew is caused by Blumeria graminis f. sp. tritici and is one of the most important diseases affecting wheat crops. The fungus develops at temperatures of 15-22 ℃ and appears on all plant organs, but most often on leaves. Given the economic importance of wheat, within the Agricultural Research and Development Station Pitesti, in order to conduct research on improving this species, the response of the studied genotypes to the attack of this pathogen is monitored, among other things. In this paper, we present the results obtained under the conditions of the 2023-2024 agricultural year. The aim of our study was to evaluate the response of five genotypes to the attack of powdery mildew (production level and quality indices, respectively protein and gluten content). The studied material was represented by the Trivale variety, as a control variant, and 4 new winter wheat genotypes created within the wheat breeding laboratory, lines A4-10, A44-13, A95-13 and A57-14. The experimental factors were: genotype, seed treatment and type of fertilization. The results obtained showed that line A4-10 presented better tolerance to powdery mildew.*

**Key words:** *Blumeria graminis, fertilization, genotype, gluten, protein.*

## INTRODUCTION

opulation growth also increases the demand for agricultural products, and wheat is one of the most important food species for a significant part of the global population. Agricultural producers face numerous obstacles in achieving agricultural production, and one of the major challenges is the control of fungal diseases (Dodhia et al., 2021). Powdery mildew is one of the main diseases of wheat, present in all cultivation areas and produces quantitative and qualitative losses through grain shrinkage (Cotuna et al., 2015). It is known that agricultural practices, such as monoculture, high plant density, and high atmospheric humidity favor the occurrence of *Blumeria graminis* disease. High levels of atmospheric humidity are an important factor in the occurrence of powdery mildew on wheat plants, a very common phenomenon in spring. In cereals, powdery mildew causes symptoms on leaves, stems and ears (Köhl et al., 2019). *Blumeria graminis* f. sp. *tritici* is a globally important pathogen that can evolve rapidly, destroying wheat resistance genes (Kloppe, 2023). The pathogen's rapid spread and adaptation are amplified by its short life cycle, the ease with which airborne spores can spread over long distances, and the possibility of sexual recombination leading to the generation of new virulent races (Jankovics et al., 2015). Therefore, it is essential to identify new resistance genes and develop new sustainable solutions to prevent the attack of this pathogen on wheat (Ren et al., 2024). Thus, breeding plays a particularly important role in meeting the needs of agricultural producers from this perspective, as the creation of resistant varieties is the most economically and ecologically relevant way to reduce or control powdery mildew attack (Li et al., 2023). The creation of new varieties should not only aim to increase production potential, but also to increase the plasticity of the species towards environmental factors (Vlasenko et al., 2019), especially towards those pathogens that cause significant damage to wheat production and its quality.

The aim of the study that is the subject of this paper was to evaluate the response of five wheat genotypes compared to a recognized variety in terms of response to powdery mildew attack. The effects on production and quality indices (protein and gluten content) were monitored.

## MATERIALS AND METHODS

The study was conducted in one of the experimental fields of the Agricultural Research and Development Station Pitești between September 2023 and June 2024, with winter wheat being cultivated in Romania. The soil is acidic, has a low content of nutrients, being poorly supplied with nitrogen (Nt=0.130% mg/kg), poorly fertile, with a humus content in the arable horizon of 1.96% and a high content of mobile aluminum ions of about 30 ppm, which leads to the blocking of mobile phosphorus. Therefore, it is necessary to periodically apply calcium-based amendments ($CaCO_3$).

To see the influence of environmental factors on plant evolution, temperatures and precipitation were recorded between September 2023 and June 2024. The organization of the experiment was carried out according to the randomized block method, trifactorial type AxBxC in four repetitions. The experimental factors were: factor A - genotype (A1 - Trivale variety - control, A2 - line A4-10, A3 - line A44-10, A4 - line A95-13, A5 - line A57-14), factor B - seed treatment with two graduations, B1 - untreated, B2 - treated, factor C - mineral fertilization with two graduations, C1 - N:120, P:96, K0, C2 - N:160, P: 96, K0. For seed treatment, the insect-fungicide Austral Plus from Syngenta was used. The dose used was 5L/ton of seeds. During the crop's vegetation, the systemic herbicide Axial One from Syngenta was used to combat weeds, 1L/ha. Disease and pest control during vegetation was achieved by performing treatments in two phases: a) at the end of twinning, simultaneously with herbicide application, with the fungicide Verben from Corteva, 1L/ha (Proquinazid 50 g/L and Protioconazole 200 g/L) and the insecticide Mospilan 20 SG (Agro Pataki) 0.1 L/ha (acetamiprid 200g/kg) and b) at the end of flowering with Nativo Pro 325SC from Bayer (protioconazole 175 g/L+trifloxystrobin 150 g/L) 0.8 L/ha. The frequency of attack by powdery mildew on wheat plants was determined with a metric frame (1 m x 1 m). The frequency of attack (F%) represents the ratio between the number of plants or plant organs attacked (n) and the total number of plants or organs analyzed (N), expressed as a percentage, according to the formula: F(%) = (n x 100)/N. Protein content (P%) and gluten content (G%) were determined using the Inframatic IM 9500 device.

Statistical data processing was performed with the PoliFact statistical calculation program (Ivan, 2001).

## RESULTS AND DISCUSSIONS

The temperatures recorded in the months of this agricultural year, except for May when a negative deviation of -0.5°C was recorded, had positive thermal deviations, with values ranging between +1.72°C in November and +6.7°C in February (Figure 1). The average thermal deviation of the entire period was +3.27°C, compared to the 40-year multiannual average of 8.54°C.

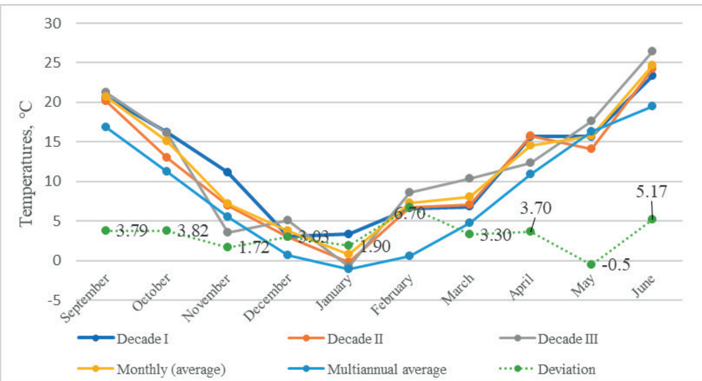

Figure 1. Average monthly temperatures recorded during September 2023-June 2024 at ARDS Pitești

During the analyzed period, a precipitation deficit was recorded in the months of September (-10.3 mm), October (-41.1), December (-46.0 mm), February (-24.4 mm), April (-10.8 mm), May (-65.2 mm) and June (-78.1), the values being below the multiannual average of the mentioned months (Figure 2). In January, there was an excess of 28.5 mm, compared to the multiannual average for this month. During the period in which the study was conducted, September 2023-June 2024, a total of 334.2 mm of precipitation was recorded, so that, compared to the multiannual average for 40 years, which was 542.3 mm, a deficit of -208.1 mm was recorded.

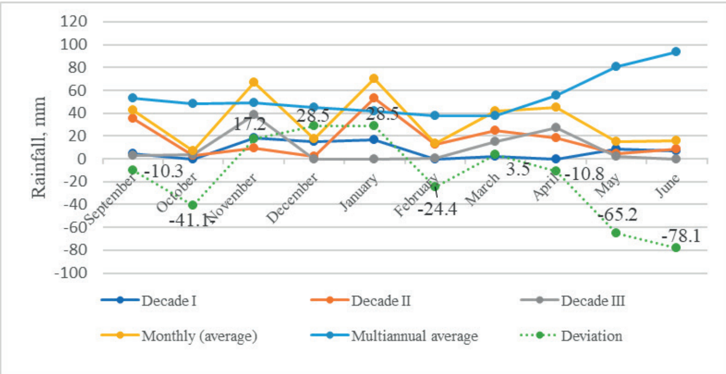


Figure 2. Average monthly rainfall recorded during september 2023-June 2024 at ARDS Piteşti

Regarding the frequency of powdery mildew attack, Table 1 presents the data resulting from the analysis of the interaction of the studied factors, fertilization with 120 kg/ha N a.s. being taken as a control in each case. Thus, in the Trivale variety, the frequency of attack was very significantly positively influenced in the case of fertilization with 160 kg N a.s./ha compared to fertilization with 120 kg N a.s./ha. The wheat genotype A4-10 recorded a significantly positive frequency of powdery mildew attack in the case of fertilization with 160 kg N/ha, compared to the variant in which 120 kg N a.s./ha were applied; in the case of the genotypes A44-13 and A95-13, a very significantly positive frequency of attack is observed in the variants fertilized with 160 kg N a.s./ha, compared to those fertilized with 120 kg N a.s./ha, and the frequency of powdery mildew attack in the case of the genotype A57-14, recorded a distinctly significant positive difference in the variants fertilized with 160 kg N a.s./ha compared to those fertilized with 120 kg N a.s./ha. This highlights that the level of N fertilization increases the sensitivity of plants in general, but some genotypes show a certain tolerance, as is the case for A4-10 and A57-14.

Table 1. Interactions between fertilized variants and genotype on the frequency of powdery mildew (%)

| Fertilizer rates | Genotype | F (%) | % | Difference | Significance |
|---|---|---|---|---|---|
| 120 kg N/ha | Trivale | 12.68 | 100.0 | 0.00 | Mt. |
| 160 kg N/ha | | 15.91 | 125.5 | 3.23 | *** |
| 120 kg N/ha | A4-10 | 3.22 | 100.0 | 0.00 | Mt. |
| 160 kg N/ha | | 4.26 | 132.3 | 1.04 | * |
| 120 kg N/ha | A44-13 | 16.39 | 100.0 | 0.00 | Mt. |
| 160 kg N/ha | | 18.18 | 110.9 | 1.79 | *** |
| 120 kg N/ha | A95-13 | 12.46 | 100.0 | 0.00 | Mt. |
| 160 kg N/ha | | 15.77 | 126.6 | 3.31 | *** |
| 120 kg N/ha | A57-14 | 3.83 | 100.0 | 0.00 | Mt. |
| 160 kg N/ha | | 5.48 | 143.1 | 1.65 | ** |
| LSD (p 5%) | | | | 0.94 | |
| LSD (p 1%) | | | | 1.26 | |
| LSD (p 0.1%) | | | | 1.68 | |

Data on production and the influence of the interaction between the studied genotype and the applied fertilization level are presented in Table 2. Thus, the production achieved in lines A4-10, A44-13 and A95-13, in the variants fertilized with 120 kg N a.s./ha, recorded very significant positive differences, compared to the Trivale control. But, the production achieved in line A57-14, in the variants fertilized with 120 kg N a.s./ha, recorded a distinctly significant negative difference compared to the Trivale control. As in the case of fertilization with 120 kg N a.s./ha, in the variants fertilized with 160 kg N a.s./ha, the production obtained in lines A4-10, A44-13, and A95-13 recorded a very significant positive difference compared to the Trivale control, and the production achieved in line A57-14 recorded a distinctly significant negative difference compared to the same control.

Table 2. Interactions between genotype and fertilized variants on production

| Fertilizer rates | Genotype | Production (kg/ha) | % | Difference | Significance |
|---|---|---|---|---|---|
| 120 kg N/ha | Trivale | 5936.75 | 100.0 | 0.00 | Mt. |
| | A4-10 | 6378.00 | 107.4 | 441.25 | *** |
| | A44-13 | 6260.38 | 105.5 | 323.63 | *** |
| | A95-13 | 6267.75 | 105.6 | 331.00 | *** |
| | A57-14 | 5654.25 | 96.9 | -282.50 | 000 |
| 160 kg N/ha | Trivale | 6128.75 | 100.0 | 0.00 | Mt. |
| | A4-10 | 6585.75 | 107.5 | 457.00 | *** |
| | A44-13 | 6822.75 | 111.3 | 694.00 | *** |
| | A95-13 | 6663.38 | 108.7 | 534.63 | *** |
| | A57-14 | 5888.75 | 103.1 | -240.00 | 000 |
| LSD (p 5%) | | | | 98.93 | |
| LSD (p 1%) | | | | 137.55 | |
| LSD (p 0.1%) | | | | 191.49 | |

Table 3 presents the interaction between the fertilization factor and genotype on the protein content of the studied variants. Thus, in the case of using the dose of 120 kg N d.a./ha, the genotypes A4-10, A44-13 and A95-13 recorded very significant negative differences compared to the Trivale control, while the genotype A57-14 recorded a very significant positive difference regarding the protein content compared to the Trivale control. Also, when using the dose of 160 kg N a.s./ha, it is observed that the winter wheat genotypes A4-10, A44-13, and A95-13 recorded very significantly negative differences compared to the Trivale control, unlike the A57-14 line which recorded a very significantly positive difference in protein content, compared to the same control.

Table 3. Interactions between fertilized variants and genotype on protein content (%)

| Fertilizer rates | Genotype | Protein (%) | % | Difference | Significance |
|---|---|---|---|---|---|
| 120 kg N/ha | Trivale | 14.39 | 100.0 | 0.00 | Mt. |
| | A4-10 | 13.85 | 98.3 | -0.54 | 000 |
| | A44-13 | 13.78 | 104.9 | -0.61 | 000 |
| | A95-13 | 13.81 | 103.0 | -0.58 | 000 |
| | A57-14 | 15.56 | 108.2 | 1.18 | *** |
| 160 kg N/ha | Trivale | 14.50 | 100.0 | 0.00 | Mt. |
| | A4-10 | 13.96 | 98.0 | -0.54 | 000 |
| | A44-13 | 13.91 | 104.3 | -0.59 | 000 |
| | A95-13 | 13.94 | 100.9 | -0.56 | 000 |
| | A57-14 | 15.66 | 107.3 | 1.16 | *** |
| LSD (p 5%) | | | | 0.27 | |
| LSD (p 1%) | | | | 0.37 | |
| LSD (p 0.1%) | | | | 0.52 | |

Table 4 presents the interaction between the use of fertilization doses and wheat genotypes on gluten content. It can be seen that in the case of using a dose of 120 kg N a.s./ha, the genotypes A44-13, A95-13 and A57-14 recorded very significant positive differences in gluten content compared to the Trivale control, while the wheat genotype A4-10 did not record significant differences in gluten content, compared to the same control. When using the dose of 160 kg N a.s./ha, very significant positive differences were recorded regarding gluten content in genotypes A44-13 and A57-14, compared to the Trivale control, while genotype A95-13 recorded distinctly significant positive differences, compared to the same control. Genotype A4-10 did not record significant differences regarding gluten content even when using the dose of 160 kg N a.s./ha.

Table 4. Interactions between fertilized variants and genotype on gluten content (%)

| Fertilizer rates | Genotype | Gluten (%) | % | Difference | Significance |
|---|---|---|---|---|---|
| 120 kg N/ha | Trivale | 28.40 | 100.0 | 0.00 | Mt. |
| | A4-10 | 28.35 | 99.8 | -0.05 | - |
| | A44-13 | 30.56 | 107.6 | 2.16 | *** |
| | A95-13 | 29.95 | 105.5 | 1.55 | *** |
| | A57-14 | 31.74 | 111.8 | 3.34 | *** |
| 160 kg N/ha | Trivale | 28.50 | 100.0 | 0.00 | Mt. |
| | A4-10 | 28.48 | 99.9 | -0.02 | - |
| | A44-13 | 30.55 | 107.2 | 2.05 | *** |
| | A95-13 | 29.39 | 103.1 | 0.89 | ** |
| | A57-14 | 31.83 | 111.7 | 3.33 | *** |
| | LSD (p 5%) | | | 0.50 | |
| | LSD (p 1%) | | | 0.70 | |
| | LSD (p 0.1%) | | | 0.97 | |

## CONCLUSIONS

The analysis of the interaction between fertilization with different doses of nitrogen and genotype on the frequency of powdery mildew attack revealed that it was very significantly positively influenced in the case of using the dose of 160 kg N a.s./ha, compared to the use of the dose of 120 kg N a.s./ha considered as the control. In some cases, nitrogen fertilization increases plant sensitivity, but some genotypes show better tolerance, as was the case of the genotypes A4-10 and A57-14.

When using both doses, fertilization with 120 kg N a.s./ha and 160 kg N a.s./ha, the interaction between the studied genotype and the applied fertilization level influenced the production very significantly positively in the wheat genotypes A4-10, A44-13, A95-13, compared to the Trivale genotype, considered the control, while the production of the wheat genotype A57-14 recorded a very significantly negative difference, compared to the same control.

Due to the negative correlation between production and protein content, it was observed that when using both doses, fertilization with 120 kg N a.s./ha and 160 kg N a.s./ha, the wheat genotypes A4-10, A44-13, A95-13 recorded very significant negative differences in protein content, compared to the control genotype Trivale, while the wheat genotype A57-14 recorded a very significant positive difference in protein content, compared to the same control.

From the interaction between the use of both fertilization doses, 120 kg N a.s./ha and 160 kg N a.s./ha, and genotypes on gluten content, it was found that the wheat genotypes A4-10 and A57-14 recorded very significant positive differences, compared to the Trivale control.

The interaction between fertilization doses and the frequency of attack caused by powdery mildew did not produce significant changes in the production, protein content and gluten content recorded in winter wheat genotypes in the 2023-2024

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