RESULTS REGARDING THE CONTROL OF THE PATHOGEN *Erisiphe pisi* (de Candolle) IN THE PEA CROP UNDER THE CONDITIONS AT ARDS PITEȘTI-ALBOTA

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Abstract

Erisiphe pisi (de Candolle) is the pathogen that causes powdery mildew in peas, one of the most important fungal diseases. The objective of the research was to estimate the level of the powdery mildew attack in the Alvesta and Nicoleta pea genotypes, under the experimental conditions at ARDS Piteşti-Albota, in the period 2023-2024. The effect of azoxystrobin and azoxystrobin + difenoconazole molecules in controlling the pathogen was determined. The frequency (F %), intensity (I %), degree of attack (G.A %) of the disease and effectiveness (E %) of the treatments were calculated. The results showed that the azoxystrobin + difenoconazole variant had the lowest attack degree 1.47%, followed by the azoxystrobin variant with 2.26% in the Alvesta genotype. In the Nicoleta variety, higher values of the degree of attack were recorded compared to the Alvesta variety. The effectiveness had the highest value, of 82.92%, when applying the azoxystrobin + difenoconazole treatment, for the Alvesta genotype.

Key words: Erisiphe pisi, pea, attack degree, variety, disease, effectiveness.

INTRODUCTION

Pea (*Pisum sativum* L.) is a widely distributed leguminous that is frequently affected by various biotic and abiotic stress factors during the growing season (Ali et al., 1994; Wang et al., 2007; Sun et al., 2019). Powdery mildew is one of the most damaging legume diseases, which is transmitted by air (Rubiales et al., 2015; Santos et al., 2020). *Erysiphe pisi*, belongs to the order Erysiphe's, which forms an important group of plant pathogens, producing powdery mildew in over 10,000 species of angiosperms, which include field crops and wild plants of economic and ecological importance (Ale-Agha et al., 2008; Parthasarathy et al., 2017). The development of the disease is favored by humidity above 70% with temperatures between 15-25°C during the flowering and pod filling period. Thus, under these conditions, the infection can completely colonize the plant within 5-6 days and the disease spreads rapidly to adjacent areas. Symptoms of the attack manifest themselves on leaves, stipules, stems, pods and berries.

Whitish-dusty spots appear on the leaf surfaces, which are made up of the mycelium and fruiting bodies of the fungus. As the fungus develops, the whitish layer darkens and becomes gray, and the affected tissues turn brown and necrotic (https://www.anfdf.ro/sanatate/ghid/ghid_leguminoase_2021.pdf).
These fungi have complex life cycles and are biotrophic in nature. Due to this characteristic, they are difficult to study under laboratory conditions (Singh et al., 1988; Smith et al., 1996; Parthasarathy et al., 2017). Worldwide, powdery mildew caused by *Erysiphe pisi* (de Candolle) can reduce the yield and quality of pea crops (Gritton et al., 1975; Peng et al., 1991; Smith et al., 1996; Sun et al., 2019). Severe infections can lead to a yield reduction of up to 80% (Smith et al., 1996; Ghafoor et al., 2012; Sun et al., 2019). *Erysiphe pisi,* the agent causing powdery mildew in peas, can cause infection of the aerial parts of the plants (Singh, 2000; Bahadur et al., 2008). This pathogen negatively affects the total biomass, the number of pods per plant, the number of grains per pod, the number of nodes and the height of the

plants (Gritton et al., 1975; Attanayake et al., 2010). In order to manage the disease, the use of chemicals is the most commonly used method when resistance is absent in the varieties available on the market. The high cost of fungicides makes their use uneconomical (Kapoor et al., 1995). The measures for the prevention and management of pathogens consider an integrated control based on the cultivated genotype, and where appropriate, treatments are applied and their effectiveness is also necessary to calculate (Toth & Cristea, 2018; Jaloba et al., 2019; Toth & Cristea, 2020; Podea et al., 2024). In this paper, data are presented on the behavior of two pea varieties, Alvesta and Nicoleta, to powdery mildew attack, with different treatments.

MATERIALS AND METHODS

The research aimed to identify and establish the attack caused by the pathogen *Erysiphe pisi* (de Candolle), under different treatment conditions on 2 pea varieties, Alvesta and Nicoleta. The research was carried out in the experimental field of the ARDS Pitești-Albota in 2023, 2024. To achieve the proposed objectives, a bifactorial experiment with 4 repetitions was set up.

Factor A. pea varieties (Alvesta and Nicoleta).
Factor B - treatments: V1 control variant, V2 *azoxystrobin*; V3 *azoxystrobin+ difenoconazole*. The treatments were applied during the vegetation period when the first inflorescences appeared. The control variant was not treated. The frequency (F %), attack intensity (I %), attack rate (A.D %) and efficacy (E %) of the applied treatments were determined. They were calculated according to the formulas: Frequency $(F \%) = \frac{n}{N} \, x \, 100$, where N = number of plants observed (%), n = number of plants with specific symptoms. The intensity was noted in percentages and calculated according to the formula: Intensity $(I \%) = \Sigma \, \frac{i x f}{n}$, where I = given percentage, f = number of plants/organs with the respective percentage, n = total number of plants/organs attacked. Based on the data obtained by calculating the frequency and intensity, the

degree of attack was calculated: A.D (%) = $\frac{F\% \, x \, I \%}{100}$, where A.D = degree of attack (%), F = frequency (%), I = intensity (%).

The effectiveness of the treatments was determined according to the formula E % = [Gam - Gav/ Gam] x 100 (%) (Abbott's formula), where Gam = the degree of attack on the control variant, Gav = the degree of attack on the treated variant.

Table 1. The variants used in the experiment

Var.	Product	Active ingredient	Rate (l, t, kg/ha)
1	Untreated	-	
2	Zoxis	azoxystrobin 250 g/l	1 l/ha
3	Ortiva Top	azoxystrobin (200 g/l) + difenoconazole (125 g/l)	1 l /ha

The climatic conditions were registered at the weather station located in the station during the period February-July (the crop vegetation period). The meteorological data characterize the 2 years as years with high temperatures, with positive deviations from the multiannual average, except for the months of April and May when negative deviations of - 0.9°C, - 0.7°C , and - 0.5°C were registered. In 2023, the average temperature of the period was 13.86 °C, exceeding the multiannual average of 12.25 °C by 1.61°C. The year 2024 registered an average temperature of 15.9°C, 3.65°C higher than the multiannual average (Figure 1). The weather data of the pea growing season describe the 2 years as dry with low, unevenly distributed precipitation. Regarding rainfall during the research period, in 2023 an amount of 260.7 mm was registered, with a deficit of – 126.1 mm. Negative deviations from the multiannual amount were registered during the 6 months, with the exception of April, which brought an increase of 13.9 mm compared to the multiannual amount of 55.9 mm. The amount of rainfall in 2024 was lower compared to 2023, totalling 163.4 mm, with a - 231.4 mm. March was the only month in which a positive deviation of 3.5 mm was registered (Figure 2).
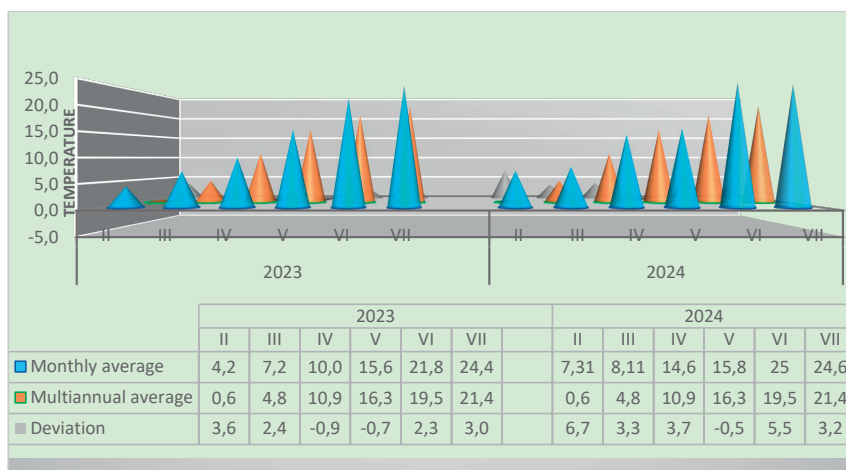
Figure 1. The monthly average temperature in the period February-July 2023 and 2024
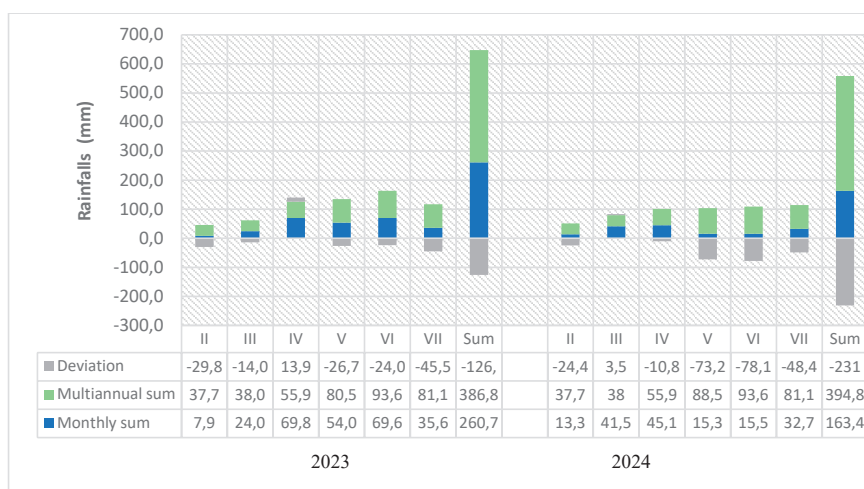(ARDS Albota weather station)

| | 2023 | | | | | | | 2024 | | | | | |
	II	III	IV	V	VI	VII		II	III	IV	V	VI	VII
■ Monthly average	4,2	7,2	10,0	15,6	21,8	24,4		7,31	8,11	14,6	15,8	25	24,6
■ Multiannual average	0,6	4,8	10,9	16,3	19,5	21,4		0,6	4,8	10,9	16,3	19,5	21,4
■ Deviation	3,6	2,4	-0,9	-0,7	2,3	3,0		6,7	3,3	3,7	-0,5	5,5	3,2

Figure 2. The evolution of rainfall in the period February - July 2023 and 2024
(ARDS Albota weather station)

	II	III	IV	V	VI	VII	Sum		II	III	IV	V	VI	VII	Sum
■ Deviation	-29,8	-14,0	13,9	-26,7	-24,0	-45,5	-126,		-24,4	3,5	-10,8	-73,2	-78,1	-48,4	-231
■ Multiannual sum	37,7	38,0	55,9	80,5	93,6	81,1	386,8		37,7	38	55,9	88,5	93,6	81,1	394,8
■ Monthly sum	7,9	24,0	69,8	54,0	69,6	35,6	260,7		13,3	41,5	45,1	15,3	15,5	32,7	163,4
				2023								2024			

RESULTS AND DISCUSSIONS

Pea is a leguminous that is affected by numerous pathogens that induce severe diseases, including powdery mildew (*Erysiphe pisi*).

The study of pathogen attack on pea crops is of major importance in determining the need for chemical treatments during the growing season. An important role in obtaining a high yield is played by the crop's disease protection system (Zotov & Badarin, 2015; Gulnar et al., 2022).

The first symptoms of powdery mildew attack appeared in the second decade of May, first on the leaves, then they covered the entire plant.

The determinations were carried out under natural contamination conditions (Figure 3).

The first fungicide treatment was applied at the appearance of the first inflorescences (T1), and the second treatment after approximately 14 days (only for the Ortiva Top product). The Zoxis product was applied only once.

Figure 3. Powdery mildew attack on peas (original)

The results obtained in 2023, regarding the frequency of attacks, registered values between 26 and 61%. Alvesta genotype obtained the lowest frequency value (26.0%) in the variant with the application of treatment with *difenoconazole + azoxystrobin*, followed by the variant with the application of treatment with a*zoxystrobin* of 32.0%, with very significantly negative differences.

Attack intensity ranged from 9.2 to 21.2%. The lowest degree of attack was also registered with the *azoxystrobin + difenoconazole* variant of 2.40%.

In the Nicoleta variety, the attack frequency was between 37% and 61% with an intensity between 9.8-20.2%, resulting in an attack degree with values between 3.62 and 12.30%.

The attack produced by powdery mildew registered very significant negative differences in both varieties tested (Table 2).

Table 2. The behavior of pea varieties to the attack caused by powdery mildew in the year 2023

Variety	Variants tested	The pathogen / disease/ powdery mildew *Erysiphe pisi* (de Candolle)							
		F%	Dif.	Sem.	I %	Dif.	Sem.	AD%	Dif.	Sem.
Alvesta	Control variant	53.0	-	Mt.	21.2	-	Mt.	11.23	-	Mt.
	Azoxystrobin	32.0	-21.0	000	11.3	-9.88	000	3.61	-7.62	000
	Azoxystrobin+ difenoconazole	26.0	-27.0	000	9.2	-12.05	000	2.40	-8.83	000
Nicoleta	Control variant	61.0	-	Mt.	20.2	-	Mt.	12.30	-	Mt.
	Azoxystrobin	41.0	-20.0	000	13.9	- 6.20	000	5.70	-5.53	000
	Azoxystrobin+ difenoconazole	37.0	-24.0	000	9.8	-10.45	000	3.62	-7.61	000
LSD 5% LSD 1% LSD 0.1%		8,12 11,40 16,10			2.34 3.29 4.65			2.21 3.10 4.38		

F(%) - Frequency, I(%) - Intensity, AD (%) - Attack degree, Dif. - Difference, Semen. - Semification

Table 3 shows results regarding the frequency, intensity of the attack and the degree of attack produced by powdery mildew in the year 2024. In the Alvesta variety, the attack frequency registered average values between 16 and 46%. The highest frequency of 46% occurred in the control variant, followed by the variant with the administration of *azoxystrobin* treatment with 21% in which the intensity was 10.75% and the degree of attack obtained 2.26%. The lowest value of 16% of the frequency was registered when *azoxystrobin +difenoconazole* products were administered, the intensity was 9.20 and the AD% obtained was 1.47%. The frequency of attacked plants in the Nicoleta variety varied between 23 and 55 %. In the control version, the attack frequency had the highest value, 55% with an intensity of 19.08, obtaining a AD% of 10.50%. The application of the *azoxystrobin* treatment thus influenced the mealybug attack: the resulting frequency was 30%, the intensity 10.38% which resulted in a AD of 3.11%. In the variant to which the two molecules of *azoxystrobin +difenoconazole* were applied, the frequency of attacked plants was the lowest (23%) compared to the rest of the variants, the intensity of 10.25% in which the degree of attack also registered the lowest value, namely 2.35%. The application of the two treatments against powdery mildew to the 2 studied varieties registered very significantly negative differences compared to the control variants.

Table 2. The behavior of pea varieties to the attack caused by powdery mildew in the year 2024
F(%) - Frequency, I(%)- Intensity, AD (%) - Attack degree, Dif-Difference, Sem-Semification

Variety	Variants tested	The pathogen / disease/ powdery mildew *Erysiphe pisi (de Candolle)*								
		F%	Dif.	Sem.	I %	Dif.	Sem.	AD%	Dif.	Sem.
Alvesta	Control variant	46.00	-	Mt.	18.50	-	Mt.	8.51	-	Mt.
	Azoxystrobin	21.00	-25.00	000	10.75	-7.75	000	2.26	-6.19	000
	Azoxystrobin+ difenoconazole	16.00	-30.00	000	9.20	-9.30	000	1.47	-7.00	000
Nicoleta	Control variant	55.00	-	Mt.	19.08	-	Mt.	10.50	-	Mt.
	Azoxystrobin	30.00	-25.00	000	10.38	-8.70	000	3.11	-7.50	000
	Azoxystrobin+ difenoconazole	23.00	-32.00	000	10.25	-8.83	000	2.35	-8.28	000
LSD 5%		**8.82**			**3.82**			**2.58**		
LSD 1%		**12.38**			**5.36**			**3.63**		
LSD 0,1%		**17.47**			**7.57**			**5.12**		

Determining the effectiveness of products in combating plant pathogens is a permanent concern in research and application activity (Buzatu et al., 2018; Jaloba et al., 2019; Alexandru et al., 2019; Chiriac &, Cristea 2021). Regarding the effectiveness of the products applied in the period 2023, 2024 (Figure 4) against the pathogen *Erysiphe pisi*, values between 53.31 and 82.92% were obtained. The application of the *azoxystrobin* treatment to the Alvesta variety in 2023 ensured an effectiveness of over 67%, while an effectiveness of 53% was registered for the Nicoleta genotype. In 2024, the same treatment reduced the attack of the pathogen ensuring an effectiveness of 73.41% for the Alvesta variety and 70.75% for Nicoleta. The treatment with the substances azoxystrobin +difenoconazole in the year 2023 had an effectiveness of the Alvesta variety of 78.37%, Nicoleta 70.43% and the year 2024 brought an effectiveness of 82.92% (Alvesta) and 78.11% for Nicoleta.
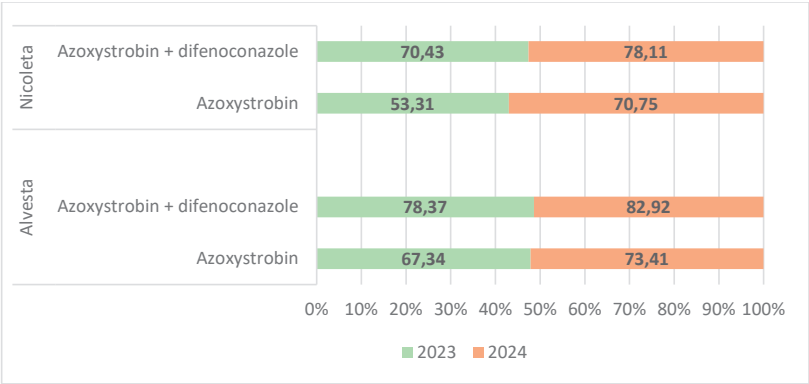

Figure 4. The effectiveness (%) of treatments in the period 2023 and 2024

CONCLUSIONS

Application of a treatment scheme with approved products to ensure disease control is necessary to obtain high yields. In the experimental conditions at ARDS Pitesti-Albota, the powdery mildew attack on the 2 pea varieties manifested itself differently during the researched period. In the Alvesta variety, the attack values were lower compared to the Nicoleta genotype in the 2 years of the study. The type of treatment applied against powdery mildew influenced the degree of attack by the fungus. In the year 2023 the AD% of the pathogen recorded higher values in the 2 genotypes, compared to the year 2024. The application of the molecules *azoxystrobin + difenoconazole* had the best effectiveness against powdery mildew.

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