Scientific Papers. Series A. Agronomy, Vol. LXVII, No. 1, 2024
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH REGARDING *Didymella pinodes* (Berk & Blox) CONTROL IN PEAS AT ARDS PITESTI

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Abstract

Didymella pinodes (Berk & Blox) is the main agent of anthracnose, one of the most important fungal diseases of peas worldwide and in Romania. The objective of this research was to estimate the level of anthracnose attack in the Alvesta and Nicoleta pea genotypes in the experimental conditions at ARDS Pitești-Albota, during 2022-2023. The following variants were tested: V1 control (untreated); V2 fluxapyroxad + difenoconazole; V3 azoxystrobin + difenoconazole; V4 Biosem (biological product); V5 cyprodinil + fludioxonil. The frequency (F%), intensity (I%) and attack degree (AD%) of the disease were calculated. The level of degree of attack varied with the variety and the treatment applied. The lowest value of the attack degree was registered in the Alvesta variety with AD = 2.2% in the fluxapyroxad + difenoconazole variant, in which the production also had the highest value of 3300 kg/ha. Nicoleta variety registered higher values of attack degree compared to Alvesta variety.

Key words*: pea, Didymella pinodes, treatment, attack degree, variety.*

INTRODUCTION

The pea (*Pisum sativum* L.) is a crop known since antiquity, with a wide ecological and production potential, it is grown for grains in most countries around the world, the grains being used in food, the processing industry and as fodder. The value of the grains lies in the high content of proteins - up to 27.8%, starch - 43.2% and fats - 1.2%, they are appreciated for their biochemical content (Celac, 2012). Pea crop is affected by an important number of pathogens, which, under favorable conditions, can significantly decrease both the yield and the quality of the grains, even leading to total losses. The seed represents an important means of disease transmission to plants (Berca & Cristea, 2015; Dudoiu et al., 2016; Zaharia et al., 2022). The transmission of diseases through seeds carrying pathogens also involves a correct management of pathogen control (Couture et al., 2002; Krnjaja et al., 2018). Annual losses due to diseases vary from year to year depending on climatic conditions (Podea & Cristea, 2023). Fungi that cause plant diseases can be seed-borne, but this is a minor source of infection compared to spores released from plant residues of the previous crop (Bretag et al., 2006). Ascochyta blight complex, is one of the main diseases affecting field pea production and can be caused by several pathogens of the genus *Ascochyta* (Tivoli & Banniza, 2007). Ascochyta blight is a serious disease of cold season grain legumes (pea, lentils, faba bean and chickpea) (Kosturkova et al., 2012; White et al., 2007). *Didymella pinodes* is the most widespread causative pathogen and the most damaging. In Romania, *Didymella pinodes* (Berk & Blox) is one of the most important pathogens causing significant damage to the pea crop. The disease manifests itself on all aerial organs of the plant: leaves, stems and pods. On plants that have just emerged, the disease makes its presence felt on the leaves, circular spots appear, dark brown in color, being basically isolated. On the stem and petiole, the spots are deep in the tissues and arranged longitudinally, showing a dark brown color with a dark and slightly raised edge. The characteristic form of disease manifestation appears on the pods, showing circular or irregular spots, confluent or isolated, light

brown, outlined with a reddish border; the pods become deformed and may fall off. If the infection occurs later, after the formation of the grains, the mycelium of the fungus also reaches the seeds, the disease manifesting itself in the form of dark or light yellow spots with a diffuse border (Ahmed et al., 2015). The development of the disease is favored by temperatures between 20 and 21°C and relatively high humidity (Jha et al., 2019). The measures to prevent and control pathogens of cultivated plants have in mind an integrated control, with an emphasis on the cultivated genotype, and where the treatments are applied, it is necessary to calculate their effectiveness (Toth & Cristea, 2020; Toth & Cristea, 2018; Jaloba et al., 2019). This paper presents the behavior of two pea genotypes when attacked by the pathogen *Didymella pinodes*, under different treatment conditions.

MATERIALS AND METHODS

The research aimed to identify and establish the attack produced by the pathogen *Didymella pinodes* (Berk & Blox) (anthracnose), in response to the application of different treatments to the Alvesta and Nicoleta pea varieties under the conditions of ARDS Pitești-Albota, in the period 2022-2023. In order to achieve the proposed objectives, a bifactorial experiment was established according to the method of randomized blocks with 4 repetitions, in the experimental field of the station.

Factor A. (pea genotypes): Alvesta and Nicoleta.

Factor B. treatments (Table 1).

Table 1. Tested variants in the trial

Var.	Product	Active ingredient	Rate (l, t, kg/ha)
1	Untreated	-	
2	Dagonis	Fluxapyroxad (75 g/l) + Difenoconazol (50 g/ l)	2 l/ha
3	rtiva Top	Azoxystrobin (200 g/l) +difenoconazol (125 g/l)	1 l/ha
4	Biosem	Biological product, Neem oil (30%), *Trichoderma harzianum* (2%)	1.5 l/t
5	Switch 62,5 WG	Cyprodinil (25%) + fludioxonil (37.5%)	1 kg/ha

The treatments were applied during the vegetation period at the appearance of the first inflorescences, except for the Biosem product which was applied to the seed. No treatments were applied to the control variant. Evaluations of frequency (F%), attack intensity (I%), attack degree (A.D) and effectiveness (E%) were performed. The frequency and intensity of the attack were calculated according to the formula:

$$\text{Frequency (F \%)} = \frac{n}{N}\ x\ 100,$$

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:

$$\text{Intensity (I \%)} = \Sigma\ \frac{ixf}{n},$$

where: i = the given percentage; f = the number of plants/organs with the respective percentage; n = the total number of plants/organs attacked.

Based on the data obtained by calculating the frequency and intensity, the degree of attack was calculated:

$$\text{A.D (\%)} = \frac{F\%\ x\ I\ \%}{100},$$

where: A.D = degree of attack (%); F = frequency (%); I = intensity (%).

The effectiveness of the treatments was determined according to the formula:

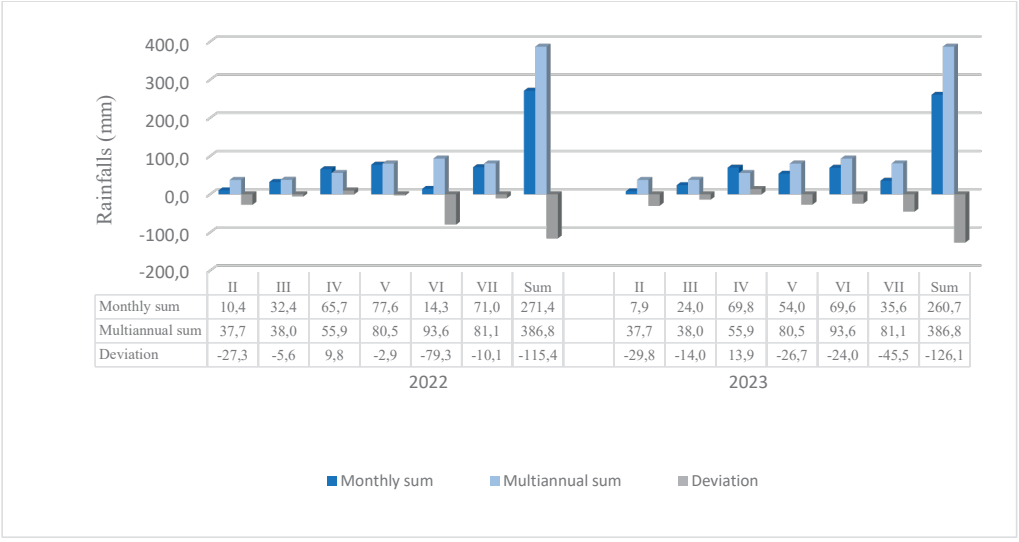
E % = [Gam-Gav/ Gam] x 100 (%) (Abbott' formula), where: Gam = the degree of attack on the control variant; Gav = the degree of attack on the treated variant.

In terms of the temperature regime, the February-July period of 2022 (Figure 1) began with the month of February with higher temperatures compared to the multi-year average, registering a positive thermal deviation of 3.1°C, followed by the months of March and April characterized as being colder than the multi-year average, with negative thermal deviations of –1.2°C for March, –0.1°C in April, continuing with 3 warmer months with positive thermal deviations (for May 0.8°C, June and July with deviations of 2.1°C). For the year 2023, the climate data for the period of 6 months characterizes the year as warm and dry, with increased temperatures in February, March, June and July with positive deviations from the multi-year average of 3.6°C in February, 2.4°C in March, 2.3°C in June, and 3°C in July, with negative deviations in April of –0.9°C, May –0.7°C with day/night temperature alternations.

	II	III	IV	V	VI	VII	II	III	IV	V	VI	VII
Monthly average	3,7	3,6	10,8	17,1	21,6	23,8	4,2	7,2	10,0	15,6	21,8	24,4
Multiannual average	0,6	4,8	10,9	16,3	19,5	21,7	0,6	4,8	10,9	16,3	19,5	21,4
Deviation	3,1	-1,2	-0,1	0,8	2,1	2,1	3,6	2,4	-0,9	-0,7	2,3	3,0

Figure 1. The monthly average temperature registered in the period February-July 2022, 2023

In 2022, the monthly sum rainfall registered during the 6 months was 271.4 mm, with a deficit of -115.1 mm, compared to the multi-year amount of 386.8 mm. The amount of precipitation recorded between February and July 2023 was 260.7 mm, with a deficit of -126.1 mm, compared to the multiannual amount of 386.8 mm (Figure 2). Climatic data show that, during the 2 years of research, the conditions of 2022 were more favorable for the appearance of the disease due to the rather high rainfall regime, especially in the second decade of May, a moment that coincided with the formation of pods.



	II	III	IV	V	VI	VII	Sum	II	III	IV	V	VI	VII	Sum
Monthly sum	10,4	32,4	65,7	77,6	14,3	71,0	271,4	7,9	24,0	69,8	54,0	69,6	35,6	260,7
Multiannual sum	37,7	38,0	55,9	80,5	93,6	81,1	386,8	37,7	38,0	55,9	80,5	93,6	81,1	386,8
Deviation	-27,3	-5,6	9,8	-2,9	-79,3	-10,1	-115,4	-29,8	-14,0	13,9	-26,7	-24,0	-45,5	-126,1

Figure 2. The monthly sum rainfall registered in the period February - July 2022, 2023

RESULTS AND DISCUSSIONS

Visual observation is the fastest method of identifying a disease based on the signs and symptoms present on infected pea plants. Research on the attack of anthracnose (*Didymella pinodes*) in the pea crop is of particular importance to determine the need for treatments during the growing season. The first symptoms of anthracnose appeared in the pea crop in the second decade of May, and they were present first on the leaves and then on the pods (Figure 3). The observations were made under conditions of natural contamination.

Figure 3. Anthracnose attack on leaves and pods

The application of appropriate fungicides at the time of the appearance of the first typical symptoms of anthracnose in the pea crop, plays an important role in the management of the disease. Following the results obtained in 2022 (Table 2) regarding the frequency of attacked plants, it was highlighted that the attack frequency had average values between 31.5 and 74.8%. In the Nicoleta variety, the lowest registered attack value was in the variant with the Dagonis vegetation treatment (fluxapyroxad + difenoconazole) of 32.4%, followed by the variant to which the Ortiva Top (azoxystrobin + difenoconazole) treatment was applied 38.1%, the differences being statistically assured as very significantly negative.

In the variants to which Biosem (biological product) and Switch 62.5WG (cyprodinil + fludioxonil) products were applied, no differences were registered from a statistical point of view. Regarding the Alvesta variety, the highest value of the frequency was registered in the control variant of 66.7%, and the lowest value of 31.5%, in the variant with the Dagonis treatment, in this case the differences were very significantly negative.

The intensity of the attack varied according to the variety and treatment as follows: in the Nicoleta variety, the lowest attack intensity was registered in the version with the Dagonis treatment 14.2%, the values being close to the version with the chemical product Ortiva Top (14.4%), at both variants the differences were significantly negative compared to the control variant. In the other two variants (Biosem, Switch) no differences were registered.

In the Alvesta variety, the intensity of the attack had values between 19.1 (the control variant) and 12.1 % (Dagonis). The degree of attack in the two varieties varied between 14.7 and 3.8 %. The lowest values of the degree of attack were recorded by the Alvesta variety with values between 3.8 (variant with Dagonis treatment) and 12.7% (untreated control variant). When applying the Ortiva Top treatment, the degree of attack had average values of 5.3% with statistically ensured negative differences.

Table 2. The attack caused by anthracnose (*Didymella pinodes*) in the pea crop in 2022

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

Variety	Variants tested	The pathogen/disease Anthracnose (*Didymella pinodes)* (Berk & Blox)								
		F%	Dif.	Sem.	I %	Dif.	Sem.	AD%	Dif.	Sem.
Nicoleta	Control variant	74.8	-	-	19.7	-	-	14.7	-	-
	Dagonis	32.4	-42.4	°°°	14.2	-5.4	°	4.6	-10.2	°°°
	Ortiva Top	38.1	-36.7	°°°	14.4	-5.2	°	5.4	-9.3	°°°
	Biosem	67.4	-7.4	-	18	-1.7	-	12.2	-2.5	-
	Switch	63.8	-11	-	17.6	-2	-	11.2	-3.5	°
Alvesta	Control variant	66.7	-	-	19.1		-	12.7	-	-
	Dagonis	31.5	-35.2	°°°	12.1	-7	°°	3.8	-8.9	°°°
	Ortiva Top	36.4	-30.3	°°°	14.6	-4.5	°	5.3	-7.4	°°
	Biosem	62.5	-4.2	-	18.8	-0.3	-	11.7	-1	-
	Switch	61.7	-5	-	16.8	-2.3	-	10.3	-2.4	-
LSD 5%			**11.826**			**3.659**			**3.011**	
LSD 1%			**17.432**			**5.600**			**4.537**	
LSD 0.1%			**29.359**			**10.401**			**8.100**	

In the year 2023 (Table 3) the average attack frequency of the Nicoleta variety registered values between 25.4 and 65%. The lowest frequency value of 25.4% was registred in the variant with Dagonis treatment and with an intensity of 13.8%, resulting in a degree of attack with a value of 3.4%. In the control variant, the attack frequency was 65%, the attack intensity 21%, and the AD% 13.6%. In the variant with the Ortiva Top treatment, the frequency was 32.4%, the intensity 14.2%, with a AD of 4.5%. For the Biosem variant (biological product) the frequency was 56%, the intensity 19%, AD% 10.6 and for the variant with the Switch treatment (cyprodinil + fludioxonil) the frequency recorded values of 40%, the intensity 17.5% and AD of 7%. In the pea genotype Alvesta, the frequency of attacked plants in the control variant was 59%, the attack intensity 18.6%, and the resulting AD was 10.9%. In the case of the variant in which the fungicide Dagonis (fluxapiroxad + difenoconazole) was administered, the registered frequency was 20%, with an intensity of 11.3% and a AD of 2.2%. In the Ortiva Top (azoxystrobin + difenoconazole) treatment variant, the attack frequency was 28.4%, the attack intensity 13%, resulting in a AD% of 3.6. In the rest of the variants, the following attack parameters were registered: frequency (Biosem 48%), (Switch 37%), intensity (Biosem 20%), (Switch 18%) resulting in a AD % of 9.6 (variant with Biosem treatment) and 6.6% for the version with the Switch 62.5WG product.

Table 3. The attack caused by anthracnose (*Didymella pinodes*) in the pea crop in 2023
F (%) - Frequency, I (%) - Intensity, AD (%) - Attack degree, Dif - Difference, Semn. - Semnification

Variety	Variants tested	The pathogen/diseases Anthracnoze (*Didymella pinodes*) (Berk & Blox)								
		F %	Dif.	Sem.	I %	Dif.	Sem.	AD %	Dif.	Sem.
Nicoleta	Control variant	65	-	-	21	Mt.	-	13.6	-	-
	Dagonis	25.4	-39.6	°°°	13.8	-7.2	°°	3.4	-10.1	°°°
	Ortiva Top	32.4	-32.6	°°°	14.2	-6.8	°°	4.5	-9	°°°
	Biosem	56	-9	°	19	-2	-	10.6	-3	°°
	Switch	40	-25	°°°	17.5	-3.4	-	7	-6.5	°°°
Alvesta	Control variant	59	-	-	18.6	-	-	10.9	-	-
	Dagonis	20	-39	°°°	11.3	-7.3	°°	2.2	-8.7	°°°
	Ortiva Top	28.4	-30.6	°°°	13	-5.6	°	3.6	-7.3	°°°
	Biosem	48	-11	°	20	1.4	-	9.6	-1.3	-
	Switch	37	-22	°°	18	-0.6	-	6.6	-4.3	°°
LSD 5%		**7.870**			**4.074**			**2.038**		
LSD 1%		**12.387**			**5.791**			**2.898**		
LSD 0.1%		**24.547**			**8.751**			**4.380**		

The application of treatments ensures effectiveness in controlling the attack of plant diseases with an impact on agricultural production (Buzatu et al., 2018). The effictiveness of the treatment scheme in the period 2022-2023 (Figure 4) for the pea crop recorded values between 7.87 and 79.8%. The application of the Dagonis treatment to the Alvesta variety in 2023 reduced the attack of the pathogen *Didymella pinodes* and ensured an effectiveness of over 79%, while in the Nicoleta variety we have an effectiveness of 75%. In 2022, when applying the same treatment (Dagonis), values of 69.4% (for the Nicoleta variety) and 70% for the Alvesta variety were registered. Treatment with the fungicide Ortiva Top in 2022 was effective for the Nicoleta variety (63.3%), for Alvesta (58.2%) and in 2023 values of 66.9% (Nicoleta) and 66% were registered (Alvesta). In the version with the application of the biological product (Biosem), the effectiveness registered in 2022 was 7.87% (Alvesta), 17% (Nicoleta) and in 2023 11.9% (Alvesta) and 22% for the Nicoleta variety (Figure 4).

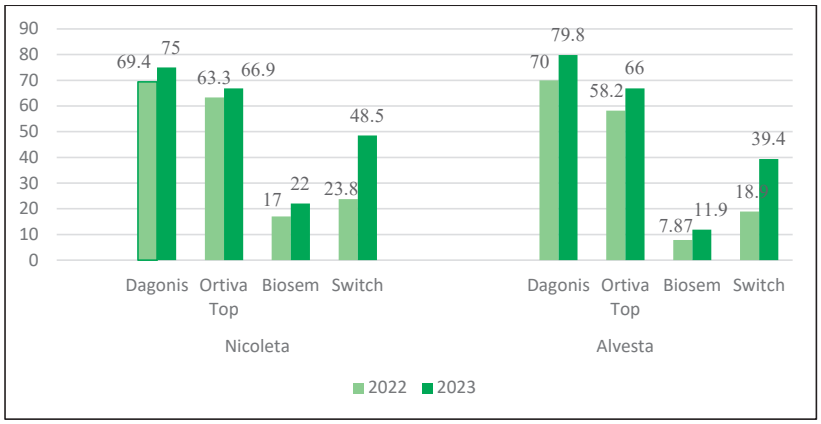


Figure 4. The effectiveness (%) of treatments in the period 2022-2023

Analyzing the yield data from the year 2022 (Figure 5) for the 2 genotypes studied, it can be seen that the highest production values were recorded by the variants to which the Dagonis product was applied as follows: 2790 kg for the Nicoleta variety, 2825 kg Alvesta with very significantly positive differences, compared with the blank version. When applying the treatment with the Ortiva Top fungicide, the yield values were 2702 kg/ha (Nicoleta) and 2796 kg/ha respectively for the Alvesta genotype with positive differences statistically ensured. The influence of the biological treatment (Biosem) on the yield did not show any differences compared to the control, and the application of the Switch fungicide to both the Nicoleta and Alvesta varieties brought an increase in yield of 100 and 172 kg/ha respectively, with differences significant in favor of the Alvesta genotype.

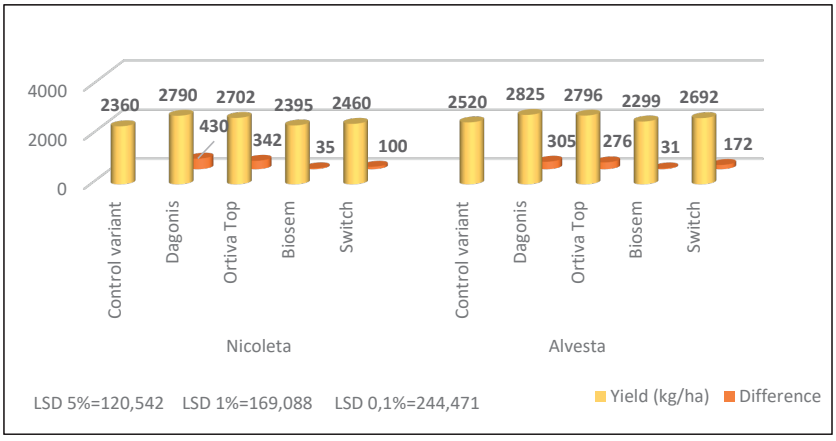


Figure 5. Grain pea yield kg/ha in 2022

In 2023, the average grain yield was somewhat higher compared to 2022, so the average yield of the Nicoleta variety was 2965 kg, while the Alvesta genotype registered a value of 3109 kg. The highest values were also, as in 2022, for the variants with the application of the fungicide Dagonis, which brought a very significant positive increase in yield of 420 kg for Nicoleta and 370 kg/ha for the Alvesta variety. Also, the treatment with the Ortiva Top product registered a yield of 3132 kg/ha in the case of the Nicoleta variety, respectively 3245 kg/ha for Alvesta, with distinctly significantly positive differences compared to the control variant (Figure 6).

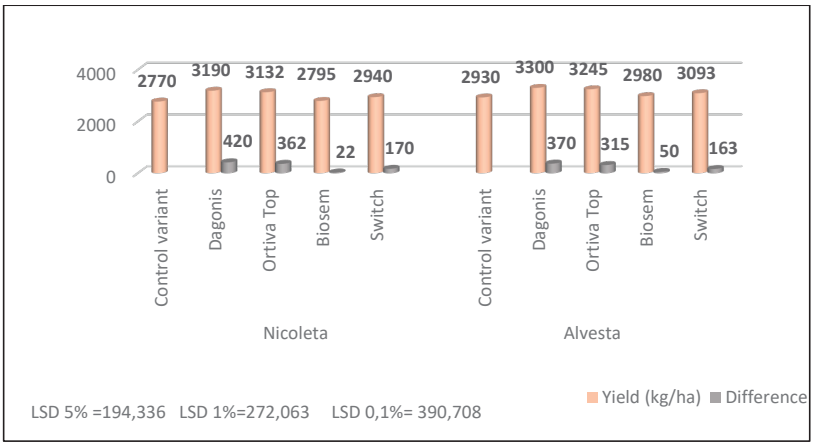


Figure 6. Grain pea yield kg/ha in 2023

CONCLUSIONS

The application of phytosanitary treatments by spraying fungicides approved in Romania against the attack of the complex of pathogens that attack the pea crop is of particular importance, especially in years with favorable conditions for their appearance and evolution.

In the conditions of the research area at ARDS Pitesti, the anthracnose attack manifested itself differently in the Nicoleta and Alvesta varieties during the 2 years of study.

The Alvesta variety registered lower values of the attack of the studied pathogen compared to the Nicoleta variety, throughout the research period.

The type of treatment applied can influence the degree of attack of the fungus *Didymella pinodes*. The degree of anthracnose attack in 2022 registered higher values in both varieties compared to 2023.

The application of the treatment scheme to the 2 varieties with the fungicide Dagonis was the most effective against anthracnose during the researched period.

The Biosem biological product treatment was the least effective of the treatments.

Grain yield was also influenced by the attack of the studied pathogen, thus the highest yield values were registered in 2023 for the Dagonis variant (Alvesta variety) of 3300 kg/ha.

REFERENCES

Ahmed, H., Chang, K. F., Hwang, S. F., Fu, H., Zhou, Q., Strelkov, S., & Gossen, B. (2015). Morphological characterization of fungi associated with the *Ascochyta blight* complex and pathogenic variability of *Mycosphaerella pinodes* on field pea crops in central Alberta. *The Crop Journal*, *3*(1), 10-18.

Berca, L., Cristea, S. (2015). Research on micoflora present on rapeseed (*Brassica napus*) in the south region of Romania. *Romanian Biotehnological Letters*, *20*(5), 10809–10813.

Bretag, T. W., Keane, P. J., & Price, T. V. (2006). The epidemiology and control of *Ascochyta blight* in field peas: a review. *Australian Journal of Agricultural Research*, *57*(8), 883-902.

Buzatu, M.A., Costache, M., Hoza, D., Sovarel, G., Cristea, S. (2018). The efficacy of different treatments for pathogens control on the eggplant crops in the field. *Scientific Papers-Series BHorticulture, 62. 495–498.*

Celac, V., Makidon, M. (2012). *Leguminoase pentru boabe vechi şi noi.* Academia de Ştiinţe a Republicii Moldova, Chişinău: 7-16.

Couture, L., Dhont, C., Chalifour, F-P., Drapeau, R., Tremblay, G., Castonguay, Y., Belanger, G., Nadeau, P. (2002). *Fusarium* root and crown rot in alfalfa subject to autumn harvests. *Canadian Journal of Plant Science, 82*. 621–624.

Dudoiu, R., Cristea, S., Lupu, C., Popa, D., Oprea, M. (2016). Micoflora associated with maize grains during storage period. *AgroLife Scientific Journal*, *5* (1), 63–68

Jaloba, D., Jinga, V., Cristea, S. (2019). Research on effectiveness of fungicides treatments on Jonathan variety for apple scab control in Voinesti Area. *Scientific Papers - series A - Agronomy, 62.* 135–139.

Jha, A.C., Sonika Jamwal, Reena, Anil Kumar and Parmendra Singht (2019). Loss Assessment caused by Ecomomically Important Pea (*Pisum sativum* L.). Diseases and their Management in Hills of Doda (Jammu & Kashmir) under Field Condition. *Int. J. Curr. Microbiol. App. Sci.* 8 (5):170-176.

Kosturkova, G., Rodeva, R., Tasheva, K., Dimitrova, M., Dimanov , D. (2012). Effect of crude culture filtrates of the pathogenic fungus Phoma medicaginis

on in vitro cultures of pea. *AgroLife Scientific Journal*, *1*.

Krnjaja, V., Stanković, S., Obradović, A., Petrović, T., Mandić, V., Bijelić, Z., & Božić, M. (2018). Trichothecene genotypes of Fusarium graminearum populations isolated from winter wheat crops in Serbia. *Toxins*, *10*(11), 460.

Podea, M. M., & Cristea, S. (2023). Pea crop diseases – an overview. *Scientific Papers. Series A. Agronomy*, *66*(1).

Tivoli, B., & Banniza, S. (2007). Comparison of the epidemiology of *ascochyta blights* on grain legumes. In *Ascochyta blights of grain legumes* (pp. 59-76). Springer, Dordrecht.

Toth, K., & Cristea, S. (2020). Efficacy of treatments in controlling cercosporiosis (*Cercospora beticola Sacc*.) in sugar beet. *Scientific Papers. Series A. Agronomy,* Vol. LXIII, Issue 2, ISSN 2285-5785, 236-239.

Toth, K., Cristea, S. (2018). Evolution Areas Planted With Sugar Beet and Markets Beet in Romania. 31st International-Business-Information-ManagementAssociation: Milan, Italy Date: APR 25-26, 2018. *Innovation management and education Excellence Through Vision* 2020, Vol S I –XI, 1689–1695.

White, D., & Chen, W. (2007). Towards identifying pathogenic determinants of the chickpea pathogen Ascochyta rabiei. *Ascochyta blights of grain legumes*, 3-12. *Eur J plant Pathol*, 119:3-12

Zaharia, R., Petrisor, C., Cornea, C., Diguţa, C., Cristea, S., Stefan, S. (2022). Isolation and molecular identification of fungal isolates from stored cereals using pcr-rflp method. *Romanian Agricultural Research*, *39*. 13-22.