Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Agriculture
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The Resistance of Sunflower to the Attack of Some Pathogenic Agents in the Climate Conditions of the Northeast Baragan

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RESEARCH ARTICLE

Abstract
Due to its national economic importance, the sunflower crop has established itself as the main oleaginous crop cultivated in Romania. It faces several diseases that are difficult to fight chemically. The creation of hybrids resistant to the attack of pathogens has proven to be an effective, safe, and environmentally friendly solution. This paper aims to examine the resistance of some biological sunflower creations created in Romania, to the attack of *Phomopsis helianthi* and *Phoma macdonaldi* fungi, in 2021. The experiment was placed in field conditions with a natural infestation, at A.R.D.S. Braila. The used biological material was represented by nine new sunflower hybrids. Two problem pathogens were studied: *Phomopsis helianthi* (perfect stage *Diaporthe helianthi*) and *Phoma macdonaldi* (perfect stage *Leptosphaeria lindquistii*). The climatic conditions of 2021 were favorable for the growth of the pathogens. *Phoma macdonaldi* had an average attack frequency of 38.8% and an average attack intensity of 1.71%, while *Phomopsis helianthi* recorded average values of 67.8% and 3.08%, respectively. The lowest attack degree of the *Phoma macdonaldi* pathogen was found in H3 (0.35%). Regarding the pathogen *Phomopsis helianthi*, the hybrid H3 showed good resistance, with an attack degree of 1.64%.

Keywords: diseases, *Phoma macdonaldi, Phomopsis helianthin*, resistance, sunflower

Received: 10 November 2022
Accepted: 13 November 2022
Published: 15 November 2022

DOI:
10.15835/buasvmcn-agr:2022.0034

INTRODUCTION
Initially, the sunflower was known as an ornamental plant. Thanks to its seeds with high oil content, it was especially cultivated for the human food industry as a raw material in the manufacturing of oil. It is also a basic ingredient in animal feed mixtures (Nahar et al., 2005). Due to its capacity to adapt to different agroecological conditions, the cultivation of the sunflower crop has become possible on the entire planet. Thus, specific diseases appeared that spread from one country to another, mainly through the transport of seeds. The most significant diseases responsible for large production losses are mycoses. In the present paper, we studied two of these diseases, *Phomopsis helianthi* (perfect stage *Diaporthe helianthi*) and *Phoma macdonaldi* (perfect stage *Leptosphaeria lindquistii)*, which cause stem breakage and consequently significant losses of good seeds regarding the quantity and quality. As far as plant protection goes, in addition to pathogens, sunflower plants are also attacked by pests, the most dangerous in the first stages of its development being *Tanymecus dilaticollis* Gyll. (Georgescu et al., 2015). *Phoma macdonaldi* (Figure 1) initially manifests itself at

the base of the leaf petiole as brown-black spots that expand and wither the leaves from the base of the plant. In severe cases, these symptoms can quickly cause the death of plants (Seassau et al., 2012). The fungus enters the plant tissue through injuries caused by external factors, natural openings, such as stomata, or enzymes and toxins. The attacked organs are the petiole of the cotyledon and of the leaf, the stem, and not only (Roustaee et al., 2000), but significant infections occur at the stages when the plants are more mature (Martens et al., 1970). The fungi overwinter on plant debris in the form of pycnidia. In the spring, when it encounters favorable conditions as far as temperature and humidity go, the pycnidia fructify (Boerema et al., 1964) and release pycnospores that come into contact with the embryo of the newly germinated sunflower seeds. Pycnospores infect plants, causing them to die. The infection also occurs later, at different stages of plant development, when the mycelia and other spores of the fungus attach to the external organs of sunflower plants through mucilages, which may contain some recognition substances of the host plant (Seassau et al., 2012, Roustaee et al., 2000).

(a) (b)

Figure 1. Symptoms of *Phoma macdonaldi* on sunflower stem (a); Symptoms of *Phomopsis helianthi* on sunflower stem (b)

Phomopsis helianthi (Figure 1) manifests itself as necrotic spots on the stem and leaves. Unlike *Phoma macdonaldi*, the stains are wider, irregular, and spread on the entire surface of the stem, not only near the petiole (Mazars et al., 1990). The initial symptoms appear after the flowering of the calathidium, on the middle leaves, as small, chlorotic spots near the veins. Later, the infection spreads to the petiole and the stem, where the specific symptoms appear. The fungus overwinters as a mycelium on plant debris. In spring, it forms perithecia that release asci with ascospores, spread by wind and water droplets. Following ascospore germination, the fungus develops pycnidia with pycnospores of alpha and beta type (Masirevic et., 1992).

MATERIAL AND METHOD

The experiment, divided into four repetitions, was carried out in natural infestation field conditions at the Agricultural Research - Development Station, Braila (A.R.D.S. Braila), in the agricultural year 2021.

The used biological material was represented by nine new sunflower hybrids, tested to observe their behavior in different climate and soil conditions, hybrids created within the Laboratory for the Improvement of Oil Plants and Medicinal Plants - National Institute of Agricultural Research and Development, Fundulea (N.A.R.D.I. Fundulea).

Two problem pathogens for the sunflower crop were studied: *Phomopsis helianthi* (perfect stage *Diaporthe helianthi*) and *Phoma macdonaldi* (perfect stage *Leptosphaeria lindquistii)*. Observations were made on the frequency and intensity of pathogen attack, for each hybrid, in all four repetitions. From the quantified parameters, the attack degree was analyzed in the results of the present experience.

RESULTS AND DISCUSSIONS

The climatic conditions of the 2021 agricultural year were favorable for the development of pathogens. Rainfall was recorded during the entire vegetation period of the sunflower, especially from April to August. Similarly, the temperatures necessary for pathogens to develop (20 – 25 °C) were also favorable, especially between June and August (Table 1). In the same period, there were intensifications of the wind. All these factors (temperature, rainfall, and wind) were optimal for the fungi to develop and the dissemination of the spores.

Table 1. Climatic conditions registered in 2020-2021, in Braila county

Climatic conditions of the agricultural year, 2020 - 2021			
Month	**Average air temperatures (°C)**	**Rainfall (mm)**	**Speed of wind (m/s)**
IX	20,3	39,5	1,9
X	15,1	26,5	2
XI	5,7	24,5	1,7
XII	4,7	67,7	3,3
I	2,2	41,2	3,2
II	2,4	7,4	2,8
III	4,7	31,4	2,8
IV	9,4	53,3	2,4
V	16,7	75,8	2,2
VI	20,2	173,8	3,1
VII	23,9	40,4	1,6
VIII	23,4	36,7	3,8
Average	***12,4***	***618***	***2,6***

Plants attacked by *Phoma macdonaldi* had an average frequency of attack (F%) of 38.8% and intensity of attack (I%) of 1.71% while for the pathogen *Phomopsis helianthi*, the averages of F% and I% were 67.8% and 3.08%.

In the case of *Phoma macdonaldi*, hybrids H1, H4, H9, H7, H5, and H6 exceeded the average frequency of 38.75%, with values between 1.0 and 8.7% (Figure 2), while hybrids H8 and H2 performed well. The hybrid with the lowest frequency is the H3, with a value of 19.6%.

Compared to the average attack frequency of *Phomopsis helianthi* (67.8%), the hybrids H6 (90%), H4 (77.6%), and H9 (71.1%) had poor resistance behavior. Hybrids H5 and H3 stood out for the lowest frequency values, 56.8% and 59.7% (Figure 1). For values below the average attack frequency, three hybrids stood out for *Phoma macdonaldi*, and six hybrids for *Phomopsis helianthi*, which proves that the latter pathogen manifests itself on the sunflower crop, through a more aggressive attack.

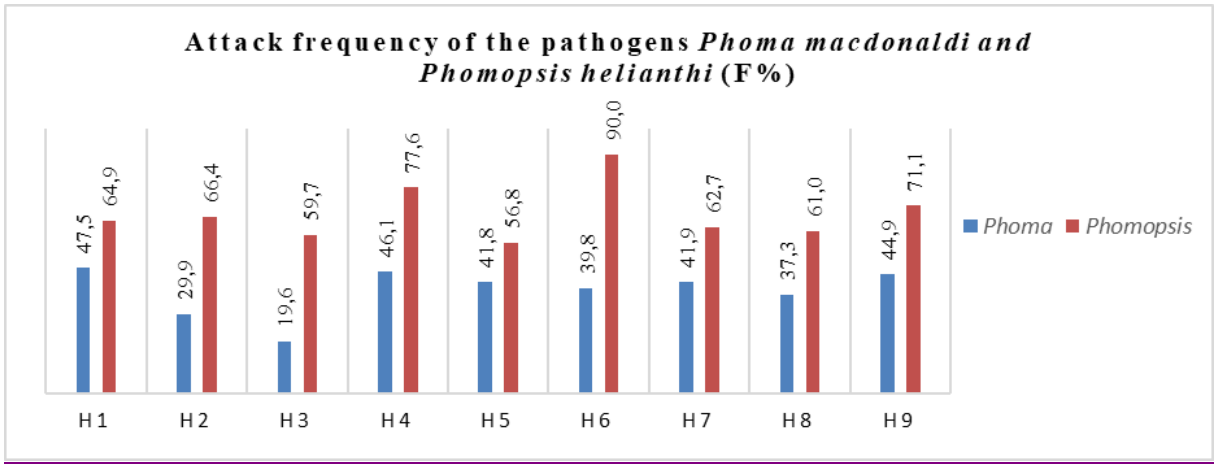

Figure 2. Attack frequency of the two observed pathogens

In terms of intensity, similar to frequency, the aggressiveness of the pathogen *Phomopsis helianthi* is observed (Figure 3). The best-performing hybrids with below-average values of 3.08% were in order H4 (2.54%), H5 (2.69%), and H8, followed by H9 (2.98%) and H3 (3.03). Regarding *Phoma macdonaldi* mycosis, hybrids H8 (1.53%), H4 (1.56%), H7 (1.56%), and H3 (1.69%) stand out against the average attack intensity of 1.71%.

The highest attack degree (AD%) was observed in hybrids H1 (1%) and H5 (0.9%) for the pathogen *Phoma macdonaldi* (average attack degree - 0.7%) and hybrid H6 (3%) for *Phomopsis helianthi* (average attack degree - 2.1%). The hybrids with the best behavior towards the two pathogen agents followed in the experiment were H3 (0.3%), H2 (0.5%) regarding *Phoma macdonaldi* and H2 (1.6%), H8 (1.8%) regarding *Phomopsis helianthi* (Figure 4).

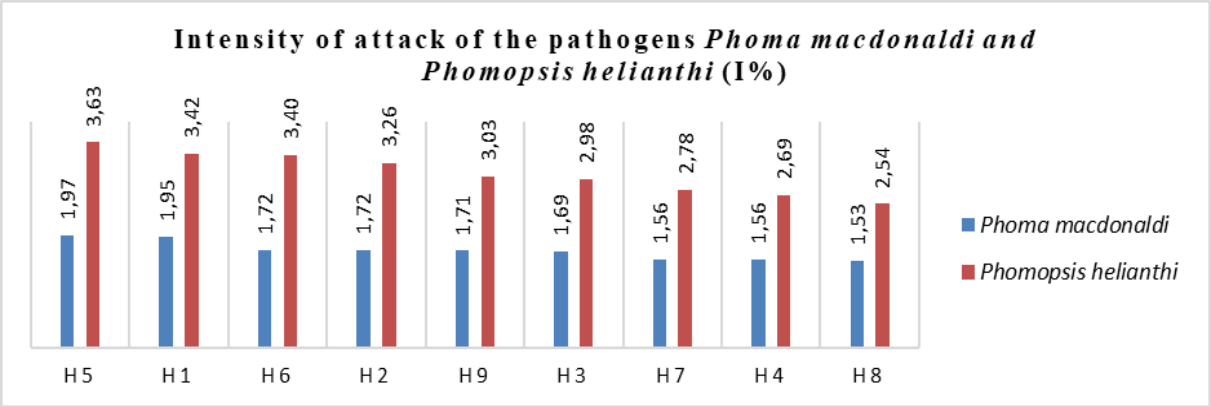

Figure 3. The attack intensity of the two observed pathogens

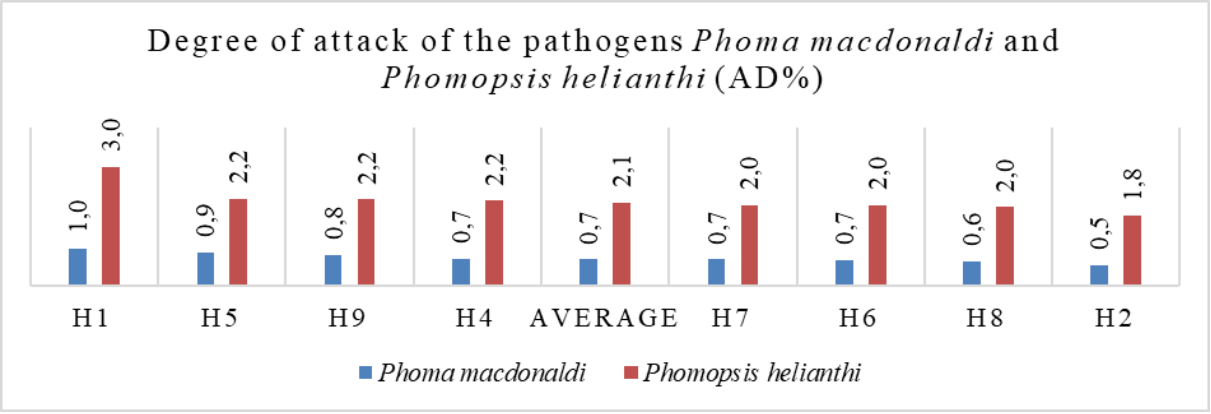

Figure 4. Attack degree of the two observed pathogens

Following the statistical analysis (using the ANOVA tool) of the attack degree, the obtained differences were interpreted as insignificant for both pathogens (Table 2 and Table 3).

Table 2. Statistical analyses of the difference of the attack degree from the mean

Phoma macdonaldi			
Hybrid	AD%	Difference	Symbol
H1	0,96	0,27	-
H5	0,86	0,17	-
H9	0,80	0,11	-
H4	0,70	0,02	-
Average	0,69	0,00	-
H7	0,68	-0,01	-
H6	0,67	-0,02	-
H8	0,64	-0,05	-
H2	0,53	-0,16	-
H3	0,35	-0,34	-
DL 5%		0,67	
DL 1%		0,91	
DL 0,1%		1,22	

Table 3. Statistical analyses of the difference of the attack degree from the mean

Phomopsis helianthi			
Hybrid	AD%	Difference	Symbol
H6	3,02	0,90	-
H7	2,20	0,09	-
H1	2,19	0,07	-
H9	2,15	0,04	-
Average	2,12	0,00	-
H5	2,05	-0,07	-
H2	2,04	-0,08	-
H4	2,00	-0,12	-
H8	1,77	-0,35	-
H3	1,64	-0,47	-
DL 5%		1,66	
DL 1%		2,26	
DL 0,1%		3,02	

CONCLUSIONS

Among the studied hybrids, the minimum attack degree of *Phoma macdonaldi* disease was found in H3 (0.35%) and the maximum in H1 (0.96%). Regarding the pathogen *Phomopsis helianthi,* hybrid H3 showed good resistance, with an attack degree of 1.64% while hybrid H6 had low resistance (3.02%).

The highest attack degree was recorded in hybrids H1 (1%) and H5 (0.9%) for the pathogen *Phoma macdonaldi* (average attack degree, 0.7%) and hybrid H6 (3%) for *Phomopsis helianthi* (average attack rate, 2.1%). The hybrids with the best behavior were H3 (0.3%), H2 (0.5%), respectively H2 (1.6%), and H8 (1.8%) (Figure 3).

The hybrid H3 had the most remarkable behavior, while hybrids H1 and H9 had the weakest behavior regarding both pathogens.

The pathogen *Phomopsis helianthi* manifested itself with frequency, intensity and as a result, attack degree, much higher than *Phoma macdonaldi*, which highlights its aggressiveness on sunflower crop plants.

The sunflower hybrids, newly created at N.A.R.D.I. Fundulea, prove resistant to the pathogens *Phoma macdonaldi* and *Phomopsis helianthi*, in the 2021 agricultural year, a year with rainfall and temperatures above the multiannual average, in the soil conditions of Eastern Romania, at A.R.D.S. Braila.

Author Contributions: D.O. collected the data, conceived and designed the analysis, performed the analysis, and wrote the paper; M.J.P. supplied the biological material; F.A.G. supplied the biological material; L.R. collected the data, conceived and designed the analysis, wrote the paper.

Acknowledgments

This study was financed through the project "Creation and identification of sunflower genotypes with superior quality characteristics and complex resistance to biotic and abiotic factors and genetic resistance to total herbicides applied post-emergence", co-financed by the Ministry of Agriculture and Rural Development, Romania, for the period 2019-2022, within the A.D.E.R. 2.1.4 program.

Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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