

Features of the appearance of sunflower *Septoria* disease in the conditions of the Southern Steppe of Ukraine

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ABSTRACT

In recent years, *Septoria* leaf spot in sunflowers has become increasingly widespread in Ukraine. The research was conducted to establish the features of the appearance of *Septoria* leaf spot on sunflower plants in years with different levels of moisture availability and the possible development of this disease together with other foliar fungal diseases in the conditions of the Southern Steppe of Ukraine. Experiments were performed on a stationary infectious diseases plot of the Institute of Oilseed Crops of NAAS. It was established that the development of *Septoria* leaf spot on sunflowers was highly dependent on weather conditions. It was noted that the greatest damage to plants by *Septoria* leaf spot was at the beginning of the sunflower growing season in 2021, which was characterized by a record amount of precipitation. The first symptoms of *Septoria* leaf spot were noted in the middle or at the end of May on the cotyledon leaves. Lesions in the form of spots were up to 5 mm, rounded or uneven in shape. In the affected areas, pycnidia with pycnidiospores up to 65 µm in size and having up to 5 septa were identified. It was established that the appearance of the disease in breeding lines depended both on the level of their resistance and the weather conditions of the year. The number of affected plants in individual samples in 2021 reached about 100%. The severity of infection of experimental lines changed significantly under the influence of weather conditions. In resistant lines, the leaves of the lower or middle part of the plant were affected while in susceptible lines the symptoms of the disease were found on all leaves. It was established that in 2021 there were almost twice as many plants with damage to lesions on all leaves fall as in 2020. The possibility of simultaneous development of downy mildew and *Septoria* leaf spot on the same plant was revealed. In a year with an increased amount of precipitation, about 90% of plants affected by downy mildew were simultaneously affected by *Septoria* leaf spot. This indicates that these pathogens can develop on one plant and subsequently lead to a decrease in its main physiological functions.

Keywords: *Septoria helianthi*, weather conditions, symptom, frequency of infection, severity of infection, sunflower

INTRODUCTION

Sunflower *Septoria* leaf spot is widespread throughout the world, especially in Australia, the USA, India, Pakistan, Brazil, China and other countries (Liu and Li, 1988; Block, 2005; Marques et al., 2011). Sunflower *Septoria* disease is caused by the fungus (*Septoria helianthi*) Ellis & Kellerm (Maldaner, 2015). The optimal temperature

for the development of the disease is from 22 to 25 °C. The source of infection is pycnidia, preserved on plant residues. The spread of infection is facilitated by rain splashes and moderate air temperatures (Retman et al., 2020).

The appearance of the disease in sunflower on cotyledon leaves looks like brown, smooth spots pressed into the tissue on the inside and convex on the outside of the leaf. The size of the spots is usually up to 0.5 cm. On true leaves, the lesions appear in the form of small spots of round or irregular shape, starting from the upper side of the leaf blade. They are dark brown and may have a grey tint or light edging. After some time, the spots coalesce and the leaves dry. During rainy weather, the affected leaf tissue ruptures and the leaves become holey (Gindrat and Frei, 1997; Berglund, 2007; Hamid and Jalaluddin, 2007; Mukhtar, 2009; Marques et al., 2011). The symptoms disease may vary significantly under different environmental conditions (Das et al., 2020).

Pycnidia form in spots infected on leaves which contain pycnidiospores. The pycnidia are dark, brown to dark brown, and globose. Pycnidia give a black color to necrotic spots on the leaf (Hamid and Jalaluddin, 2007). Pycnidiospores are colourless, hyaline, filamentous with 2–5 transverse septate. Their size ranges approximately from 37.5 to 70 μm (Aćimović, 1998; Hamid and Jalaluddin, 2007).

The harmfulness of *Septoria* leaf spot manifests itself in the suppression of plants, premature drying of leaves, a decrease in chlorophyll content and an increase in the intensity of transpiration. *Septoria* leaf spot causes destruction of chloroplast, which leads to a decrease in the size of the assimilation surface and leads to a decrease in the rate of photosynthesis and respiration rate (Brand et al., 2020).

In Ukraine, *Septoria* leaf spot on sunflowers appeared relatively recently, but every year it becomes more and more widespread and under favorable weather conditions can lead to significant losses in sunflower yields. In some years, the prevalence of the disease reached 100% in different fields of Ukraine (Retman et al., 2020). However, detailed research has not been conducted on the development of this disease in Ukraine.

This research aimed to establish the characteristics of the appearance of *Septoria* leaf spot on sunflower plants in years with different levels of moisture supply and to

investigate the possible development of this disease in combination with other leaf fungal diseases in the conditions of the Southern Steppe of Ukraine.

MATERIALS AND METHODS

The research was carried out on a stationary infectious diseases plot of the Institute of Oilseed Crops of the National Academy of Sciences. The stationary infectious plot was organized in the field crop rotation of the Institute of Oilseed Crops in 2005 to evaluate the breeding material of oil crops for a complex of diseases, including *Septoria* leaf spot. Every year it is enriched with infected plant residues collected in different regions of the Ukraine. ZL70A, ZL78A, ZL22A, ZL58A lines of Zaporozhye breeding and F_2 families ZL58A×HAR-7 and ZL78A×HAR-7 served as the material for the study. In 2020, the sowing of experimental material was carried out on April 23, and in 2021 – on April 29. Seeds of the samples were sown by hand in accordance with field research methods (Levytskaya et al., 2023).

The weather conditions differed across the years of research (Table 1), but were sometimes close to the long-term average humidity and temperature.

It can be seen from Table 1 that there were differences in the indicator of the amount of precipitation during the experimental years. In June 2020, 73.9 mm of precipitation fell, while in June 2021, the amount of precipitation was 177.0 mm, which was three times higher than the long-term indicators. The amount of precipitation for the entire growing season of sunflowers (May–August) in 2020 was 198.5 mm, which is close to the average annual indicators. In 2021, 307.8 mm of precipitation fell during this period, which significantly exceeded the amount of precipitation in 2020 and average annual indicators. The temperature in both research years during the sunflower growing season was relevant for this region and exceeded long-term indicators.

So, the weather conditions of 2020 and 2021 were extremely favorable for the development of the sunflower *Septoria* leaf spot. Precipitation was increased in the first half of the sunflower growing season, especially in

Table 1. Weather conditions during growing season of sunflower (2020–2021)

Months	Average temperature, t °C			Rainfall, mm		
	2020	2021	Average longterm rates	2020	2021	Average longterm rates
V	15.8	17.4	16.0	73.0	39.8	40.0
VI	24.3	22.0	19.4	73.9	177.0	62.0
VII	25.5	25.6	22.6	27.6	52.0	58.0
VIII	24.3	25.4	21.2	24.0	39.0	51.0

2021. Air temperatures were moderate during the two experimental years and were close to long-term values.

The assessment of damage to breeding lines in field conditions was carried out using the “Scale for assessing the severity of infection of sunflower plants by the pathogen *S. helianthi*”, compiled based on a scale developed for wheat (Table 2) (Babayants and Babayants, 2014).

The scale for assessing the severity of infection of sunflower plants included gradation according to the corresponding tier of affected leaves (Figure 1). The distribution of lesion grading was carried out based on the “E. E. Saari and I. M. Prescott Scale” (Eyal, 1987).

Identification of the *S. helianthi* pathogen was carried out by the morphological characteristics of pycnidia, and pycnidiospores, by the cultural and morphological characteristics of the colony obtained in pure culture, according to literary sources (Petrov and Arsenijevic, 1996; Aćimović, 1998; Hamid and Jalaluddin, 2007). For that, parts of plants affected by the disease, that is, sunflower leaves affected by *Septoria* leaf spot, were collected at a stationary infectious disease nursery and the presence of pycnidia was determined in a laboratory using a microscope. Leaves with existing pycnidia or necrotic lesions were placed in the distillate for microscopic examination of *S. helianthi* pycnidiospores.

Table 2. Scale for assessing the severity of infection of sunflower plants by the *S. helianthi* pathogen

Gradation of the degree of plant infection		Characteristics of the phenotype		The level of plant resistance
-	No lesions on leaves	No lesions on all leaves	All plants in the sample are not affected	Highly resistant
±	Minor	Only the lower leaves are affected	Most of the plants in the sample are not affected, on some of them, the leaves of the lower tier are affected	Resistant
+	Average	Affected leaves of the lower and middle part of the plant	Most of the plants in the sample are not affected, on some of them, the leaves of the middle tier or leaves of all plant are affected	Moderately resistant
++	Severe	Lesions are present on all leaves	In most plants, the leaves of the lower tier are affected	Moderately susceptible
			In most plants, the leaves of the middle tier are affected	Susceptible
			In most plants in the sample, the leaves of all plants are affected	Highly susceptible

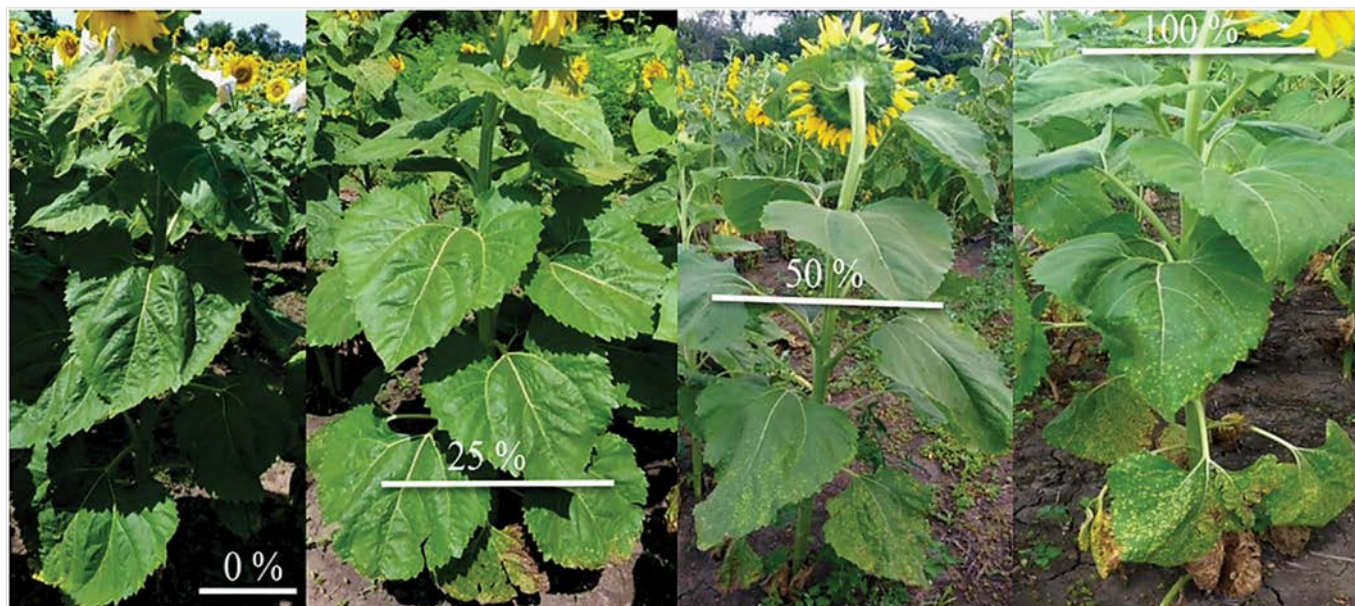


Figure 1. Gradation according to the severity of infection of sunflower plants by *Septoria* leaf spot (0% (-) – no lesions on leaves, 25% (±) – minor, 50% (+) – average, 100% (++) – severe)

To cultivate the *S. helianthi* pathogen, we used potato-glucose agar medium with the addition of an antibiotic. The sowing of pathogen spores was carried out in a laminar box under sterile conditions. Dishes with the *S. helianthi* culture were placed in a thermostat for 7–10 days and cultivated at a temperature of 23 °C. After a certain time, the mycelium of the *S. helianthi* pathogen was identified. Mycological research was carried out following standard methods, supplementing them with original ones (Eyal et al., 1987; Joshi et al., 2010).

The assessment of damage to sunflower plants by downy mildew was carried out similarly to *Septoria* leaf spot, by visual inspection of all leaves on a scale (Table 2). Initially, the assessment was performed on the V8 stage, as single leaves of the lower tier dried up suffering from *Septoria* disease. The final assessment was performed during the assessment of plant damage by *Septoria* disease. Simultaneous infection of sunflower plants with *S. helianthi* and (*Plasmopara halstedii*) was determined as a proportion of plants with *Septoria* leaf spot symptoms among plants affected by downy mildew. F₂ families obtained from crossing sunflower lines of Zaporozhye breeding were analyzed.

Statistical processing of the obtained data was performed using the Microsoft Excel 2010 software package (Kronthaler, 2023).

The percentage error was determined by the formula:

$$S_p = \sqrt{\frac{P \times (100 - P)}{n}}$$

where S_p is the percentage error; P is the percentage of affected plants; n – the total number of plants analyzed (Kiselyov et al., 2017).

RESULTS AND DISCUSSION

Evaluation of sunflower breeding lines for resistance to Septoria leaf spot

Tables 3 and 4 summarise the data on the evaluation of sunflower breeding line damage by *Septoria* leaf spot. The lines showed varying degrees of *Septoria* leaf spot infection during the experimental years.

Table 3 shows that the ZL70A and ZL78A lines in 2020 were slightly affected by *Septoria* leaf spot. These lines had about 90% of plants without damage. Infected plants had lesions only on the leaves of the lower tier.

Table 3. Assessment of *Septoria* leaf spot damage to sunflower breeding lines (2020)

Line	Number of infected plants, %	Severity of infection, %				Resistance of lines to <i>Septoria</i> leaf spot
		-	±	+	++	
ZL70A	12.5*	87.5 ± 4.8	12.5 ± 4.8	-	-	Resistant (R)
ZL78A	12.9*	87.1 ± 4.3	12.9 ± 4.3	-	-	Resistant (R)
ZL22A	89.2	10.8 ± 3.8	1.5 ± 1.5	58.5 ± 6.1	29.2 ± 5.6	Susceptible (S)
ZL58A	97.9	2.1 ± 2.1	6.5 ± 3.6	45.7 ± 7.3	45.7 ± 7.3	Susceptible (S)

Note: * - differences in plant lesions between ZL70A, ZL78A and ZL22A, ZL58A lines are significant at ($P < 0.05$)

Table 4. Assessment of *Septoria* leaf spot damage to sunflower breeding lines (2021)

Line	Number of infected plants, %	Severity of infection, %				Resistance of lines to <i>Septoria</i> leaf spot
		-	±	+	++	
ZL70A	34.8*	65.2 ± 9.9	17.4 ± 7.9	17.4 ± 7.9	-	Resistant (R)
ZL78A	50.0*	50.0 ± 8.1	36.8 ± 7.8	13.2 ± 5.5	-	Resistant (R)
ZL22A	97.5	2.5 ± 2.5	10.0 ± 4.7	37.5 ± 7.7	50.0 ± 7.9	Susceptible (S)
ZL58A	100	-	-	29.8 ± 6.7	70.2 ± 6.7	Susceptible (S)

Note: * - differences in plant lesions between ZL70A, ZL78A and ZL22A, ZL58A lines are significant at ($P < 0.05$)

The ZL22A line was heavily affected by *Septoria* leaf spot this line had 89.2% of damaged plants. Most (58.5%) of the plants showed symptoms of the disease on the leaves of the lower and middle tier of the plant, and about 30% of the plants had lesions on all leaves. There were only 1.5% of plants with minor lesions.

The ZL58A line had the most infected plants. So, 97.9% of plants in this line were affected by *Septoria* leaf spot. Half of these plants had lesions on the leaves of the lower and middle tier (45.7%), and the other half - had lesions on all plants. There were 6.5% of plants with minor severity of infection.

In 2021, the ZL70A line had a higher percentage of affected plants (34.8%) (Table 4) than in 2020 (Table 3). Affected plants had disease symptoms on leaves of the lower and middle tier, i.e. they had minor and average severity of infection in the same quantity - 17.4%. In 2021, the ZL78A line had 50% of the affected plants.

Minor severity of infection was in 36.8% of plants, and 13.2% of plants had lesions on the leaves of lower and middle tiers. Plants without damage in these samples ranged from 50% (ZL78A) to 65.2% (ZL70A).

The ZL22A line was heavily affected by the disease in 2020. The number of plants affected by *Septoria* leaf spot was 97.5%, of which 10% of plants had minor severity of infection, 37.5% - average severity of infection, and 50% of plants had severe lesions on all leaves. The ZL58A line was the most affected by *Septoria* leaf spot in 2021. This line was 100% affected by the disease. In severity of infections, the line had 29.8% of plants with average lesions and more than 70% of plants with lesions on all plants.

Based on data from *Septoria* leaf spot infections in 2020 and 2021 (Tables 3 and 4), ZL70A and ZL78A lines (12.5% and 12.9% in 2020; 34.8% and 50.0% in 2021) were classified as resistant and ZL58A and ZL22A lines

(89.2% and 97.9% in 2020; 97.5% and 100% in 2021) – as susceptible. The infection rate of line samples was significantly higher in 2021 due to the record humidity in that year. The severity of infection by the *S. helianthi* depended on both the level of resistance of the lines and the conditions of the year.

Symptoms of *Septoria* leaf spot in the ontogenesis of sunflower plants

The beginning of the development of *Septoria* leaf spot was noted on seedlings of sunflower plants and first to be affected was the cotyledon leaves. Wet and warm weather influenced the development of the disease. Appearance of the first symptoms of *Septoria* leaf spot was observed on cotyledon leaves at different periods, usually they could be seen in the middle (2021) or at the end of May (2020). Figure 2 shows the dependence of the onset of the first symptoms of the *Septoria* leaf spot on sunflower plants on the presence of precipitation in May, given that the temperature at this time was favourable for the development of the disease.

Figure 2 shows that rainfall was greatest in May 2020 in the third decade of the month – 56.0 mm. Accordingly, the first symptoms of *Septoria* leaf spot appeared in this period of high humidity. In May 2021, an active period of rainfall was observed in the first and second decades of the month. Accordingly, the first symptoms of the disease appeared on seedlings in the second decade of May, which is earlier compared to the previous year.

Symptoms of *Septoria* leaf spots on cotyledon leaves of sunflowers first appeared as slightly visible areas of chlorosis (Figure 3 a). Subsequently, brown spots of rounded shape with irregular edges were formed in these areas and pressed into the leaf tissue (Figure 3 b). They were actively formed after rainfall. Ordinarily, the lesions started from the leaf margin or the middle of the cotyledon. Subsequently, the area of the cotyledon leaf was almost completely affected by the disease. The affected leaves lost turgor and wilted, and later withered together with the petiole and hung on the stem. Then the *Septoria* infection spread to the true sunflower leaves.

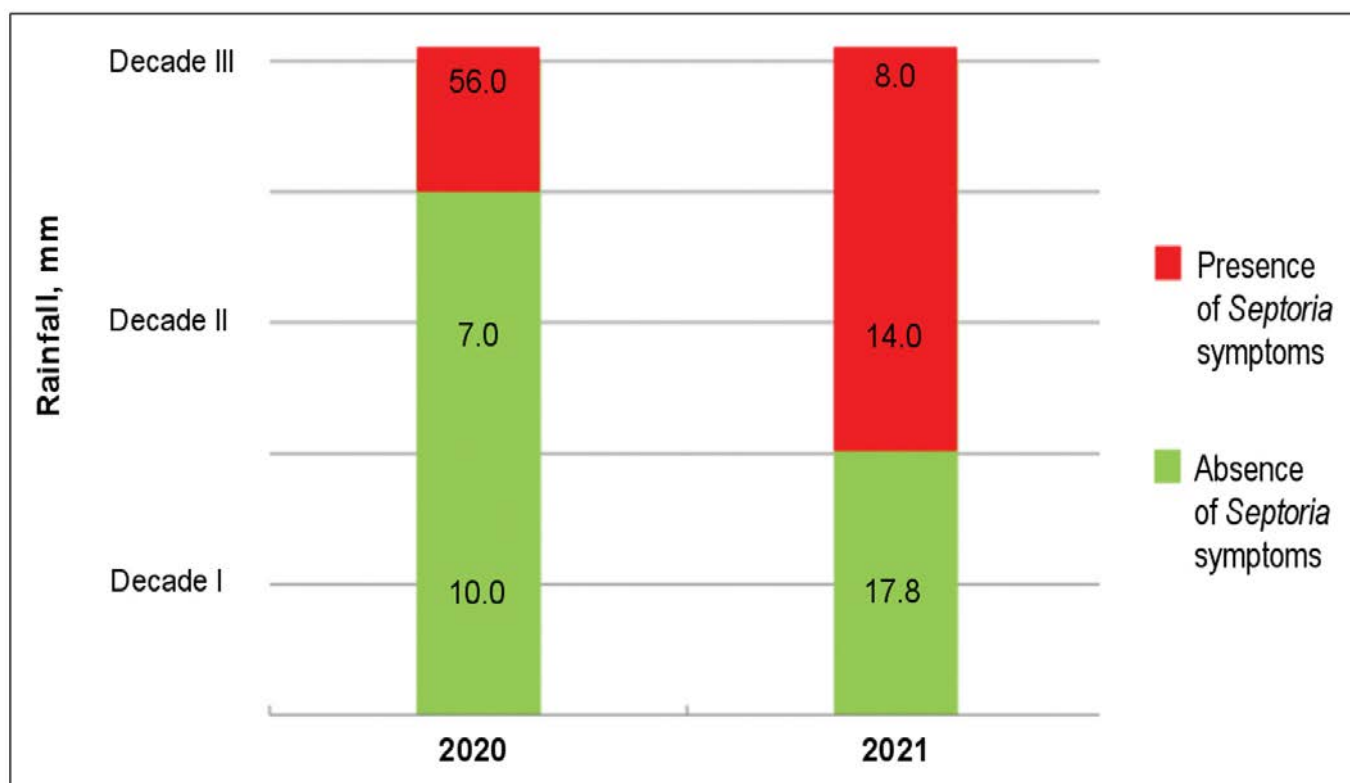


Figure 2. Dependence of the appearance of the first symptoms of *Septoria* leaf spot on the presence of precipitation in May

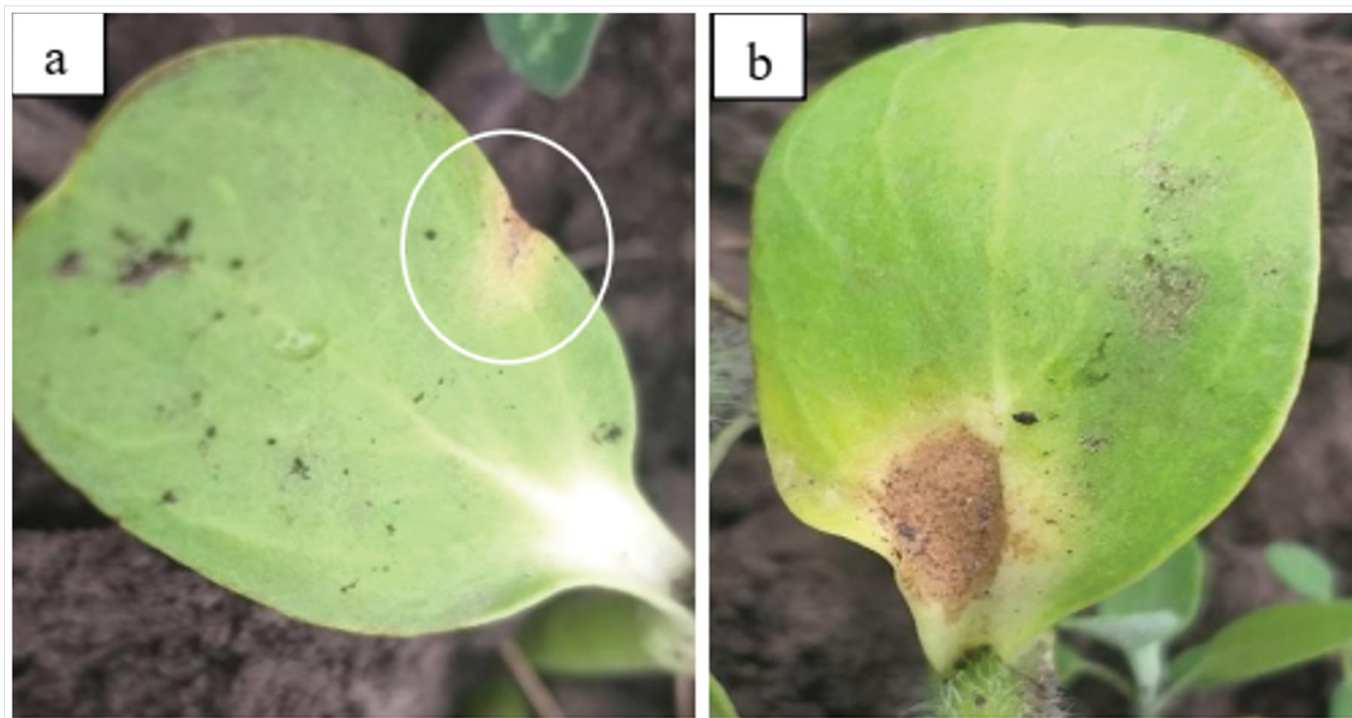


Figure 3. First symptoms of *Septoria* leaf spot on cotyledon leaves of sunflower (a – initial lesion, b – brown spot lesion)

On true leaves, the infection developed on the upper side of the leaf blade and then spread to the all leaf. Lesions on the true leaves were observed as small spots up to 5 mm on average, usually rounded or irregular in shape (Figure 4).

The colour of the spots ranged from brown, brown with a light margin to dark brown almost grey (ashy). The spots became more irregular in shape when they merged (Figure 4 b). In wet weather and windy conditions, leaves became holey (Figure 4 c), due to loss of necrotised parts

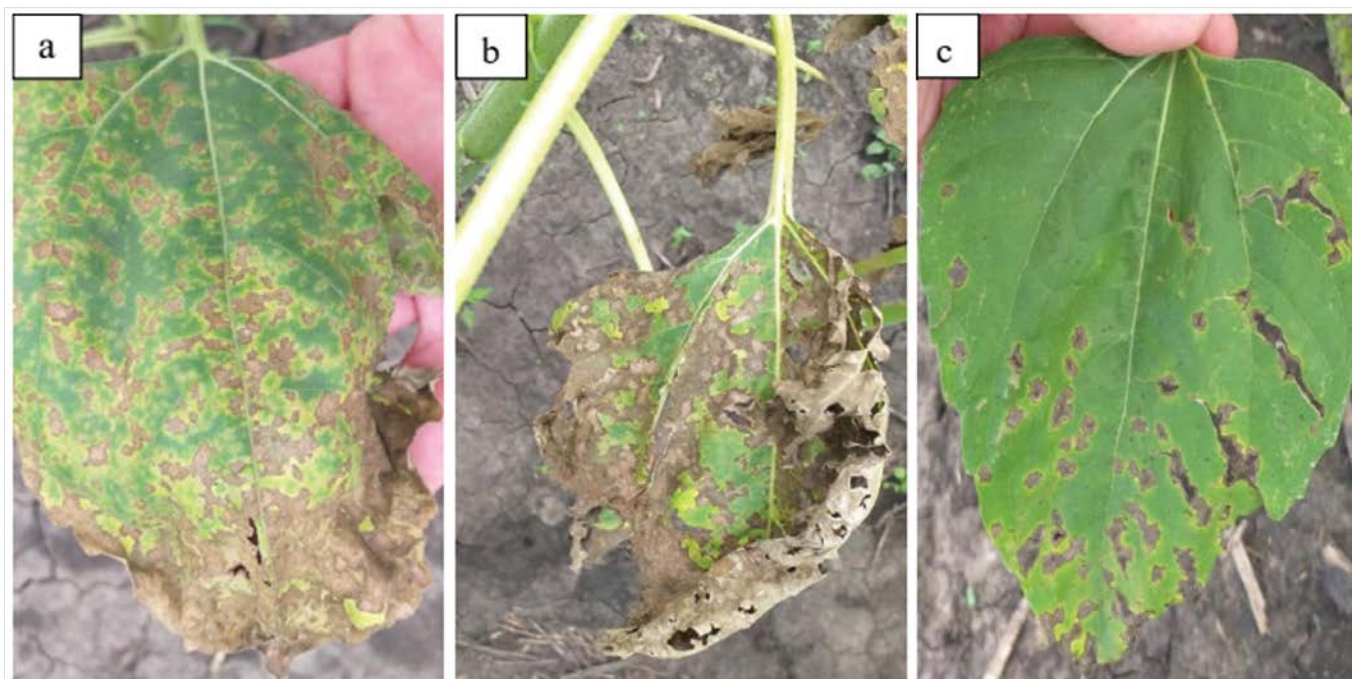


Figure 4. Characteristic damage by *Septoria* leaf spot to sunflower true leaves (a – R-1 – bud forms a miniature floral head rather, b – R-5.5 – flowering stage, c – sunflower leaves in the affected areas – V-8 – 8 true leaves)

of the affected leaf. In the absence of relative wet, the damaged leaves withered. When brief rainy weather was restored, new lesions on the leaves were much smaller, and irregularly shaped.

The formation of pycnidia and pycnidiospores was observed in the centre of spots on cotyledon and true leaves (Figure 5).

Pycnidia on cotyledons were embedded in the affected tissue, small in size, and grey to black in colour (Figure 5 a). On true leaves, pycnidia were spherical in shape, brown, dark brown or black in colour (Figure 5 b). They were noticeable on the leaves in places of damage under microscope magnification. Pycnidia were observed up to the flowering period of the plants. In the absence of rainfall, pycnidia were difficult to detect or were not apparent. However, spores of the pathogen were isolated from necrotised lesions on leaves. This was usually observed during the second half of the sunflower growing season. The pycnidia of the pathogen contained pycnidiospores. The pycnidiospores (Figure 5 c) with 3 to 5 septa, were transparent and thin, and up to 65 μm in size.

The appearance of *Septoria* leaf spots on sunflower plants differed during the experimental years (Figure 6). Symptoms were different in colour, shape and size. Differences were also observed in the area of the damaged leaf surface. So, leaf spots were brown with a

light margin, usually up to 3 mm in size in 2020 (Figure 6). At the beginning of the disease development, the lesions occupied half of the leaf blade. Later, the spots merged under wet conditions and covered the whole leaf.

In 2021, intensive *Septoria* leaf spot damage was observed starting from cotyledon leaves (Figure 6). Localisation of lesions was observed on both cotyledons at once or lesions were present on one leaf in several places, thus occupying the whole leaf. On true leaves, the spots were brown to grey (ashy) in colour up to 5 mm. When they merged, they occupied almost the entire leaf blade. Leaves quickly necrotised and as a result, completely withered.

In both experimental years and first of all, in 2021, a severe lesion of plants was observed in the first half-growing season of sunflower, because it was in this period that weather conditions were most favourable for the development of the pathogen. So, the greatest damage of all experimental plant material by *Septoria* leaf spot was observed in 2021, which was characterised by record wetness compared to the previous experimental year. Accordingly, the appearance of *Septoria* leaf spot on plants had significant differences, both in the symptoms of the disease and the frequency of infection of experimental samples. This indicates that the development of *Septoria* leaf spots on sunflower plants significantly depends on environmental conditions.

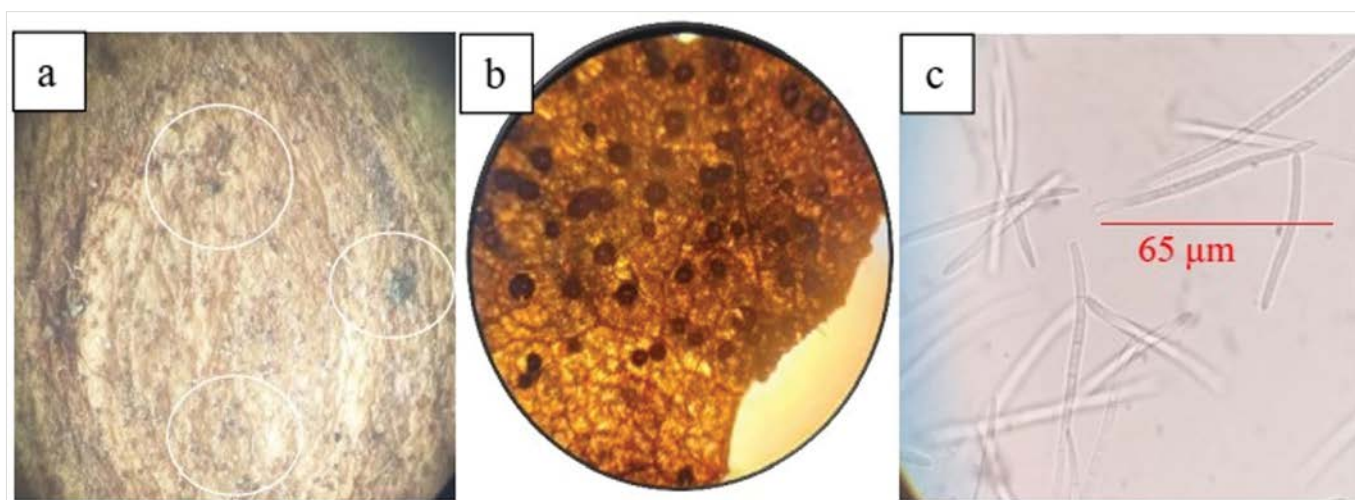


Figure 5. Formation of pycnidia (a – cotyledon leaf; b – true sunflower leaf) and pycnidiospores of *S. helianthi* (c)

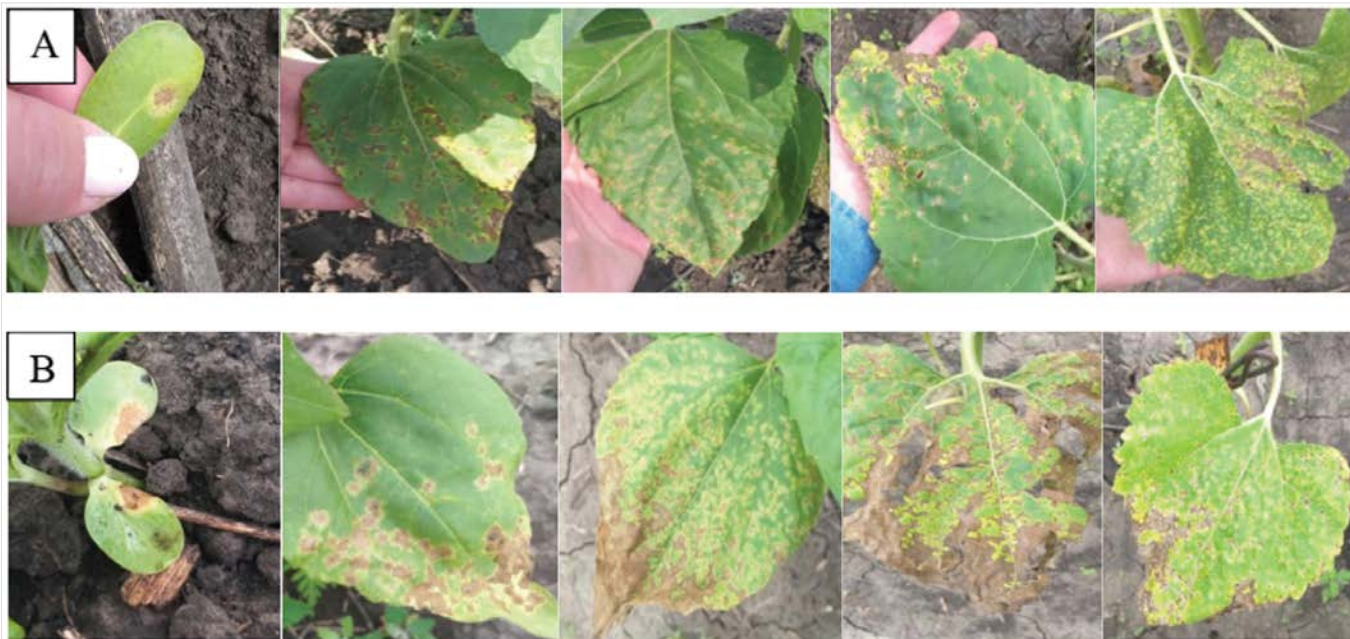


Figure 6. Symptoms of *Septoria* leaf spot on sunflower leaves in different years of research (A - 2020, B - 2021)

Development of *Septoria* leaf spot in combination with downy mildew

The development of *Septoria* leaf spot on sunflower plants in 2021 occurred in combination with another pathogen, such as *P. halstedii* (Figure 7). *Septoria* leaf spot

was the first to be detected on plants since the symptoms of the disease were already detected on cotyledon leaves (Figure 7a). Symptoms of downy mildew were observed later on true sunflower leaves.

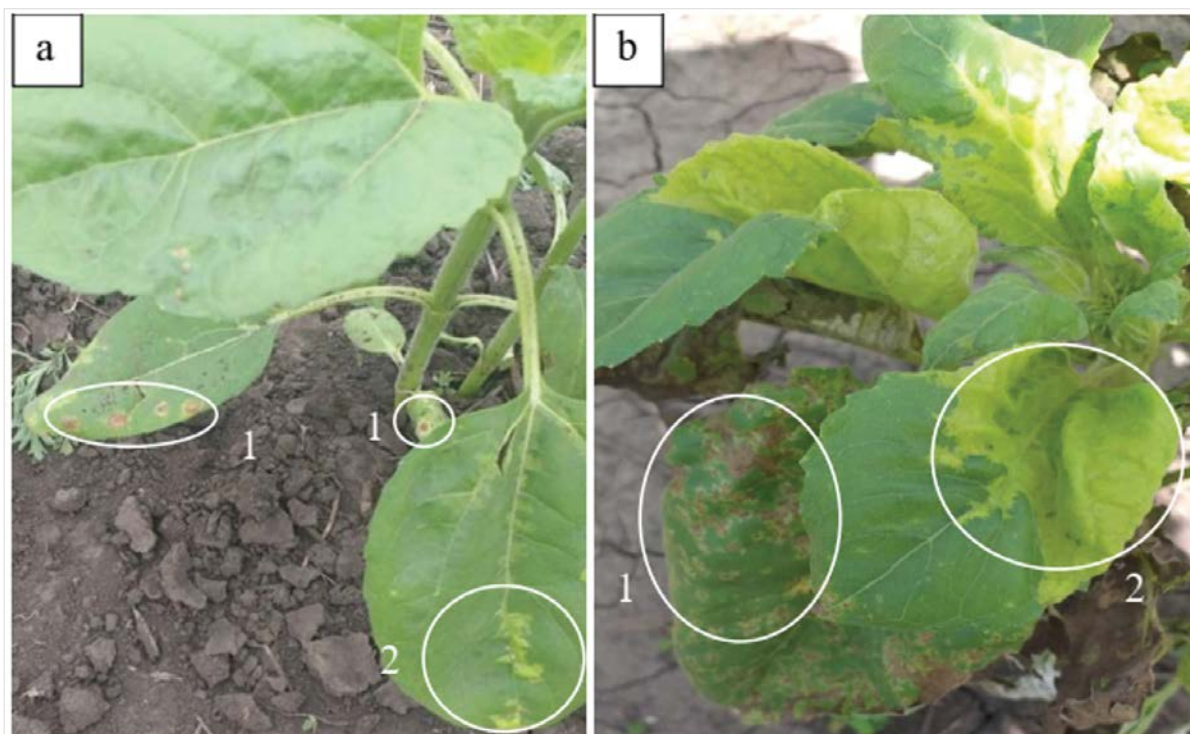


Figure 7. Joint damage to sunflower leaves by *Septoria* leaf spot (1) and downy mildew (2) (a - V-8 - 8 true leaves; b - R-1 - bud forms a miniature floral head rather)

It was revealed combined damage to sunflower plants by *Septoria* leaf spot and downy mildew on the V-8 stage. In some cases, plants simultaneously affected by *Septoria* leaf spot and downy mildew developed to the early ripening stage. However, despite the formation of a head, full-fledged seeds were not formed in it.

The results of assessment of the damage to samples by downy mildew individually and in combination with *Septoria* leaf spot are presented in Table 5.

Table 5 shows that in the F₂ families ZL58A×HAR-7 and ZL78A×HAR-7, downy mildew infection reached 8.1% of the total number of plants. At the same time, most of them were infected with *Septoria* leaf spot. In the F₂ family ZL58A×HAR-7, the number of simultaneously infected plants by two pathogens was 88.9%, and in the family ZL78A×HAR-7 – 89.7%. The degree of downy mildew damage was severe in most plants, that's all the leaves were affected, and average in only a few plant, where leaves of the lower and middle part were damaged.

So, most of the plants affected by downy mildew were simultaneously affected by *Septoria* leaf spot. The number of plants affected by downy mildew in combination with *Septoria* leaf spot was about 90% of the total number of plants affected by downy mildew.

It should be noted that *Septoria* leaf spot was the first to colonize leaves in the early stages of sunflower development and through its influence, probably disrupted the processes of photosynthesis in the plant. This could lead to inhibition of the plant and increase its susceptibility to the action of another biotic factor. The first symptoms of downy mildew were detected on the

true leaves of sunflower plants at the end of May, and the active development of the disease occurred in June. That is, downy mildew developed on sunflower plants later than *Septoria* leaf spot. The symptoms of downy mildew on sunflowers identified in our studies indicate both systemic and local infection. According to the literature, downy mildew can affect sunflowers at different stages of their development (Harveson, 2011; Gascuel et al., 2015).

According to the literature, the symptoms of *Septoria* leaf spot develop first on the lower leaves of the sunflower and then move to the upper tiers of the leaves. Symptoms appear as spots, irregular in shape, ranging from yellow, and dark brown to light gray. A pycnidia develops in affected areas in wet weather (Mukhtar, 2009). The pycnidia contain pycnidiospores (Gindrat and Frei, 1997; Hamid and Jalaluddin, 2007; Marques et al., 2011). In our research, a similar development of *Septoria* leaf spot symptoms was observed.

Scientists have noted that the harmfulness of the causative agent of *Septoria* leaf spot and the type of appearance of the disease can depend on and change under the influence of environmental conditions (Das et al., 2020). It was noted that average temperature, humidity and precipitation influenced the severity and area of sunflower leaf damage (Brand et al., 2018). According to research by Liu et al. (1996), the severity of the disease was closely correlated with humidity and temperature. These authors also noted that the period of onset of disease development was associated with the presence of precipitation from the end of May to the beginning of June. These data are consistent with

Table 5. Assessment of combined infection of sunflower plants with *Septoria* leaf spot and downy mildew

Sample	Number of plants, pcs.	Number of plants infected with <i>P. halstedii</i> , pcs.	Number of them with <i>S. helianthi</i>	
			pcs.	%
F ₂ (ZL58A × HAR-7)	435	27	24	88.9
F ₂ (ZL78A × HAR-7)	380	39	35	89.7
Total	815	66	59	89.3

our results obtained in this research and indicate that the appearance of *Septoria* leaf spot and the intensity of damage by the pathogen significantly depends on the weather conditions of the experimental year, primarily on the amount of precipitation in May.

The simultaneous development of *Septoria* leaf spot with other diseases on sunflower plants has not been studied to date. Scientists argue that damage to plants by one disease often leads to infection by another (Vanev et al., 1997). According to research given by Brand et al. (2020), the simultaneous influence of (*Alternaria helianthi*) and *Septoria helianthi* led to a decrease in the yield of sunflower plants. Some researchers have described the simultaneous development of pathogens of the *Septoria* genus in combination with other pathogens on various plant species (Clark, 1980; Basu and Butler, 1988).

CONCLUSIONS

It was found that the development of *Septoria* leaf spot on sunflower plants in the conditions of the Southern Steppe of Ukraine was highly dependent on weather conditions, specifically on increased precipitation and moderate temperature. The most severe damage to sunflower plants by *Septoria* leaf spot was observed in 2021 with record rainfall at the beginning of the growing season of sunflower.

Sunflower lines ZL70A, ZL78A and ZL22A, ZL58A were characterised by different resistance to *Septoria* leaf spot. Symptoms manifestation of the disease depended on both the level of resistance of the lines and weather conditions. In 2020, the ZL70A and ZL78A lines were least affected by *Septoria* leaf spot, and the severity of infection in both samples was characterised by damage to the leaves of the lower tier only. In 2021, with a large amount of rainfall, these lines were more severely affected, the damaged plants showed symptoms of the disease on the leaves of not only the lower but also the middle tiers. Lines ZL22A and ZL58A were severely affected in both experimental years. The number of affected plants of these lines in 2021 reached about 100%. The severity of infection in these samples varied significantly. In 2021,

there were almost twice as many plants with *Septoria* leaf spot lesions on all leaves as in 2020.

It was found that the active development of the disease was observed in the first half of the sunflower growing season. The first symptoms of *Septoria* leaf spot were observed on cotyledon leaves in the middle or end of May of the respective year. Lesions on the true leaves were observed in the form of spots up to 5 mm, rounded or irregular in shape. The colour varied from brown with a light margin to grey. Merged spots covered the entire leaf, the leaves were necrotic and withered. In the lesions on leaves, the pycnidia with pycnidiospores with 5 septa were found. The size of the spores was up to 65 µm.

The simultaneous development of downy mildew and *Septoria* leaf spot was found on the same plant. The number of plants affected by downy mildew in combination with *Septoria* leaf spot was about 90% of the total number of plants affected by downy mildew alone. This indicates that the *S. helianthi* and *P. halstedii* pathogens can develop on the same plant and subsequently lead to a decrease in its main physiological functions.

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