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FEATURES OF THE DEVELOPMENT OF THE MAIN SUNFLOWER DISEASES IN THE EASTERN PART OF THE FOREST-STEPPE OF UKRAINE

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The author monitored the species composition of the main sunflower diseases and identified their harmfulness. A necessary condition for creating highly productive hybrids is to study the prevalence, development, and harmfulness of the main sunflower diseases, determine the species composition of pathogens, morpho-biological properties of pathogens, and optimize existing measures to protect the crop from diseases. Despite significant successes in breeding, the issue of creating highly productive sunflower hybrids that are resistant to the main diseases remains relevant. According to the results of field studies of the resistance of the studied material to dry rot of baskets in 2021–2024, sunflower samples were divided into two groups. Namely, resistant samples with a level of damage of 11.0–25.0% and medium-resistant – 26.0–50.0%. The assessment of the field resistance of the studied sunflower samples in 2021–2024 to rust showed that the group of moderately resistant (26–50%) samples to rust consisted of the Yarilo hybrid, pollen sterility fixer lines OdOl1A and Sx588A, and two parental forms of the hybrids X1814B and X2283B. These samples had a resistance score of 5. The group of weakly resistant samples, with a resistance score of 7, consisted of the Kadet and Kosmos hybrids, the pollen sterility fixer line Sx66A, and the parental form of the hybrids X526B. Their incidence was 51.0–75.0%. As a result of the records in the experimental years regarding the damage of the studied sunflower samples by Phomopsis, the group of resistant samples, the level of damage of which did not exceed 10.0%, was made up of the pollen sterility fixer line Cx66A, the parental form of the hybrids X2283B, as well as the hybrids Kadet and Kosmos (resistance score 1). The maternal form of the hybrid Kadet – ОдОл1А, the hybrid Yarilo and the parental forms of the hybrids X1814B and X526B were found to be moderately resistant (11.0–25.0%). They had a corresponding resistance score of 2. The pollen sterility fixer line Cx588A had a resistance score of 3 and was classified as weakly resistant, while having a pathogen infection rate of 28.0%. According to the results of the research (2021–2024), the group of highly resistant to downy mildew of sunflower was made up of the Kadet and Yarilo hybrids, as well as the parental form of the X1814V hybrid. Their NBR infection during the research years was 0.0% and the corresponding pathogen resistance score was 0. Two pollen sterility fixer lines Sx66A and Sx588A, two parental components of the X526V and X2283V hybrids, as well as the Cosmos hybrid, were resistant to the pathogen. Their pathogen infection level did not exceed 10.0% and the corresponding resistance score was 1. The pollen sterility fixer line OdOl1A showed average resistance to NBR. It had a resistance score of 2, and the pathogen infection of this sample was at the level of 24.0%.

Key words: *sunflower, diseases, pathogens, symptoms, rust, phomopsis, dry rot of baskets, downy mildew.*

Стороженко Д.С. Моніторинг посівів соняшнику на ураженість збудниками основних хвороб у східному лісостепу України

Автором проведено моніторингу видового складу основних хвороб соняшнику та виявлення їх шкідливості. Необхідною умовою для створення високопродуктивних гібридів є вивчення поширеності, розвитку, та шкідливості основних хвороб соняшнику, визначення видового складу патогенів, морфо-біологічних властивостей збудників та оптимізація існуючих заходів захисту культури від хвороб. Незважаючи на значні успіхи в селекції актуальним лишається питання щодо створення високопродуктивних гібридів соняшнику, які є стійкими до основних хвороб. За результатами досліджень польової стійкості досліджуваного матеріалу до сухої гнилі кошиків у 2021–2024 рр. зразки соняшнику розподілено на дві групи. А саме стійкі зразки, з рівнем ураження 11,0–25,0 %

та середньостійкі – 26,0–50,0 %. Оцінка польової стійкості досліджуваних зразків соняшнику у 2021–2024 роках до іржі показала, що групу середньостійких (26-50 %) зразків до іржі склали гібрид Ярило, лінії закріплювачі стерильності пилку – ОдОл1А та Сх588А і дві батьківські форми гібридів Х1814В та Х2283В. Дані зразки мали бал стікості 5. Групу слабкостійких зразків, з балом стійкості 7, склали гібриди Кадет та Космос, лінія закріплювач стерильності пилку Сх66А та батьківська форма гібридів Х526В. Їх ураженість складала 51,0–75,0 %. В результаті обліків у дослідні роки щодо ураження досліджуваних зразків соняшнику фомопсисом групу стійких зразків, рівень пошкодженості яких не перевищував 10,0 %, склали лінія закріплювач стерильності пилку Сх66А, батьківська форма гібридів Х2283В а також гібриди Кадет і Космос (бал стійкості 1). Середньостійкими (11,0–25,0 %) виявились материнська форма гібриду Кадет – ОдОл1А, гібрид Ярило і батьківські форми гібридів Х1814В та Х526В. Вони мали відповідний бал стікості 2. Лінія закріплювач стерильності пилку Сх588А мала бал стійкості 3 і була віднесена до групи слабкостійких при цьому маючи ураженість патогеном на рівні 28,0 %. За результатами досліджень (2021–2024 рр.) групу високостійких до несправжньої борошнистої роси соняшнику склали гібриди Кадет та Ярило а також батьківська форма гібриду Х1814В. Їх ураженість НБР в роки досліджень складала 0,0 % і відповідний бал стійкості до патогена був 0. Стійкими до збудника хвороби були дві лінії закріплювачі стерильності пилку Сх66А та Сх588А, два батьківських компонента гібридів Х526В та Х2283В а також гібрид Космос. Їх рівень ураження патогеном не перевищував 10,0 % а відповідний бал стійкості був 1. Середню стійкість до НБР показала лінія закріплювач стерильності пилку ОдОл1А. Вона мала бал стійкості 2, а ураженість патогеном даного зразка була на рівні 24,0 %.

Ключові слова: *соняшник, хвороби, патогени, симптоми прояву, іржа, фомопсис, суха гниль кошиків, пероноспороз.*

Problem statement. One of the most profitable crops in Ukraine is sunflower, which, if its cultivation technologies are followed, can provide a profit of up to 80 percent or more [1]. A necessary condition for creating highly productive hybrids is to study the prevalence, development, and harmfulness of the main sunflower diseases, determine the species composition of pathogens, morpho-biological properties of pathogens, and optimize existing measures to protect the crop from diseases [2]. Analysis of literary sources shows that due to the increase in the area sown under sunflower, there is a tendency to increase the harmfulness of the main crop diseases and, as a result, an increase in the need to optimize measures to protect against them. The difficulty in solving the problem of sunflower resistance to pathogens lies in the insufficient level of development of the theoretical direction. Despite significant successes in breeding, the issue of creating highly productive sunflower hybrids that are resistant to the main diseases remains relevant. The need to monitor the species composition of the main sunflower diseases and identify their harmfulness has been recognized [8, 9, 10].

Materials and methods. Field studies were conducted in 2021–2024 in the scientific crop rotation of the V. Ya. Yuryev Institute of Plant Production of the NAAS, which is located in the Kharkiv district of the Kharkiv region in the north-eastern part of the Left-bank Forest-Steppe of Ukraine. In order to determine the feasibility and optimal timing of chemical treatments or additional plant protection measures, as well as to predict the dynamics of the spread of diseases in sunflower crops, constant observations of the emergence, development and spread of harmful organisms are necessary. To monitor the prevalence of diseases in sunflower crops, methods are used that are improved as knowledge about the development, harmfulness, nature of damage or the appearance of symptoms of these harmful organisms is enriched. The prevalence of diseases – as a share (percentage) of affected plants – in our crops was determined in order to timely apply protection measures, as well as during testing. For this purpose, standard

phytopathological methods were used to determine the prevalence of the disease, when the percentage of affected plants from the total number of registered plants was determined [3].

Differentiation of the studied material into resistance groups was carried out according to the indicators of damage according to the scales. Immunological characteristics were determined according to the results of four-year studies and given in resistance scores, which were determined by the maximum indicator of damage or injury during the years of study, at background levels sufficient for differentiation of the material.

The resistance of each sample was established according to the indicators of the prevalence of the disease and the intensity of disease development, using generally accepted formulas [10].

The prevalence of the disease is the number of diseased plants (organs), expressed in percentages. The formula used to determine it was:

$$P = \frac{n}{N}100\%,$$

where P is the prevalence of the disease (%);

N is the total number of plants in the samples;

n is the number of diseased plants in the samples.

For qualitative characteristics of crop damage, the average percentage of disease development was calculated using the formula:

$$R = \frac{£(ab)}{Nk}100\%,$$

where R is the disease development (%),

a is the number of plants with the corresponding score, (pcs.),

b is the corresponding damage score,

N is the total number of plants recorded, (pcs.),

k is the highest score on the recording scale [6].

The incidence of dry rot of baskets in crops was determined before harvesting. On a field with an area of less than 50 hectares, 10 sunflower plants were examined diagonally in 10 places and the number of healthy and dry rot-affected plants was counted. The intensity of basket damage was determined on a 4-point scale:

0 – baskets are healthy;

1 – (weak damage) on the lower side of the basket there is a small damage, up to 10% of the surface;

2 – (medium damage) 11–25% of the basket surface is affected;

3 – (severe damage) 26–50% of the basket surface is affected;

4 – (very severe damage) more than 50% of the basket surface is affected.

The rust damage of sunflower samples was recorded on seedlings and during flowering. The intensity of damage in each leaf layer is different, so it was assessed on the plant as a whole, giving a score based on the largest number of leaves affected by a particular score. A 9-point scale was used for rust damage (Table 1).

Regarding the damage of the studied sunflower samples by Phomopsis, the accounting was carried out at the end of the sunflower ripening. The number of accounting plants for one sample was 50 pieces. The level of damage was determined by the scale (Table 2), in which the weighted average indicator was determined by the area of the affected surface of each accounting plant. intensity of the disease development.

Table 1

Scale for recording the degree of damage by the rust pathogen

Score	Degree of damage
1	The plant is not affected even with artificial infection
3	The plant is not affected, or there are only single pustules on the whole plant.
5	The plant is weakly affected. Single groups of pustules on the leaves. More intensive distribution of pustules on the underside of the leaf.
7	The plant is moderately affected. Numerous, sometimes continuous pustules on the leaves of the lower and middle tiers. Sometimes single pustules on the baskets.
9	The plant is severely affected. Continuous development of large pustules on the leaves of all tiers, the back side of the basket.

Table 2

Scale for determining the degree of damage to sunflower by phomopsis

Score	Degree of damage	Characteristic signs	Area of affected surface, %
0	absent	Healthy plant	0
0,1	minor	Single brown spots on individual leaves	<1
1	weak	Spots cover up to 1/10 of the plant surface (leaves, stem), development of spots in the form of a triangle towards the petiole, leaf veins darken	1–10
2	medium	Up to ¼ of the plant surface is affected, gray-brown spots on the stems at the attachment points of the petioles	11–25
3	strong	Up to ½ of the plant surface is affected, leaves dry out, stems turn brown, become tubular, pycnidia of the fungus are visible	26–50
4	very strong	More than ½ of the plant surface is affected, stems break. The sunflower field looks like a windbreak.	>50

Sunflower powdery mildew infestation was recorded in the field in the 3–4 true leaf phase and in the flowering phase. Affected plants were identified by signs of dwarfism, stem thickening, waviness, and light spots on the leaves. The scale for determining the infestation of sunflower samples by the intensity of disease manifestation is given in Table 3.

Table 3

Scale for recording the damage to sunflower by powdery mildew in field conditions by the intensity of the disease manifestation

Score	Degree of damage	Characteristic signs / Area of affected surface, %
0	absent	Healthy plant
1	weak	Individual leaves not more than 10% of the plant are affected
2	medium	Up to 50% of all leaves on the plant are affected
3	strong	More than 50% of all leaves on the plant are affected
4	very strong	Not only the leaves are affected, but also the reproductive organs on the plant
5	strongest	Plants are underdeveloped or dead

Research results. The best sign of resistance to diseases and pests is manifested directly in direct contact of the crop with harmful organisms.

The immunological characteristics of field crops in field conditions are of great breeding importance in the selection of resistant biotypes and their further use in scientific and production programs. But at the same time it is very laborious and requires a long period to identify resistant samples [4].

The prevalence of diseases in sunflower crops depends on the technologies of growing the crop in crop rotation and the soil and climatic conditions that have developed and prevail in a certain territory, in our case – the eastern part of the Forest-Steppe of Ukraine. Failure to comply with growing technologies and favorable weather conditions contribute to the accumulation and preservation of pathogens.

Although treatment with fungicides contributes to an increase in yield, due to the protection of crops from harmful organisms [5], nevertheless, the basis for obtaining high yields is the genetic productivity of sunflower.

The main factors limiting the level of genetic productivity are environmental factors, such as the amount of moisture in the soil, the amount of precipitation, plant damage by pests, disease damage, etc. [6].

The averaged weighted average values of the infestation of the total number of sunflower samples studied each year determined the level of the infectious background of the main diseases of the crop [7].

The levels of infectious backgrounds in the years of research (Fig. 1) were sufficient to assess the infestation of diseases and further differentiate the studied material by resistance groups.

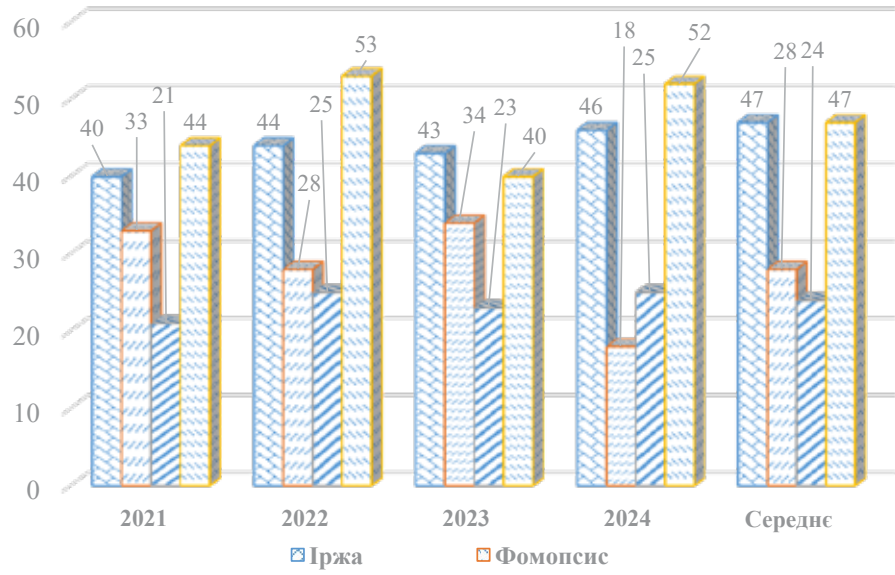

Fig. 1. Levels of infectious backgrounds in the years of research, % (2021–2024)

According to the results of a four-year assessment (2021–2024) of the field resistance of sunflower samples to dry rot of baskets (Fig. 2), they were divided into two groups.

Namely, resistant samples, with a level of infestation of 11.0–25.0% and medium-resistant – 26.0–50.0%. The resistant group included the Kadet hybrid and the parent form of the hybrids X1814B with the level of basket damage by dry rot in the range of 11.0–25.0% and had a resistance score of 2. The moderately resistant group included the hybrids Cosmos and Yarilo, the parent forms of the hybrids X526B, X2283B, the maternal form OdOl1A and two lines that fix pollen sterility Sx66A and Sx588A. Their level of basket damage by dry rot was in the range of 26.0–50.0%, a resistance score of 3.

Fig. 2. Sunflower damage by dry rot of baskets (photo by the author)

According to the results of the assessment of the field resistance of the studied samples in 2021–2024 to rust (Fig. 3), it was found that sunflower was affected by this pathogen somewhat more than by basket rot. The group of moderately resistant (26–50%) samples to rust consisted of the Yarilo hybrid, pollen sterility fixer lines – OdOl1A and Sx588A and two parental forms of the hybrids X1814B and X2283B. These samples had a resistance score of 5. The group of weakly resistant samples, with a resistance score of 7, consisted of the Kadet and Kosmos hybrids, the pollen sterility fixer line Sx66A and the parental form of the hybrids X526B. Their incidence was 51.0–75.0%.

The studied samples were distributed as follows in terms of resistance to Phomopsis. The group of resistant samples, the level of damage of which did not exceed 10.0%, consisted of the pollen sterility fixer line Cx66A, the parental form of the hybrids X2283B, as well as the hybrids Kadet and Kosmos (resistance score 1). The maternal form of the hybrid Kadet – ОдОл1А, the hybrid Yarilo and the parental forms of the hybrids X1814B and X526B were found to be moderately resistant (11.0–25.0%). They

had a corresponding resistance score of 2. The pollen sterility fixer line Cx588A had a resistance score of 3 and was classified as weakly resistant, while having a pathogen infection rate of 28.0%.

Fig. 3. Sunflower rust (photo by the author)

According to the results of four-year studies (2021–2024), we found that among the studied material, the group of highly resistant to downy mildew of sunflower was made up of the Kadet and Yarilo hybrids, as well as the parental form of the X1814V hybrid. Their NBR infection during the years of research was 0.0% and the corresponding pathogen resistance score was 0. Two pollen sterility fixer lines Sx66A and Sx588A, two parental components of the X526V and X2283V hybrids, as well as the Cosmos hybrid, were resistant to the pathogen. Their level of pathogen infection did not exceed 10.0% and the corresponding resistance score was 1. The pollen sterility fixer line OdOl1A showed average resistance to NBR. It had a resistance score of 2, and the pathogen infection of this sample was at the level of 24.0%.

So, analyzing the incidence of sunflower by pathogens of the most common diseases in our area, it should be noted that there is an urgent need for constant monitoring of crops for the presence of harmful organisms to select the most effective crop protection measures. As well as the selection of pathogen-resistant forms for their further involvement in breeding programs.

Conclusions. 1. According to the results of field studies of the resistance of the studied material to dry rot of baskets in 2021–2024, sunflower samples were divided into two groups. Namely, resistant samples, with a level of damage of 11.0–25.0% and medium-resistant – 26.0–50.0%.

Fig. 4. Sunflower plants affected by Phomopsis (photo by the applicant)

Fig. 5. Sunflower plants affected by powdery mildew (photo by the author)

2. Assessment of the field resistance of the studied sunflower samples in 2021–2024 to rust showed that the group of moderately resistant (26-50%) samples to rust consisted of the Yarilo hybrid, pollen sterility fixer lines – OdOl1A and Sx588A and two parental forms of the hybrids X1814V and X2283V. These samples had a resistance score of 5. The group of weakly resistant samples, with a resistance score of 7, consisted of the Kadet and Kosmos hybrids, the pollen sterility fixer line Sx66A and the parental form of the hybrids X526V. Their incidence was 51.0–75.0%.

3. As a result of the records in the experimental years regarding the damage of the studied sunflower samples by Phomopsis, the group of resistant samples, the level of damage of which did not exceed 10.0%, was formed by the pollen sterility fixer line Cx66A, the parental form of the hybrids X2283B, as well as the hybrids Kadet and Kosmos (resistance score 1). The maternal form of the hybrid Kadet – ОдОл1А, the hybrid Yarilo and the parental forms of the hybrids X1814B and X526B turned out to be moderately resistant (11.0–25.0%). They had a corresponding resistance score of 2. The pollen sterility fixer line Cx588A had a resistance score of 3 and was classified as weakly resistant, while having a pathogen infection at the level of 28.0%.

4. According to the results of the research (2021–2024), the group of highly resistant to downy mildew of sunflower was made up of the Kadet and Yarilo hybrids, as well as the parental form of the X1814V hybrid. Their NBR infection during the research years was 0.0% and the corresponding pathogen resistance score was 0. Two pollen sterility fixer lines, Sx66A and Sx588A, two parental components of the X526V and X2283V hybrids, as well as the Cosmos hybrid, were resistant to the pathogen. Their pathogen infection level did not exceed 10.0% and the corresponding resistance score was 1. The pollen sterility fixer line, OdOl1A, showed average resistance to NBR. It had a resistance score of 2, and the pathogen infection of this sample was at the level of 24.0%.

5. Analyzing the incidence of sunflower by pathogens of the most common diseases in our area, it should be noted that there is an urgent need to conduct constant monitoring of crops for the presence of harmful organisms in order to select the most effective measures for crop protection. As well as the selection of pathogen-resistant forms for their further involvement in breeding programs.

REFERENCES:

1. Кириченко В.В., Макляк К.М., Петренкова В.П., Кучеренко Є.Ю., Звягінцева А.М., Харитоненко Н.С., Михайленко В.О. Соняшник. Спеціальна селекція. Монографія. Харків. СГ НТМ «Новий курс», 2020 р. 498 с.

2. Jocic S., Miladinovic D., Imerovski I. [et al]. Towards sustainable downy mildew resistance in sunflower. *Helia*. 2012. 35, N 56. P. 61–72.

3. Кучеренко Є.Ю., Луценко Т.М., Кобизєва Л.Н., Кириченко В.В., Макляк К.М., Коломацька В.П., Чернобай Л.М. Методика оцінки вихідного матеріалу польових культур на стійкість до біотичних чинників в умовах лабораторії. Методичні рекомендації. Інститут рослинництва ім. В.Я. Юрєва НААН. Харків, 2023. 76 с.

4. Кучеренко Є. Ю. Характеристика сучасних сортів сої за стійкістю до фузаріозу. Інтегрований захист та карантин рослин. *Перспективи розвитку в XXI столітті. Тези міжнар. наук. конф. НУБіП*. Київ, 2015. С. 98–100.

5. Білик М.О. Захист злакових і бобових культур від шкідників, хвороб і бур‘янів. Харків, Еспада, 2005. 672 с.

6. Трибель С. О. Стійкі сорти: проблеми і перспективи. *Карантин і захист рослин*. 2005. № 4. С. 3–5.

7. Троценко В. І., Жатова Г. О Адаптивна реакція сортів соняшника. *Основи формування продуктивності сільськогосподарських культур за інтенсивних технологій вирощування. Зб. наук. праць Уманського держ. аграрного ун-ту.* Умань, 2008. С. 475–483.

8. Горяінова В.В., Станкевич С.В., Батова О.М., Жукова Л.В. Загальна фітопатологія: навч. посіб. Житомир: ПП «Рута», 2023. 378 с.

9. Жукова Л.В., Станкевич С.В., Туренко В.П., Горяінова В.В., Батова О.М. Патологія насіння сільськогосподарських культур: навч. посіб. Житомир: Видавництво «Рута», 2023. 292 с.

10. Станкевич С.В., Положенець В.М., Немерицька Л.В., Журавська І.А. Моніторинг хвороб сільськогосподарських культур: навч. посіб. Житомир: Видавництво «Рута», 2022. 304 с.