ЗЕМЛЕРОБСТВО І РОСЛИННИЦТВО

DOI: 10.32636/01308521.2023-(73)-1-1
UDC 633.85:632.4
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FEATURES OF DISEASES OF WINTER RAPE IN THE CONDITIONS OF THE WESTERN FOREST-STEPPE

An important task for the development of the agricultural sector of the economy of Ukraine in modern conditions is the selection of crops capable of giving high productivity and profitability. A special role in this belongs to rapeseed, which has become a promising and competitive culture of Ukrainian farmers thanks to the demand for it in the EU countries and in the domestic market.

According to the biological and technological requirements, winter rape belongs to crops with an increased risk of cultivation. Significant increase in the area under this crop caused a rapid increase in the spread and damage of plant diseases, especially in the conditions of the Western Forest-Steppe.

According to the results of monitoring the phytosanitary condition of winter rape during 2016–2020, the greatest damage to these crops in the study area was caused by fungal diseases: alternariosis *(Alternaria brassicae)* and phomosis *(Phoma lingam)*.

Alternariosis is the most common disease of rape, which is found in almost all regions where this crop is grown. The disease manifests itself on all above-ground organs of plants during the growing season and is especially dangerous during the period of crop formation. Due to the epiphytotic nature of the disease of winter rapeseed plants, it can significantly reduce the seed yield. Alternaria spreads significantly in wet weather and causes premature cracking of the pods.

Winter rape is also significantly damaged by phomosis (stem cancer), which is especially common in areas of high humidity. The disease can appear on seedlings and adult plants. External manifestations of phomosis can be very diverse: stem and root neck cancer, dry rot, leaf spotting, fruit damage.

Based on the results of the study, data on the development of alternariosis and phomosis of winter rape are given, depending on varietal characteristics and meteorological conditions.

Over the years of research on winter rapeseed varieties in 2016–2020, on the natural background of the lesion, the development of alternariosis in the flowering

phase averaged 1.9–10.5 %, in the phase yellow-green pods – 12.3–32.8 %. The least development of this disease was noted on the varieties: Cheremosh, Anna, Dembo. The variety Smaraht was most affected by this pathogen.

The development of phomosis in the flowering phase on the natural background of the lesion was on average 0–4.9 %, in the yellow-green pod phase – 7.9–16.0 %. Anna and Dembo varieties in the flowering phase were not affected by this disease for four years, and Cheremosh for three. The least development of this disease in the yellow-green pod phase was noted on Anna and Dembo varieties.

The highest development of alternariosis and phomosis on winter rapeseed varieties was established in 2020, and the lowest in 2017 in the yellow-green pod phase under the influence of the weather conditions of those years.

Our research has confirmed that varietal features of winter rapeseed plants, as well as environmental conditions (air temperature and rainfall) are important factors that determine both the possibility of disease manifestation and its development.

Keywords: winter rape, diseases, alternariosis, phomosis, variety, resistance.

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Особливості ураження хворобами ріпаку озимого в умовах Лісостепу Західного

Важливим завданням розвитку аграрного сектору економіки України в сучасних умовах є підбір культур, спроможних давати високу продуктивність і прибутковість. Особлива роль у цьому належить ріпаку, який став перспективною та конкурентоспроможною культурою українських аграріїв завдяки попиту на нього країн ЄС та на внутрішньому ринку.

За біолого-технологічними вимогами ріпак озимий належить до культур з підвищеним ризиком вирощування, а значне збільшення площ під посівами цієї культури зумовило стрімке зростання поширення й ураження хворобами рослин, особливо в умовах Лісостепу Західного.

За результатами моніторингу фітосанітарного стану ріпаку озимого впродовж 2016–2020 рр., найбільшої шкоди посівам цієї культури в умовах зони дослідження завдавали грибні хвороби: альтернаріоз *(Alternaria brassicae)* та фомоз *(Phoma lingam)*.

Альтернаріоз – найпоширеніше захворювання ріпаку, яке виявляють майже в усіх регіонах вирощування цієї культури. Хвороба проявляється на всіх надземних органах рослин впродовж вегетації, а особливо небезпечна в період формування врожаю. За епіфітотійного характеру захворювання рослин ріпаку озимого може суттєво знижувати врожай насіння. Альтернаріоз значно поширюється у вологу погоду й спричиняє передчасне розтріскування стручків.

Ріпак озимий значно пошкоджується і фомозом (рак стебла), який особливо поширений в районах підвищеної вологості. Захворювання може проявлятися на сходах і дорослих рослинах. Зовнішні прояви фомозу можуть

бути дуже різноманітними: рак стебел та кореневої шийки, суха гниль, листова плямистість, ураження плодів.

За результатами дослідження наведено дані щодо розвитку альтернаріозу та фомозу ріпаку озимого залежно від сортових особливостей та метеорологічних умов.

За роки досліджень в сортів ріпаку озимого в 2016–2020 рр. на природному фоні ураження розвиток альтернаріозу у фазі цвітіння в середньому становив 1,9–10,5 %, жовто-зеленого стручка – 12,3–32,8 %. Найменший розвиток цієї хвороби відзначено на сортах: Черемош, Анна, Дембо. Найбільш ураженим цим патогеном був сорт Smaraht.

Розвиток фомозу у фазі цвітіння на природному фоні ураження в середньому становив 0–4,9 %, жовто-зеленого стручка – 7,9–16,0 %. Сорти Анна та Дембо у фазі цвітіння протягом чотирьох років не були уражені цією хворобою, а Черемош – впродовж трьох. Найменший розвиток цієї хвороби у фазі жовто-зеленого стручка відзначено в сортів Анна та Дембо.

Найбільший розвиток альтернаріозу та фомозу в сортів ріпаку озимого встановлено у 2020 р., а найменший – в 2017 р., у фазі жовто-зеленого стручка за впливу фактора погодних умов цих років.

Нашими дослідженнями підтверджено, що сортові особливості рослин ріпаку озимого, а також умови навколишнього середовища (температура повітря та кількість опадів) є важливими чинниками, які визначають як можливість прояву хвороби, так і її розвиток.

Ключові слова: ріпак озимий, хвороби, альтернаріоз, фомоз, сорт, стійкість.

Introduction. The most important of the tasks aimed at the development of the agricultural sector of the economy of Ukraine in modern conditions is the selection of crops capable of giving high profitability. Rapeseed has a special role in this. In the structure of oil crops, rapeseed has taken an important place, as it is characterized by stable and high purchase prices throughout the year. Thanks to the demand for it from the EU countries, as well as the growing demand for processing products in the domestic market, rapeseed has become a promising crop for Ukrainian farmers [10, 15−17, 25].

Winter rape is a crop with an increased risk of cultivation. A significant increase in the area under crops of this culture led to a rapid increase in the number of harmful organisms [7, 28].

Oversaturation of crop rotations with rapeseed caused an increase in plant disease and damage by phytophages [29].

Fungal diseases cause great damage to these crops, especially in the conditions of the Western Forest-Steppe [19, 20]. It was established that the damage to rapeseed leaves by pathogens of peronosporosis, alternariosis, phomosis, and cylindrosporiosis in plants increases the content of carotene, dry matter, fiber and ash, but the content of vitamin C, protein, fat, and

sugars significantly decreases. The amount of amino acids in affected rapeseed leaves, depending on the intensity of disease development, decreases by 1.4–2.7 times, in particular, essential amino acids by 1.5–2.9 times and replaceable ones by 0.13–2.6 times [24] .

Depending on the variety or hybrid and cultivation technology, the lack of seed harvest due to diseases reaches 15–70 % or more. Its technological and sowing qualities deteriorate significantly. And when rapeseed pods are affected by pathogens, the oil content in the seeds decreases by 1.3–3.4 times [6, 11, 13, 21, 22].

One of the radical ways to increase the production of winter rapeseed is the use of highly productive and comprehensively resistant varieties to harmful organisms and stressful abiotic factors [9, 14, 27, 31].

The correct selection of varieties and hybrids of winter rapeseed is of crucial importance for its successful cultivation, that is, the biological features and needs of the crop under certain weather conditions should be taken into account.

Alternaria is the most common disease of rape, which is found in almost all regions where this crop is grown. The disease manifests itself on all above-ground organs of plants. The causative agents of the disease are mito-spore fungi from the genus *Alternaria: Alternaria brassicola* and *A. brassicae*. Its first symptoms on winter rapeseed can be observed already in the fall, the cotyledon leaves are first affected, on which small rounded, dot-like, dark spots appear, which subsequently increase in size. With the formation of new leaves, symptoms of the disease also appear on them.

Alternaria is especially dangerous during the period of crop formation. At this time, the spores of the pathogen spread to the pods and quickly germinate under favorable conditions. With early defeat of the pod, deep black ulcers are formed; the pods are deformed, the seeds in them are thin, underdeveloped. When Alternaria acquires an epiphytotic character, it can significantly reduce seed yield. The disease spreads significantly in wet weather and causes premature cracking of the pods [14].

Winter rape is significantly damaged by such diseases as phomosis, or stem cancer, which is common in all areas of Ukraine where cabbage is grown, especially in areas of high humidity. The disease is found on seedlings and adult plants. External manifestations of phomosis can be very diverse: stem and root neck cancer, dry rot, leaf spotting, fruit damage. The causative agent of the disease is the marsupial fungus *Leptosphaeria maculans (Desm.) Ces. et de Not),* in the pycnidial stage – *Phoma lingam (Tode ex Fr.) Desm.* During the growing season of winter rape plants, the pathogen *Phoma lingam* is spread by ascospores, mainly in autumn, and by pycnospores during the growing season of cabbage crops. On affected

plants of winter rape, the causative agent of phomosis is stored by a mycelium [4].

The harmfulness of the disease is manifested in the thinning of the seedlings, the reduction of the assimilation surface of the plants, the reduction of the fodder quality of the green mass of rapeseed, the significant reduction of the weight of 1000 seeds, the sowing and technological qualities of the seeds. Sprouts with clear signs of phomosis on the coleoptile, root neck, and cotyledons are formed from the affected seeds. Crop failure due to the disease can be 50 % or more [4, 12].

Abiotic factors play a major role in the occurrence of the disease and its development. They directly affect both the pathogen, stimulating or inhibiting its development, and the host plant, increasing its susceptibility or resistance.

Depending on these factors, the resistance and endurance of plants to diseases changes during the growing season, and they also affect the intensity of the pathogenic process itself [1, 2, 8].

The self-protection of plants in agrobiocenosis is based on the resistance of the variety, therefore the creation of disease-resistant varieties is considered an important and priority direction in plant protection [3, 23, 26, 30].

The purpose of our research was to study the resistance of winter rapeseed varieties to alternaria and phomosis in the conditions of the Western Forest-Steppe.

Materials and methods. Research was conducted in 2016–2020 on winter rapeseed varieties on the fields of the laboratory of seed science and in laboratory conditions (laboratory of plant protection) of the Institute of Agriculture of the Carpathian Region of the National Academy of Sciences.

Agricultural cultivation techniques are generally accepted for cultivation in the Western Forest-Steppe zone. The total area of the sown plot is 60 m^2, the accounting area – 50 m^2. Repetition – three times.

Under the condition of describing the weather conditions for 2016–2020, we used the data of the Obroshynska water balance station, hydromelioration observation post – v. Obroshyne.

Meteorological conditions during the years of research were different and had deviations from the average long-term indicators (Figs. 1, 2).

Phytopathological assessment of winter rapeseed varieties for disease damage was carried out according to the methods [5, 18].

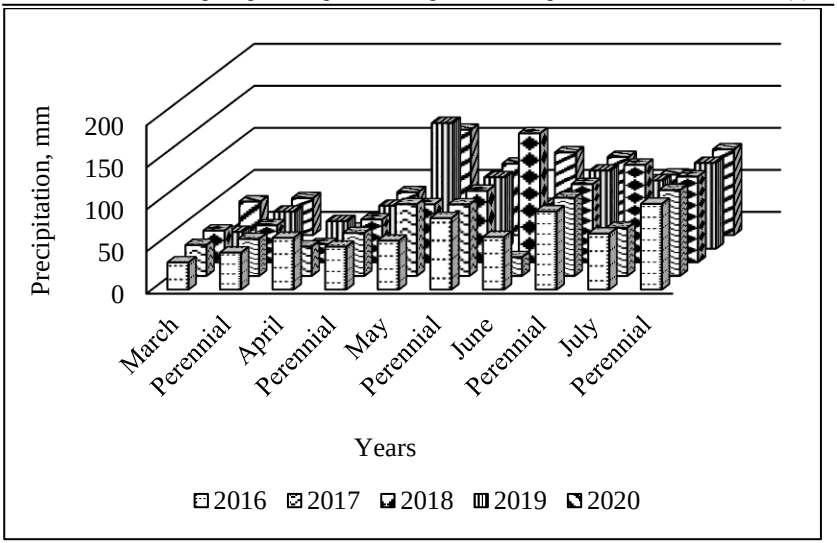

Fig. 1. Distribution of average monthly temperatures during the spring-summer growing season of winter rapeseed (2016–2020)

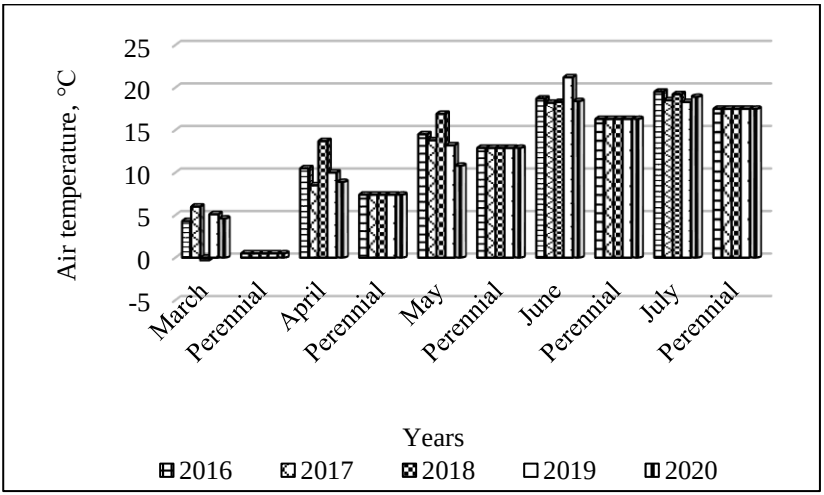

Fig. 2. Distribution of precipitation by month during the spring-summer growing season of winter rapeseed (2016–2020)

Results and discussion. In modern technologies for growing winter rapeseed, the role of the variety and its adaptive capacity is of more and more importance.

According to the results of monitoring in 2016–2020, winter rape varieties were affected by fungal, bacterial and viral diseases. The greatest damage to these crops was caused by fungal diseases: alternariosis *(Alternaria brassicae)* and phomosis *(Phoma lingam)*. During our research, the weather conditions contributed to the development of these diseases almost every year.

According to our observations during 2016–2020, Alternaria was the most widespread and aggressive disease on winter rape in the conditions of the Western Forest-Steppe. This disease developed on crops from autumn onwards after the restoration of plant vegetation in the spring-summer period. All aerial parts of plants were affected: leaves, stems, pods.

According to our research, the greatest development of alternariosis in the flowering phase was in 2016. This disease appeared in autumn on the rosette leaves of rapeseed, on which black-brown zonal rounded spots formed. A mild and short winter contributed to good overwintering of winter rapeseed, and therefore the causative agent *Alternaria brassicae* also overwintered well. But, at the same time, last year's leaf mass was the source of infection of this disease, which developed in autumn and partly in winter, when snow fell on unfrozen ground. Spring was characterized by its early onset with moderate rates of temperature increase. Such weather conditions contributed to the damage of winter rape varieties by alernaria, the development of which in the flowering phase was 2.5–15.0 % (Table 1).

1. Winter rape affected by Alternaria in the flowering phase (2016–2020), %

Varieties	Year					Average
	2016	2017	2018	2019	2020	
Cheremosh	3.4	2.0	1.5	1.6	1.2	1.9
Dembo	3.5	3.4	2.5	2.0	0.5	2.4
Smaraht	15.0	13.5	12.0	7.0	4.8	10.5
Chornyi veleten	10.0	7.5	6.0	5.5	–	7.2
Anna	2.5	3.8	2.8	1.8	–	2.7
Atlant	9.0	8.0	5.5	4.0	–	6.6

Note. Lack of variety this year.

The smallest development of alternariosis in the flowering phase was observed in 2020. This year, the weather conditions of late April – early May (dry and windy weather) were not favorable for the spread and development of alternariosis in winter rape varieties. Affected by autumn

diseases, the leaves of the lower tier gradually died. Maintaining low air temperatures continued to slow down vegetation processes. Therefore, the development of alternariosis in the flowering phase in 2020 was small, as low air humidity restrained reinfection with the disease and averaged 0.5–4.8 % (Table 1).

A rather similar situation was observed in 2019. The end of March and the beginning of April this year were warm and very dry with low air humidity. Such weather conditions to some extent restrained the intensity of re-infection of winter rape with Alternaria, with which plants were more infected since autumn and its damage grew slowly. The development of alternariosis in the flowering phase in 2019 was 1.6–7.0 %, depending on the variety (Table 1).

In 2020, the second decade of May was characterized by sharp temperature fluctuations, and frosts were observed on the soil surface. Significant rains, abundant dew and high relative air humidity, which occurred in the third decade of May and the first half of June, contributed to the mass spread and development of Alternaria on winter rape varieties. That is, abiotic factors (air temperature and rainfall) directly influenced the development of the causative agent of the disease *Alternaria brassicae*, stimulating its development on winter rape varieties.

The development of alternariosis (Table 2) in the yellow-green pod phase in 2020 reached 39.4 % (variety Smaraht), and the lowest was observed on the Cheremosh winter rapeseed variety (17.2 %).

2. Affection of winter rapeseed by Alternaria in the yellow-green pod phase (2016–2020), %

Varieties	Year					Average
	2016	2017	2018	2019	2020	
Cheremosh	9.6	5.8	13.5	15.5	17.2	12.3
Dembo	14.5	6.4	14.0	18.0	19.6	14.5
Smaraht	36.2	17.6	34.0	37.0	39.4	32.8
Chornyi veleten	19.0	14.2	26.0	33.5	–	23,2
Anna	11.5	7.5	16.5	20.0	–	13.9
Atlant	27.6	15.2	28.2	35.5	–	26.0

The set of abiotic factors that developed after the flowering of winter rapeseed in 2020 led to a significant development of Alternaria, which was the largest in the yellow-green pod phase compared to other years.

A similar pattern of weather conditions was observed in 2019, in which, with an increase in temperature in conditions of fairly high air humidity at the end of May and in the first half of June, the damage to

plants by Alternaria rose sharply, the supply of infection of which was high everywhere. The development of Alternaria in the yellow-green pod phase in 2019 was 15.5–37.0 %.

According to the results of our research, in winter rape varieties during the spring-summer period of 2016–2020, on the natural background of the lesion, the development of alternariosis in the flowering phase was on average 1.9–10.5 %, in the phase of yellow-green pods – 12.3–32.8 %. The least development of this disease was noted in the varieties Cheremosh (12.3 %), Anna (13.9 %), Dembo (14.5 %). The Smaraht variety was most susceptible to this pathogen (32.8 %).

It should be noted that the greatest development of alternariosis in the yellow-green pod phase was observed in 2020, and the least in 2017, which was facilitated by the weather conditions of those years.

During 2016–2020, such a disease on winter rapeseed as phomosis developed on crops from autumn, and then during the spring-summer period. Phomosis affected both seedlings and vegetative plants. On the leaves and pods the disease developed in the form of gray dry spots with concentric zonation and black pycnidia. On adult plants, gray spots or sores covered with black pycnidia appeared at the bottom of the stem. Affected seeds were dull and poorly filled.

The weather conditions at the beginning of the spring of 2016 and 2017 were very favorable for the development of winter rapeseed plants. Spring was characterized by its early beginning, therefore, a gradual recovery of the development of phomosis was observed on winter rapeseed, which has been present on the crops since the autumn of last year. The development of phomosis in the flowering phase in 2016 was 0–8.0 %, and in 2017 – 0–9.0 % (Table 3).

3. Affection of winter rape by phomosis in the flowering phase (2016–2020), %

Varieties	Year					Average
	2016	2017	2018	2019	2020	
Cheremosh	1.0	0.5	0	0	0	0.1
Dembo	0.8	0	0	0	0	0.8
Smaraht	8.0	5.2	3.0	1.3	2.8	4.1
Chornyi veleten	1.2	1.5	0	0.8	–	0.9
Anna	0	0	0	0	–	0
Atlant	2.5	9.0	5.0	3.0	–	4.9

The weather conditions in the spring of 2020 did not contribute to intensive re-infection of winter rape with phomosis, and its damage grew

rather slowly. In April of this year, there were frosts and a lack of atmospheric precipitation, which restrained the development and spread of phomosis on winter rape varieties.

The varieties Anna and Dembo in the flowering phase were not affected by this disease for four years, and Cheremosh – for three.

According to our research in the yellow-green pod phase, the greatest development of phomosis was observed in 2019 and 2020. The agroclimatic conditions at the end of the spring and summer growing season of these years turned out to be generally non-standard for the growth and development of winter rapeseed plants due to the uneven distribution of atmospheric precipitation, air humidity, temperature changes and led to the variegation of the distribution and development of phomosis. The development of phomosis in the yellow-green pod phase in 2019 was 9.5–20.5 %, and in 2020 – 11.2–21.6 % (Table 4).

4. Affection of winter rape by phomosis in the yellow-green pod phase (2016–2020), %

Varieties	Year					Average
	2016	2017	2018	2019	2020	
Cheremosh	10.0	5.4	9.0	14.0	15.8	10.8
Dembo	9.6	3.8	6.5	9.5	11.2	8.1
Smaraht	16.0	8.6	14.5	18.0	21.6	15.7
Chornyi veleten	11.5	6.8	11.5	13.0	–	10.7
Anna	7.5	12.5	6.0	10.5	–	7.9
Atlant	13.0	12.5	18.0	20.5	–	16.0

On average, during 2016–2020, the incidence of winter rape plants with phomosis in the yellow-green pod phase (Table 4) was 7.9–16.0 %. The least development of this disease was noted in varieties Anna (7.9 %) and Dembo (8.1 %).

According to the results of our research, the greatest development of phomosis in the yellow-green pod phase was observed in 2020, and the least in 2017, abiotic factors contributed significantly to this (air temperature and precipitation).

Conclusions. According to the results of monitoring the phytosanitary condition of winter rape during 2016–2020, the greatest damage to these crops in the conditions of the Western Forest-Steppe was caused by fungal diseases: alternariosis *(Alternaria brassicae)* and phomosis *(Phoma lingam)*.

On winter rapeseed varieties in 2016–2020, on the natural background of the lesion, the development of alternariosis in the flowering

phase averaged 1.9–10.5 %, in the yellow-green pods phase – 12.3–32.8 %. The least development of this disease was noted on the varieties Cheremosh 12.3 %), Anna (13.9 %), Dembo (14.5 %). The Smaraht variety was most affected by this pathogen (32.8 %).

The development of phomosis in the flowering phase on the natural background of the lesion was on average 0–4.9 %, in the yellow-green pod phase – 7.9–16.0 %. Anna and Dembo varieties in the flowering phase were not affected by this disease for four years, and Cheremosh for three. The smallest development of this disease in the yellow-green pod phase was noted on Anna (7.9 %) and Dembo (8.1 %) varieties.

The highest development of alternariosis and phomosis on winter rapeseed varieties was in 2020, the lowest in 2017 in the yellow-green pod phase under the influence of the weather conditions of those years.

Our research has confirmed that varietal features of winter rapeseed plants, as well as environmental conditions (air temperature and rainfall) are important factors that determine both the possibility of disease manifestation and its development.

To reduce the intensity of damage to winter rape by alternariosis and phomosis, we recommend growing Dembo, Anna and Cheremosh varieties, which are the most adapted to the changing weather and climatic conditions of the growing season in the Western Forest-Steppe.

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Received: January 5, 2023
Accepted: February 7, 2023