

Susceptibility of collection pear cultivars to the agent of scab pathogen *Venturia pirina* Aderh

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Abstract. The objective of the research is to study the biology of the pathogen of the scab *Venturia pirina* Aderh depending on the agrometeorological conditions of the pear vegetation and to assess the collection cultivars for susceptibility to the disease. The biological features of the pear scab in the western foothill agro-climatic region of the Crimea are studied. The influence of climatic conditions on the occurrence of various epidemiological types of scab manifestations on pears is estimated. As a result of the research, highly resistant cultivars were found: Zhukovka, Zaporozhskaya, Triumph of Jodoin, Vodyanistaya, Dorodnaya, Bere Shibasso, Martin Sekl, which showed moderate levels of infection spread in all years of research, with the development of the disease in the range of 0.2 -1.3 %. Immune cultivars of pears with absolute resistance to the pathogen agent *V. pirina*, which was not affected by changes in weather conditions, were identified. These cultivars are the following: Zimovka, Trapezitsa, Chervona, Shara Bera, Seyanets Kolossa, Populyarnaya, Kurzemskaya Maslyanaya, Wonderful Italy, which can be used in breeding and ecologized protection systems when supplying with cuttings horticultural industries in the Crimea and the south of Russia.

1 Introduction

The foothill regions of the Crimea, especially its southwestern part, are ancient centers of horticulture, where soil and climatic conditions have developed favorably, contributing to the cultivation of valuable fruit crops, including pears. The Crimean Pomological Station was created on the initiative of N.I. Vavilov in 1937, as a source of gene pool collections of plant resources of the country. Among fruit crops, the station has created a genetic database of unique pear cultivars, the task of which is an objective assessment and selection of cultivars in the process of in-depth study according to the main indicators: high commercial and technological qualities of fruits, high productivity, adaptation to environmental stress factors, immunity to diseases and resistance to pests [1].

The priority directions in the creation of new plantings of seed crops in the Republic of the Crimea are compiled in the Horticulture Development Program for the period 2015-2025 [2]. Among the main crops provided for by the plans to expand the area for fruit

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orchards, the pear (*Pyrus communis*) occupies a modest place (less than 36%), despite the fact that it is a highly profitable crop (the cost is 2-3 times more expensive than apples). This situation is explained by the fact that in recent decades the pear culture has been intensively affected by pathogens of several diseases, including scab caused by the fungus *Venturia pirina* Aderh, anamorph of *Fusicladium pirinum* (Sib.) Fokl is particularly harmful [3,4,5,6]. The pathogens of pear scab are being studied in many countries [7,8,9].

Phytosanitary control of infection in order to preserve the crop should include measures of biologized protection against phytopathogens. One of the elements of such a system is the introduction into production of immune cultivars and hybrids with complex resistance to pathogens [10,11].

The infectious potential of the *V. pirina* fungus is formed on fallen leaves, which are the sources of primary scab infection. The intensity of the infection in the spring depends on the number of affected leaves in autumn. The first signs of the disease appear in the phase of mass petal fall [12]. In the optimal variant of symptoms, when during the flowering phase the surface of the leaf tissues remains moist for more than 4-6 hours, and the average daily air temperature reaches values of 18-20 °C, alongside with the development of the ascigerous stage of scab, a secondary inoculate is formed – the conidial stage of *F. pirinum* pathogen agent [13].

The symptoms of the lesion on the fruits are manifested by small necrosis on the cover, which merge to form a large spot. Epiphytotic infection occurs when condensed moisture is present on the vegetative tissue of the plant for at least 48 hours. In addition to leaves and fruits, pear scab infects shoots and branches, leading to a decrease in the number of fruit buds, which affects the productivity of trees in new seasons [14].

The objective of the research is to study the biology of the agent of scab pathogen *Venturia pirina* Aderh, depending on the agrometeorological conditions of the pear vegetation and to evaluate the collection cultivars for susceptibility to the disease.

2 Materials and methods

The disease was monitored on a natural infectious background, during 2019-2021, on 31 cultivars of pear collection plantings of the Crimean Pomological Station of the Federal State Funded Institution of Science "NBG-NSC", which is located in the western foothill agro-climatic region of the Crimea, in the nature protection zone of the Belbek River valley. The object of research is a highly specialized fungus *Venturia pirina* Aderh, with a conidial stage of *Fusicladium pirinum* (Sib.) Fokl [13].

The infectious potential of the pathogen *V. pirina* was taken into account in autumn on fallen leaves. We took 2-4 samples of 20-25 leaves from a plot of 1 ha. From the first decade of March, the percentage of maturation and the time of mass emergence of ascospores were detected by analyzing infected last year's leaves under a microscope.

The cultivar susceptibility of pear trees to scab was analyzed using indicators of the prevalence and degree of development of the disease using the formula:

$$X = \frac{\sum(b \times p)}{n \times 4} \times 100$$

where X is the degree of development of the disease; b is the lesion score, p is the number of leaves of this score, n is the total number of registered leaves, 4 is the highest lesion score. The scale for determining the degree of development of the disease: - there is no lesion; 0.1 - from 1 to 10% of the surface of the accounting body is affected; 1 – from 10 to 25% of the surface of the accounting body is affected; 2 – from 25 to 50% of the surface of the accounting body is affected; 3 – from 50 to 75% of the surface of the accounting body is affected; 4 – over 75% of the surface of the accounting body is affected [10, 15].

3 Results and discussion

As a result of our research, it was found that ascospore infection of pear scab begins to develop in pseudotheciums in the second half of March. It was found that the air temperature is a less significant factor in this period of infection development than the length of daylight. In the winter months of 2020, the average daily air temperature on average did not fall below -4°C , but the maturation of ascospores in perithecia began at the same time as in the colder years 2019 and 2021, when the temperature in the winter months decreased to -15°C .



Fig. 1. Symptoms of *Venturia pirina* Aderh lesion on pear leaves and fruits (Original photographs)

In April, when the average daily air temperature is set at $13.5^{\circ}\text{C} - 15.0^{\circ}\text{C}$ with a relative humidity above 70 %, the maturation of ascospores occurs exponentially. The upper limit of the intensity of ascospore output from pseudotheciums is fixed as the temperature regime progresses in the phase of the "rosebud" of the pear, which corresponds to the first decade of May. Unlike apple scab, *V. pirina* is located on the underside of the leaves, forming small necrotic spots (Fig. 1). Pears are not protected from the penetration of the mycelium of the fungus into the pulp of the fruit, as in an apple tree. As a result of scab damage, the fruits become hard and unfit for consumption.

It was revealed that in 2019, in the first half of the growing season, meteorological conditions were close to the average annual indicators. As a result, a *moderate* level of disease development was manifested and the prevalence of scab was not high (P, 32 %). In May and June, the weather conditions were unstable and provoked a rapid increase in the conidial form of *F. pirinum* infection (P, 51.8 %). Thus, it was found that the parameters of humidity and temperature are less significant for summer scab spores than for ascospores and they can cause an epiphytotic type of disease development. In the conditions of the absence of chemical treatments, the intensity of lesions even on one cultivar fluctuated during the growing season: on leaves from 4.8 to 39.7% and on fruits from 20.5 to 92.0 %.

The lowest level of development of pear scab – *depressive* was recorded in the dry year 2020. In the first half of the growing season, it was only 1.5 % until the second decade of May, when minor precipitation (5.8 mm) fell, increasing the average relative humidity (77.3%). By the beginning of August in the second half of the growing season, there was P = 27.3 %. It was found that even against the background of moistening of the leaves, the development of scab slows down with an increase in the average daily temperature above 26°C .

The cool and humid conditions of the beginning of the growing season in 2021, with a period of moistening of the leaves for more than 12-48 hours, continued during all the months of experimental studies. During the flowering of the pear, 65% maturation of ascospores was noted. Mass dispersion of ascospores was recorded from the phenophase of bud loosening. As a result, an *epiphytotic* type of disease development appeared. The

symptoms of the lesion of *F. pirinum* conidia were clearly manifested on the fruits. The degree of development of the disease in July increased to 88%.

According to the research results, the studied collection pear cultivars were differentiated by the manifestations of scab on the fruits. All cultivars classified as susceptible cannot be recommended for cultivation in the conditions of the water protection territories of the Crimea. In all the years of the study, their susceptibility to scab was high – the degree of disease development was from 36.0% to 82.6% according to the average annual indicators (Table 1).

Cultivars that are tolerant to scab (R 3.3% - 17.2%) can be recommended for commercial growing, but the profitability of their cultivation will depend on the use of pesticides. A high degree of resistance to pear scab in the conditions of a natural infectious background was shown by 8 cultivars (Table 1). The low level of infection spread (R, 0.2 – 1.3 %) was manifested only in 2021 with extreme precipitation. Taking into account the valuable indicators of productivity and resistance to scab, these cultivars can be successfully recommended for active commercial growing in the south of Russia and in the Crimea (Table 1).

Table 1. Cultivar susceptibility to pear scab in the collection nursery of the Pomological station of the FSFIS "NBG-NSC" 2019-2021 (without treatments)

№	Cultivars	Origin	Terms of maturity	The index of the development of the disease on fruits, R,%			
				2019	2020	2021	Average, %
<i>Vulnerable cultivars</i>							
1	Akkord	Ukraine	Winter	72.1	63.7	85.5	73,7
2	Alupkinskaya	Russia	Summer	71.2	64,0	73.2	69.4
3	Malgorzhatka	Ukraine	Summer	81,3	78.6	88.0	82.6
4	Zamestane	Bulgaria	Summer	77.5	67.4	81.4	75.4
5	Rozovaya Rannyaya	Ukraine	Summer	64.5	55.2	72.4	64.0
6	Saint Germain	France	Winter	70.7	61.4	82.1	71.4
7	Rannyaya Vishnyovaya	Ukraine	Summer	54.9	34.1	43.5	44.2
<i>Tolerable cultivars</i>							
8	Luchistaya	Ukraine	Summer	25.8	18.3	32.2	25.4
9	Shveitsarskaya Polosataya	Sweden	Winter	25.5	21.1	27.3	24.6
10	Dekanka Boucher	France	Winter	20.2	0	23.5	14.6
11	Grand Champion	USA	Autumn	15.3	10.6	25.7	17.2
12	Korsunskaya	Ukraine	Autumn	19.6	10.4	21.1	17.0
13	Eva	Italy	Autumn	8.4	0	11.7	6.7
14	Zukhra	Uzbekistan	Autumn	10.0	0	12.9	7.6
15	Krasnomakskaya	Ukraine	Winter	2.8	0.7	6.5	3.3
<i>Resistance cultivars</i>							
16	Zhukovka	Ukraine	Autumn	0	0	4.0	1.3
17	Zaporozhskaya	Ukraine	Summer	0.5	0	3.5	1.3
18	Triumph of Jodoïn	Belgium	Winter	0	0	3.5	1.1
19	Vodyanistaya	Ukraine	Summer	0	0	3.0	1.0

20	Dorodnaya	Ukraine	Summer	0.5	0	2.5	1.0
21	Bere Shibasso	Ukraine	Autumn	0	0	0.5	0.2
22	Martin Sekl	Italy	Summer	0	0	0.5	0.2
23	Yantarnaya	Ukraine	Autumn	0	0	0.5	0.2
<i>Immunity cultivars</i>							
24	Zimovka	Russia	Autumn	0	0	0	0
25	Trapezitsa	Bulgaria	Summer	0	0	0	0
26	Chervona	Ukraine	Summer	0	0	0	0
27	Shara Bera	Ukraine	Winter	0	0	0	0
28	Seyanets Kolossa	Ukraine	Summer	0	0	0	0
29	Populyarnaya	Ukraine	Autumn	0	0	0	0
30	Kurzemskaya Maslyanaya	Latvia	Autumn	0	0	0	0
31	Wonderful Italy	Italy	Autumn	0	0	0	0

* Note: R – disease development

As a result of our research, 8 immune pear cultivars with absolute resistance to scab were found. These are cultivars: Zimovka, Trapezitsa, Chervona, Shara Bera, Seyanets Kolossa, Populyarnaya, Kurzemskaya, Wonderful Italy, which can be used in breeding, as well as for cutting and spreading seedlings in the supply of horticultural farms.

4 Conclusion

Thus, it is established that the conditions of the western foothill region of the Crimea, the maturation of pseudotheciums of *V. pirina* begins in the second half of March. The air temperature is a less significant factor during the development of the marsupial form of infection than the length of the daylight hours, so the maturation of ascospores in perithecia began at the same time, both in 2020, when the average daily air temperature in the winter months did not fall below -4 °C, and in 2019 and 2021, when the temperature limit decreased to -15 °C.

It was found that most pear cultivars in the conditions of a natural infectious background have a high degree of susceptibility to the pathogen *V. pirina* (R, 36.0% - 82.6%). Less susceptible to scab (R, 3.3% – 17.2%) cultivars: Luchistaya, Shveitsarskaya Polosataya, Decanka Boucher, Grand Champion, Korsunskaya, Eva, Zukhra, Krasnomakskaya. A high degree of resistance to the disease was shown by 8 cultivars: Zhukovka, Zaporozhskaya, Triumph of Jodoin, Vodyanistaya, Dorodnaya, Bere Shibasso, Martin Sekl, which had a low level of infection (R, 0.2 -1.3 %) only in 2021 with extreme precipitation.

We found 8 immune cultivars of pears with absolute resistance to scab: Zimovka, Trapezitsa, Chervona, Shara Bera, Seyanets Kolossa, Populyarnaya, Kurzemskaya Maslyanaya, Wonderful Italy, which can be successfully used in the selection of promising cultivars of pears for cultivation in the Crimea and in the South of Russia.

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