

INFLUENCE OF WEATHER CONDITIONS ON THE DEVELOPMENT OF KALMARAZ DISEASE ON APPLE TREE VARIETIES

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Аннотация: В данной статье изложены результаты исследований, проведенных в яблоневых садах Андижанской области Ферганской долины в 2020-2023 годах. Объектом исследований является возбудитель болезни парша- *Venturia inaequalis* (Cke.) Wint., погодные условия, температура воздуха. Длительный абиотический стресс плодовых деревьев вызвал не только значительное ухудшение состояния деревьев, но и изменение популяции фитопатогенных грибов плодовых деревьев.

Annotation: This article presents the results of research conducted in apple orchards in the Andijan region of the Fergana Valley in 2020-2023. The object of research is the causative agent of scab disease - *Venturia inaequalis* (Cke.) Wint., weather conditions, air temperature. Long-term abiotic stress in fruit trees caused not only a significant deterioration in the condition of the trees, but also a change in the population of phytopathogenic fungi in fruit trees.

Ключевые слова; Яблоко дерево, парша, эпифитотия, первичный ущерб, сезонная динамика, погодные стрессовые факторы

Keywords: Apple tree, scab, epiphytoty, primary damage, seasonal dynamics, weather stress factors.

INTRODUCTION

The demand for apples, due to their availability, remains high and a very valuable fruit in many countries. Economically, apples rank fourth after citrus fruits, grapes and bananas. World production of apples and pears is about 77.0 million tons. Among the EU countries, the main producers are Poland, Italy, France and Germany, where 9.8 million tons of fruit are grown. China, USA, Turkey, Brazil, Russia, Argentina, Ukraine occupy the leading place in the world in apple production among non-EU countries.

In total, 128.6 thousand hectares are allocated for the cultivation of apple trees in all categories of farms in our republic, of which 92.5 thousand hectares are productive areas. Currently, intensive apple orchards are established on an area of 33.1 hectares (FAO, 2022).

The apple tree is one of the main fruit trees in the Fergana Valley. One of the most common fungal diseases in plants is scab, caused by the fungus *Venturia inaequalis* (Cke.) Wint. The disease is widespread, especially in areas with high humidity, causing serious economic damage. Symptoms of the disease appear in all above-ground organs of the plant: leaves, petioles, young branches, thicket leaves, stalks and fruits.

In *V. inaequalis*, the diameter of the pseudothecium is 90-120 μm , the sizes of the bursae and ascospores are 40-70x10-12 and 13-17x6-7 μm , respectively. The spread and dispersal of ascospores occurs under conditions of intermittent humidity and temperatures from 7 to 23 °C (optimal limit 18-20 °C). Thus, ascospores are the main source of infection that affects plants in the spring. Dispersal of ascospores occurs in early spring in warm climates and late spring in cool climates. It can take up to 60 days for the ascospores to be released from the bag, depending on weather conditions. Ascospores are spread by air currents and water droplets. Ascospores grow in abundant moisture and temperatures from 2 to 30°C. At a favorable temperature (18-20 °C), their growth begins after 4 hours, and at lower and higher temperatures (6 and 27 °C, respectively) after 6 hours. The ascospore forms a bubble that penetrates the plant tissue and initiates the development of mycelium. The fungus affects young leaves, but does not affect leaves older than 25 days. The incubation period of the disease lasts 8-21 days. This is 10 days when the temperature is 17-21 °C. The first signs of scab are observed during the sudden fall of leaves. Scab appears in the growing parts of the plant during the conidial period.

During the growing season, scab pathogens can produce from 4-6 to 9-10 generations of conidia. When infected with conidia, plants undergo the same incubation period as when infected with ascospores.

The causative agent of apple scab in the conidial period is called *Fusicladium dendriticum* Fuck. In *F. dendriticum*, the dimensions of conidia-strips are 15-40x4-6 μm , and conidia - 13-30x6-12 μm . There are also reports of the mycelium overwintering and the formation of new conidial spores in the spring. This means that scab pathogens overwinter on fallen leaves, and sometimes (most often in pears) in the form of mycelium on infected branches.

Scab - an infected plant causes a deterioration in yield and quality indicators; during storage, apple fruits infected with scab are prone to rotting and infection with various molds. If conditions are favorable for the development of the disease, the plant can completely destroy the crop. In addition, the disease can cause a decrease in the cold resistance of trees [1].

Materials, sources and research methods.

The research process was carried out in farms specializing in growing apples in the Fagan Valley and at the Andijan Institute of Agriculture and Agricultural Technologies, plant protection and quarantine laboratory. When conducting scientific work, methods generally accepted in phytopathology were used [2,3,5].

Research results.

In 2021-2023, research was conducted to study the spread and damage of scab and the importance of apple tree varieties in the development and spread of the disease in apple orchards in the regions of the Fergana Valley.

Due to the disease, the leaves and fruits of the plant begin to fall off in the first and second ten days of June, and their mass fall corresponds to the first and second ten days of July. In some years, the fall of infected fruits occurs in the third ten days of May. The maximum manifestation of the disease is observed in the second or third ten days of June or the first or third ten days of August, when the entire crop is completely damaged (Table 1).

Table 1

In the conditions of the Andijan region, the infection of the Renet Simirenko variety with parser disease was revealed on the control variant.

Damaged plant organ	Maximum Damage (%)							
	2020 year		2021 year		2022 year		2023 year	
	P	R	P	R	P	R	P	R
leaf	48,4	37,6	52,2	40,0	63,5	39,2	56,7	43,4
fruit	59,1	15,4	71,3	17,8	84	61,2	74,5	61,7

Note: P - spread of disease; R-intensity of disease

Currently, many researchers point to anthropogenic impact and climatic factors as the main reasons for the increase in incidence. In recent years, the frequency of extreme weather conditions has increased in the Fergana Valley: abnormally low winter temperatures in December 2020 and 2023; decrease in temperature in April-May; in the second half of summer (2020, 2021, 2022, 2023) in combination with extremely high temperatures, relative air humidity on some days below 30%, almost no precipitation; Among them is an increase in the maximum number of temperatures (above 38°C), especially in the Fergana Valley, by 44.0%.

In addition, over the past five years, the region has seen an increase in average monthly air temperature by 2.6°C during the energy-consuming phases of plant life from May to September, as well as a decrease in precipitation against the background of relatively stable weather.

Long-term abiotic stress in fruit trees caused not only a significant deterioration in the condition of the trees, but also a change in the population of phytopathogenic fungi in fruit trees. In such a situation, without studying the dynamics of changes in the development of pathogens, the chances of trees to obtain a sustainable harvest and high-quality fruits are reduced. In this regard, studies of diseases of apple tree varieties were carried out in the regions of the Fergana Valley on farms specializing in fruit growing.

Based on the obtained data, a comparative analysis was carried out (from 2020 to 2023) in order to determine the biotic potential of the pathogen and seasonal dynamics. The influence of temperature factors on the amount of infection present in plants at the beginning of the growing season was studied. Between 2020 and 2023, inoculum potential decreased by 10-32% due to low winter temperatures. Over the past four years, very low winter temperatures for the valley (- 14 - 20°C) have not led to a significant decrease in primary infection compared to warm winters. That is, by the spring of these years, the level of primary infection in resistant varieties in all fields was lower by 4.9-7.6%. Despite drought and temperatures of 30°C and above in July-August 2021 and winter temperatures of minus 20°C in 2023, the density of primary scab infestation did not decrease even after the very high temperatures of July-August.

Thus, the abnormally low temperatures of the winter period, as well as the extreme hydrothermal regime in the second half of the growing season from 2020, do not have a significant effect on the number of pseudothecia, which does not allow reducing the number of treatments (number of sprays) against the disease. In the fall of 2020, 2021, 2022 from mid-September to mid-November and from mid-September to the first half of October 2023,

during a long warm period (up to 19-20 ° C on some days), protection against disease is not carried out, which causes scab on the leaves of the apple tree (*Venturia inaequalis* (Cke.) Wint.), promotes further development of the conidial stage.

Studies have shown that an increase in the duration of development of the conidial stage by 20 or more days in the autumn period increases the potential supply of infection by an average of 7-12% compared to long-term indicators. In 2020-2023, it was noted that the amount of primary scab infection on fallen leaves at the beginning of the growing season of an apple tree varies significantly among varieties, and in most cases its amount is directly related to the level of immunity of the variety. Thus, in practice, the fruiting bodies of the pathogen are rarely or not detected on the falling leaves of resistant varieties. In resistant varieties, the number of pseudothecia is average and 1.5-3 times less than in unstable varieties.

During studies conducted in 2020-2023 in the regions of the Fergana Valley, it was noted that the difference in the amount of primary infection was also different between groups of varieties with different resistance to the disease. Since 2021, there has been a decrease in the difference in the number of maximally formed pseudothecia between the groups of resistant, moderately resistant, resistant and highly resistant varieties (Table 2).

Table 2
Number of fungal pseudothecia on one leaf during primary infection of apple scab in the conditions of the Fergana Valley, pcs.

Apple varieties	2020-2022	2023
Poor resistance to disease		
Renet Simirenko	290,0-898,0	36,8-796,0
Gala	124,0-754,0	18,4-454,1
Pink lady	198,0-943,0	24,0-436,3
Empire	210,0-700,0	20,2-526,9
Jermyn	196,0-814,0	17,3-454,0
Moderately disease resistant		
Red delicious	90,0-998,0	6,2-621,0
Red chief	174,0-786,0	24,2-584,4
Super chief	24,0-683,0	14,2-546,3
Aydared	78,0-574,0	18,2-467,6
Jermyn	87,0-624,0	19,0-432,2
Golden	124,0-764,0	44,1-502,0
Fudji	190,0-710,0	21,2-435,4
Delicious	45,0-368,0	8,4-112,2
Breyburn	64,0-487,0	23,0-342,0
Grenni Cmit	124,0-723,0	42,1-576,5
Jonagold	27,0-572,0	11,4-252,4
Jonatan	121,0-684,0	16,2-452,7
Disease resistance		
Belmy naliv	30,0-467,0	11,2-261,2
limonnoe	21,2-348,0	16,4-296,4
Very disease resistant		
Viliyams Prayd	10,8-17,6	6,8-10,2
Kandil sinap	15,0-18,0	8,2-11,0

The current situation can be explained by the fact that the pathogen is trying, first of all, to increase the population size through more resistant varieties. Therefore, in the region it is necessary to monitor the level of *Venturia inaequalis* abundance in varieties with different levels of resistance to all diseases. If there is a high amount of primary infection in the fallen

leaves of highly resistant or resistant apple tree varieties, it is necessary to carry out control measures to reduce the infectious background of the pathogen and protect against infection by ascospores of unstable and moderately resistant varieties to diseases in early spring.

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