



RESEARCH PAPER

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Frequency of occurrence of pathogens of diseases observed in cucumber (*Cucumis sativa* L.) plants

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ABSTRACT

This study presents the results of phytopathological monitoring of diseases affecting cucumber (*Cucumis sativa* L.) plants cultivated under covered (greenhouse) conditions in the Republic of Azerbaijan. The objective was to determine the species composition of phytopathogenic organisms and evaluate their prevalence. A total of approximately 400 samples were collected and analyzed using standard phytopathological and mycological methods, including humidity chamber incubation and microscopic identification based on cultural and morphological characteristics. The results revealed the involvement of 20 species in the formation of cucumber pathogenic mycobiota, including one fungus-like organism (Chromista), 18 species from the Ascomycota division, and one from Basidiomycota. The distribution of diseases showed that root and root rot diseases were the most prevalent (42.7%), followed by leaf spot diseases (39.5%), powdery mildew (7.5%), and other diseases such as gray and white rot (10.3%). Among the pathogens, species of the genus *Fusarium* were dominant in root diseases, while *Alternaria* species were most significant in leaf spot infections. Environmental factors, particularly temperature and humidity, were identified as key determinants influencing disease development and spread. Optimal conditions for pathogen activity generally ranged between 15–20°C and 80–100% relative humidity, although variations existed among different pathogens. The findings highlight the diversity and prevalence of phytopathogenic fungi affecting cucumber crops under greenhouse conditions and emphasize the importance of environmental management and targeted disease control strategies to reduce crop losses and improve productivity.

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INTRODUCTION

The presented work is dedicated to the results of monitoring diseases observed in cucumber (*Cucumis sativa* L.) cultivated under covered conditions in the Republic of Azerbaijan. As a result of monitoring, it became clear that in the formation of phytopathogenic mycobiota of cucumbers grown in greenhouse agrocenoses are involved 20 species 1 of which belong- Fungus-like organism (Chromista), 18 to the Ascomycota division and 1 to the Basidiomycota division. Of the total number of diseases caused by these fungi, 42.7% are root diseases and root rot (rhizoctonia, verticillium wilt and fusarium wilt), 39.5% are spotting (alternaria, cladasporium, ascochytoxis, etc.), 7.5% are powdery mildew (true and false), and 10.3% are other diseases (white and gray rot).

The decline of the productivity of various vegetable crops, including cucumbers, is due to a number of abiotic and biotic factors, among which diseases caused by organisms belonging to various taxonomic groups are of particular interest. Thus, every year, about 20 -40% of agricultural production is lost due to diseases caused by various living organisms (Bakr *et al.*, 2025; Shuping and Eloff, 2017). Most of this is due to phytopathogenic fungi.

Due to the high level of crop losses in agriculture due to the activity of phytopathogenic microorganisms, and the increasing demand for agricultural products by the world population Singh *et al.* (2023). The emergence of these problems is undesirable in the context of global climate change, and therefore, preventing them or minimizing their negative impact is one of the research directions of the modern era. As a result of research conducted in this direction, varieties resistant to various diseases have been obtained, effective preventive control measures have been developed, and other work has been done and continues to be done Hyde *et al.* (2024).

Despite this, millions of tons of products are either lost or fail to meet current quality requirements due

to the effects of microorganisms every year Sapakhova *et al.* (2025).

The agricultural sector occupies a significant share in the economy of the Republic of Azerbaijan Valiyev *et al.* (2025) and all its regions have arable land, where various vegetables, melons, fodder and other plants are cultivated, and according to the State Statistical Committee of Azerbaijan, 100 thousand tons of various plant products are produced annually (<https://www.stat.gov.az/>). As in the world, in the Republic of Azerbaijan, every year, as a result of the activity of phytopathogenic microorganisms, there is a decrease in the quantity and deterioration in the quality of agricultural products. This is also confirmed by the spread of phytopathogens considered dangerous worldwide (Dean *et al.*, 2012) in the territory of the Republic of Azerbaijan (Bakshaliyeva *et al.*, 2024; Muradov *et al.*, 2019).

However, the fight against phytopathogens is not effective enough today, and crop losses continue to occur in the country every year. At the same time, the non-compliance of quality indicators of some produced plant products with the necessary requirements has a negative impact on the country's export potential.

Therefore, the purpose of the presented work was dedicated to the clarify the species composition of pathogens observed in cucumber plants cultivated under covered conditions in the Republic of Azerbaijan and their prevalence.

MATERIALS AND METHODS

The research was conducted in the greenhouses of the Vegetable Growing Scientific Research Institute of the Ministry of Agriculture of the Republic of Azerbaijan. Sampling was carried out according to known methods Maheshwari (2016), with 4 samples per 100 m², for a total of about 400.

The spread and development of diseases in greenhouses was recorded visually using generally accepted methods. The infection rate was determined

based on the formula $P(\%) = (n/N) \times 100$, where n - is the number of samples in which the fungus was detected, and N is the total number of samples taken.

The method of collecting fungi in a humidity chamber has been used to stimulate the growth of phytopathogens. For this, the samples to be studied (leaves, stems, roots and fruits) are placed in a biological thermostat with a temperature of 25°C, and the sample is monitored after 3, 5, 7 and 10 days. Identification of fungi was carried out based on cultural-morphological characteristics, using a light microscope with a magnification of up to 2500 times (OMAX 40X-2500X LED Digital Lab Trinocular Compound Microscope with USB Camera). For identification, known identifiers (Ellis and Ellis, 1987; Sutton *et al.*, 2001) and atlases (Garibova, 2009; Li *et al.*, 2023) were used. Statistical processing of the results obtained in the studies was carried out using Microsoft Office Excel (2010) software.

RESULTS AND DISCUSSION

It should be noted that there is no plant in nature that microorganisms, including phytopathogens, cannot inhabit or use as a food source. In this regard, cucumber plants are no exception, and as in other parts of the world, various diseases are known to spread in cucumber plants cultivated in both open and covered conditions in the Republic of Azerbaijan. This has been confirmed in our previous studies. Thus, in studies conducted in 2023-2025, a number of diseases were discovered in cucumber plants. In preventive measures against diseases, they use either chemical, agrotechnical, biological, or complex control measures that reflect them. For this reason, research began by monitoring diseases of cucumbers grown under covered conditions in Azerbaijan.

It has become clear that the most widespread disease of cucumber plants grown under covered conditions in the year was root and root rot, and the temperature range for their activity is favorable for 5-45°C. However, the moisture content of the substrate used for planting cucumbers also plays a role in the more intensive spread of this disease. Thus, how more water

absorbs to the substrate during irrigation, the less air is left for the roots to breathe. As a result, cracks form in the root-stem junction of the root and stem (root collar), which allow pathogens to penetrate the plant from these areas. The pathogen, which begins its activity as a saprotroph in cracked areas, later continues its activity as a phytopathogen in healthy tissues. The main symptom of root and root rot disease is the wilting of the plant, especially its leaves. This process is usually observed two to three weeks after the plant is infected. Over time, the wilting leaves of cucumbers turn yellow, the ovaries in the flowers lose their function, and the fruit stops developing. Symptoms of the disease are also found in the roots, which manifests itself in the discoloration of the roots in the infected areas. The process is observed with changes occurring in both aboveground and underground parts, even to the point of complete destruction of the plant.

When infected areas of cucumber plants were placed in a humidity chamber, it became clear that root and root rot (withering) disease is caused by several genera of fungi. Thus, fungi such as *Fusarium moniliforme*, *F. oxysporium*, *F. solani*, *Pythium debaryanum*, *Rhizoconia solanium*, *Verticillium albo-atrum* and *V. dahliae* were isolated from the samples. During the research, 42.7% of the total diseases recorded under covered conditions were caused by these mentioned fungi. Interestingly, mycological analysis of the substrates used for growing cucumbers under these conditions also revealed the presence of structures belonging to the aforementioned fungi. This suggests that the used substrates also play a role in the spread of the disease. When looking at the share of individual genera in the diseases caused, it became clear that fungi belonging to the genus *Fusarium* were more active (Table 1). As can be seen, more than half of the diseases observed in and around of plant roots are caused by fungi of the genus *Fusarium*.

One of the diseases observed in cucumber plants under covered conditions throughout the year is spotting, the observed symptom of which consists of spots of various colors (black, gray, brown, tan, etc.),

shapes (circular, irregular, rectangular, etc.), and sizes (0.1-1 cm). The main reason for the morphological appearance and diversity of the disease is that the fungi involved in its development belong to different species. Thus, placing the samples in a humidity chamber and conducting observations allowed us to note the involvement of fungi such as *Ascochyta cucumeris*, *Alternaria alternata*,

A.cucumerina, *Cladosporium cucumerinum*, *C. fulvum* (currently *Fulvia fulva*), *Colletotrichum lagenarium* and *Septoria cucurbitacearum* in the occurrence of spot diseases. In studies, 39.5% of the total diseases recorded in cucumber plants are caused by these fungi. Interestingly, a relatively limited temperature range is considered favorable for the development of these diseases: 10-37°C.

Table 1. The share of fungal species in the development of diseases root and around of root of cucumber plants

#	Pathogen	Spread rate (%)	Total share(%)
1	<i>Fusarium (F. moniliforme, F. oxysporium, F. solani)</i>	22.8	53.4
2	<i>Pythium debaryanum</i>	6.0	14.1
3	<i>Rhizoconia solanium</i>	5.7	13.3
4	<i>Verticillium (V. alboatrum and V. dahile)</i>	8.2	19.2
Total		42.7	100

Table 2. The share of fungal genera in the pathogenesis of spot disease observed in cucumber plants

#	Pathogen	Spread rate (%)	Total share(%)
1	<i>Ascochyta cucumeris</i>	5.9	14.9
2	<i>Alternaria alternata, A. cucumerina</i>	8.5	21.5
3	<i>Cladosporium cucumerinum, C. fulvum</i>	7.2	18.2
4	<i>Colletotrichum lagenarium</i>	6.3	16.0
5	<i>Septoria cucurbitacearum</i>	6.0	15.2
6	<i>Pythium debaryanum</i>	5.6	14.2
Total		39.5	100

Table 3. The share of fungal genera in the pathogenesis of powdery mildew disease observed in cucumber plants

#	Pathogen	Spread rate (%)	Total share(%)
1	<i>Erysiphe cichoracearum</i> v ₃ <i>Sphaerotheca fuliginea</i>	5.4	72
2	<i>Pseudoperonospora cubensis</i>	2.1	28
Total		7.5	100

Table 4. The share of fungal genera in the pathogenesis of other diseases observed in cucumber plants

#	Pathogen	Spread rate (%)	Total share(%)
1	<i>Botrytis cinerea</i>	5.2	50.5
2	<i>Sclerotinia sclerotiorum</i>	5.1	49.5
Total		10.3	100

Among the factors that positively influence the development of these diseases, both humidity and the moisture capacity of the substrate play a role. According to the prevalence of the causative agents of the spotted disease recorded in cucumber plants, it was determined that fungi belonging to the genus *Alternaria* are characterized by higher prevalence rates (Table 2).

One of the diseases observed as a result of monitoring is powdery mildew, of which two forms have been found in studies: true and false powdery mildew. The

fungi involved in the formation of these diseases include representatives of both true fungi and fungus-like organisms. Since these fungi are true biotrophs, it is impossible to isolate them into a pure culture; therefore, their identification was carried out on the basis of the symptoms of the diseases they cause and the structural elements they form at certain stages of their development cycles. It has become clear that the origin of true powdery mildew is caused by species such as *Erysiphe cichoracearum* and *Sphaerotheca fuliginea*, which belong to the division Ascomycota, and the origin of false powdery mildew is caused by

species such as *Pseudoperonospora cubensis*, which belongs to the division Oomycota (Chromista) of fungus-like organisms. Although they belong to different taxa from a taxonomic point of view, the recording of sexual reproduction in all three of them allows us to note their lack of an anamorphic stage. This disease is mainly observed in the leaves of the plant and causes a decrease in its activity, primarily photosynthesis. Naturally, this leads to a decrease in agricultural crop yields. The share of diseases caused by these fungi accounts for 7.5% of the total diseases recorded during monitoring (Table 3). It is noteworthy that the spread of diseases caused by these fungi largely depends on the temperature and humidity of the environment.

Finally, it should be noted that as a result of monitoring, various colored rot diseases were also observed, which cannot be generalized to the above, and occur with the participation of both anamorphs and telemorphs of ascomycetes and are mainly found in the aboveground part of the plant. The most common of these are gray and white rot, the former of which is caused by *Botrytis cinerea* (anamorph), and the latter by *Sclerotinia sclerotiorum* (telemorph). These fungi account for 10.3% of all diseases recorded in studies (Table 4) temperature and humidity are among the factors that positively affect the spread of diseases caused by these fungi. Interestingly, the development and persistence of pathogenic activity of the fungus *B. cinerea*, which is involved in the development of gray rot disease, occurs in a more limited range. Thus, during the research it was determined that the temperature between 16-20°C and air humidity between 80-100% are considered favorable for its development.

CONCLUSION

Thus, as a result of phytopathological monitoring of cucumber plants cultivated under covered conditions in the Republic of Azerbaijan, it became clear that species such as *Ascochyta cucumeris*, *Alternaria alternata*, *A. cucumerina*, *Botrytis cinerea*, *Cladosporium cucumerinum*, *Fulvia fulva* (syn. *Cladosporium fulvum*), *Colletotrichum lagenarium*,

Erysiphe cichoracearum, *Fusarium moniliforme*, *F. oxysporium*, *F. solani*, *Pseudoperonospora cubensis*, *Pythium debaryanum*, *Rhizoconia solanium*, *Sphaerotheca fuliginea*, *Sclerotinia sclerotiorum*, *Septoria cucurbitacearum*, *Verticillium alboatrum* and *V. dahliae* participates in the formation of the pathogenic mycobiota of cucumbers, and as a result of their activity, various pathologies are observed in the plant. It has been found that the main factors in the development of pathologies are environmental humidity and air temperature. Although the ambient temperature is favorable for the occurrence of the recorded pathogens between 15-20°C and air humidity between 80-100%, the activity of the pathogens of the observed diseases differs depending on the temperature range.

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