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Characteristics of general and phytopathogenic mycobiota of dry subtropical fruit plants cultivated in Azerbaijan

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Against the backdrop of global climate change, certain processes also occur in the mutual relations between plants and fungi, which was investigated in order to clarify this, based on the specific weight of phytopathogens among fungi involved in the formation of the mycobiota of some fruit plants cultivated in Azerbaijani conditions. It became clear that a total of 127 species were involved in the formation of the mycobiota of 11 plant genera and cultivars. 66.9% of the recorded species are those that cause one or another pathology in plants. When compared with previous studies, it was determined that some of these species are new to these areas. Among the reasons for this are the changes in the migration of fungi due to the global problems in nature.

Keywords: *Fruit plants, general mycobiota, phytopathogens, climatic factors*

INTRODUCTION

Climate change and food shortages remain serious threats only to people. Although climate change is generally a natural phenomenon, one of the factors causing the currently mentioned global climate change is the result of intensive human intervention in nature (greenhouses, automobile gases, factory waste, etc.) (Stern, 2006). Thus, as an example, it is enough to say what harmful effects on the human body are caused by harmful gases emitted into the atmosphere by cars in megacities and greenhouses used to grow fruits and vegetables to meet the population's needs for food products. However, climate change not only negatively affects people's health but also creates a number of economic (crop loss) and environmental problems (floods and floods). Although adverse climate change has different effects on different sectors, the most serious impact is felt in the agricultural sector, especially those related to crop production, due to waste disposal and rising temperatures. So, in the process of evolution, plants were constantly exposed to climate changes, which were related to the amount of CO_2 in the atmosphere and temperature (Franks et al., 2013; Hansen et al., 2010). According to some reports, the amount of CO_2 in the air was 0.018% ppm, since the last ice age, about 20 thousand years ago, but now it is 0.041%, and it is expected to increase to 0.051-0.1% by the end of the century. The average global temperature increased by 4.5^0C from that period to the first industrial revolution and after that, it increased by 0.8ºC until the present day. It is predicted that the temperature will rise by 1-3.7ºC by the end of our century (Ciais et al., 2013). For this reason, for a long time, the changes in the life of plants caused by the increase in temperature and CO_2 and the adaptation of their morphological and physiological characteristics to the mentioned changes have been the focus of research (Dusenge et al., 2017). According to the research conducted in this direction, experts note that a 2ºC increase in temperature can cause a 20-25% decrease in the

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productivity of some plants, primarily those used in agriculture (Gornall et al., 2010; Monaco, 2024). This is a significant loss of crop yield and its prevention is an issue that is currently of great concern to the scientific community and is an important problem that needs to be addressed. So, its occurrence leads to environmental, economic and social problems (Aragon et al., 2019). This situation is found not only in developing countries but also in developed countries. According to the assessment carried out on the climate change model, it is noted that in 2050 there could be a 15% yield loss in the production of corn in the United States, which means a financial loss of 6.7 billion dollars (Burke and Emerick, 2016; Carrraro, 2016).

It should be noted that when interacting with organisms belonging to different plant taxonomic groups (Monaco, 2024) depending on the nature of this relationship, various changes occur in the productivity of plants. The increase in temperature and the increase in the amount of CO_2 give additional nuances to the changes in these relations (Crous, 2019). Thus, microorganisms actively participate in the degradation and production processes occurring in nature, participate in the regulation of biodiversity in antagonistic relations with phytopathogens, and play an indispensable role in soil fertilization and productivity growth by establishing symbiotic relationships with plants. An increase in temperature or excessive humidity causes the destruction of these microorganisms and the creation of new microorganisms that will adapt to that environment, which does not pass without complications. The presence of floods, heavy rains, and sometimes, on the contrary, failure to irrigate agricultural fields despite extremely hot weather, leads to both crop loss and the reduction of microorganisms that are permanent inhabitants of agricultural fields, and the increase of those that are not characteristic for that region and the formation of various diseases in plants. Both the qualitative and quantitative indicators of the plant infected with the disease are low.

Like the rest of the world, Azerbaijan also has not escaped the negative consequences of climate change, such as heavy rainfall, drought, etc. Although these problems are not so serious in our country today, scientific measures must be taken in a timely manner to prevent negative situations that may arise in the future. At the Scientific Research Institute of Fruit and Tea Cultivation of the Ministry of Agriculture, in addition to fruit varieties belonging to folk selection, new varieties of fruits are grown, introduced from different countries and obtained through selection by local scientists, which is very important from the point of view of evaluating resistant varieties suitable for changing climate (Ağayeva, 2007; Sadıqov, 2023). One of the criteria used in the evaluation is the resistance of varieties to various diseases.

As it is known, fungi, bacteria and viruses are involved in the occurrence of diseases in plants (Nazarov et al., 2020), including fruit and berry plants. The diseases caused by fungi differ significantly from those of other groups both in number and in the amount of damage they cause (Fang et al., 2023). This has made a more comprehensive study of fungi an urgent task due to the elimination of difficulties caused by the impact of global problems. Taking this into account, the general mycobiota of various fruits cultivated in some regions of Azerbaijan, more precisely, dry subtropical fruit plants was set as a goal according to their species composition and the specific weight of phytopathogens.

MATERIALS AND METHODS

Researches were conducted in the Absheron-Khizi and Guba-Khachmaz economic regions of the Republic of Azerbaijan. For this purpose, samples were taken from the aerial parts of dry subtropical fruit plants cultivated in the mentioned areas and analyzed according to the species composition of the fungal biota (Barsukova et al., 2005). The species composition of the fungi was determined according to the classic mycological methods (Experimental Methods, 1982), and for this, it was carried out according to the cultural-morological and some physiological characteristics of the pure cultures of the fungi separated according to the known mycological methods in standard nutrient media (Suslo-agar, Saburo agar, Potato agar, etc.). Known determinants and atlases (Bondartseva, 1998; Crous et al., 2007; Dugan, 2017; Samson et al. 2010; Watanabe, 2002) were used to determine the species composition.

During the determination of the specific weight of the phytopathogenic species among the recorded fungi were used determinants (Horst, 2013) based on the symptoms of diseases caused by fungi as well as approaches used in the works of some authors (Crous et al., 2021).

RESULTS AND DISCUSSION

As a result of the fungal biota analysis of more than 250 samples taken from dry subtropical fruit plants during the research period, a total of 127 fungal species were found, their distribution on individual dry subtropical fruit plants is given in table 1.

As can be seen at first glance, the number of species involved in the formation of mycobiota of fruit plants differs from each other. For example, the pistachio plant is characterized by a relatively rich and the pomegranate by a low mycobiota. Fungi recorded on these or other plants are characterized by different indicators due to other aspects, namely the specific gravity of phytopathogens, ecotrophic relationships and manifestations of ecotrophic specialization. More precisely, each plant is characterized by a specific mycobiota in some sense, so the recorded fungi can be divided into 3 groups:

1. Those without substrate specificity, i.e. those found in the majority of plants studied (on average, more than 2/3 of the plants studied);
2. Those with relative substrate specificity, that is, those found in 20-50% of the studied plants;
3. Those with substrate specificity, i.e., those found in a particular plant species under study.

When characterizing the recorded fungi according to this distribution, as well as the number of phytopathogens involved in the formation of the general mycobiota, it is clear that the number of universals is greater than in other groups, and the number of specifics is relatively small, and this ratio is generally the same for all plants(tab. 2). As for the specific weight of phytopathogens, there is a difference between plants. So, although the total weight of phytopathogens is 55.1% of registered fungi, the specific weight of phytopathogens involved in the formation of mycobiota of this or that plant varies from 51.9-65.6% and in this regard, the highest index belongs to *Elaeagnus angustifolia* L. (32/21=65.6%) and the lowest index belongs to *Ziziphus jujuba* Mill. (27/14=51.9%).

Table 1. Quantitative characterization of the fungi recorded during the research

Plant species	The number of recorded species	The share of recorded total fungi, %
Elaeagnus angustifolia L.	32	25.2
Pistacia vera L.	38	29.9
Prunus dulcis Mill.	31	29.1
Punica granatum L.	23	18.1
Ficus carica L.	35	27.6
Olea europaea L.	29	22.8
Ziziphus jujuba Mill.	27	21.3
Total number of fungi recorded	127	100

Table 2. Quantitative characteristics of fungi recorded according to their relation to the substrate, specific gravity of phytopathogens

Plant species	The number of species according to their relation to the substrate			The number of phytopathogens
	Universals	Relative substrate specificity	Those with substrate specificity	
Elaeagnus angustifolia L.	17	12	3	21
Pistacia vera L.	19	14	5	23
Prunus dulcis Mill.	14	13	4	18
Punica granatum L.	12	9	2	12
Ficus carica L.	17	14	4	22
Olea europaea L.	14	10	5	19

Ziziphus jujuba Mill.	15	9	3	14
Total number of fungi recorded	61	42	24	70

A B

Fig. 1. Macroscopic (A) and microscopic (x960, B) view of the colony of the fungus *Alternaria pruni* isolated from *Pistacia vera*.

A B C

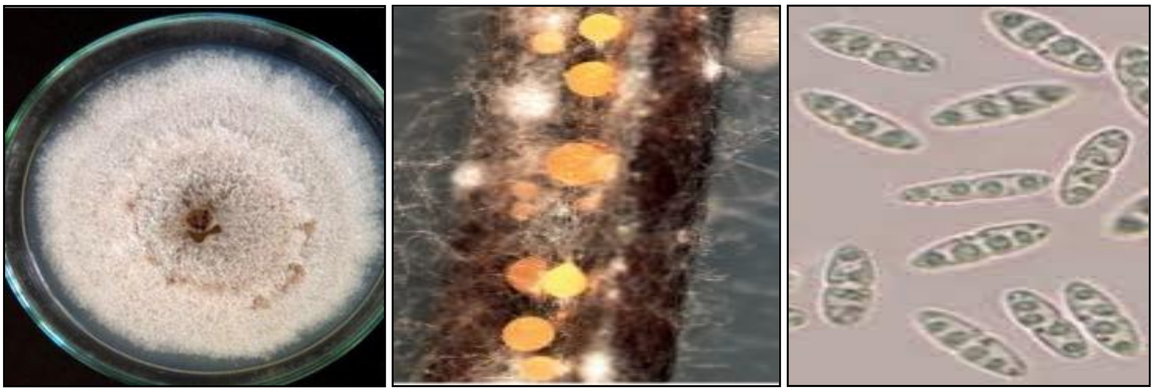

Fig. 2. Macroscopic (A, B) and microscopic (x960, C) view of the colony of the fungi *Diaporthe elaeagni* isolated from *Elaeagnus angustifolia*.

A B C

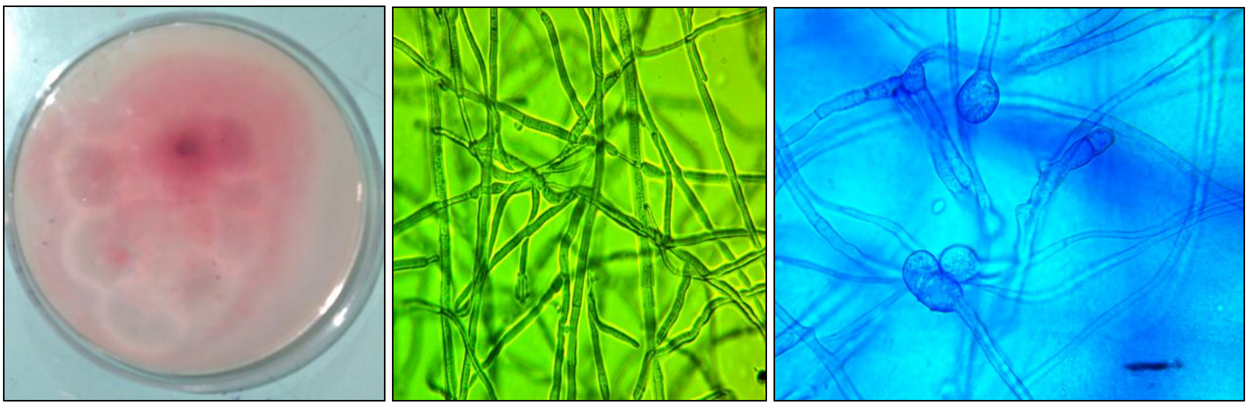

Fig. 3. Macroscopic (A) and microscopic (x960, B, C) view of the colony of the fungi *Fusarium equiseti* isolated from *Prunus dulcis.*

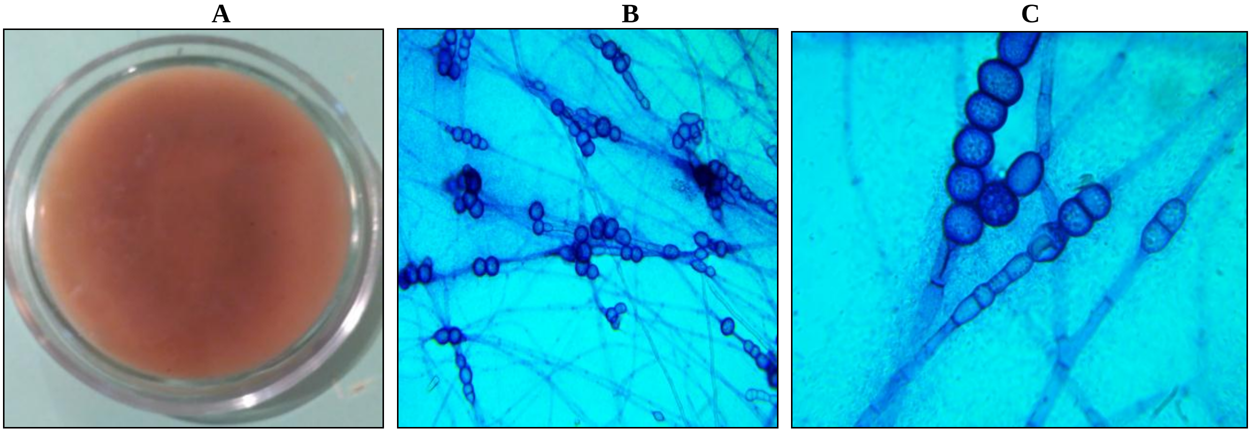

Fig. 4. Macroscopic (A) and microscopic (x960, B, C) view of the colony of the fungi *Fusarium xylarioides* isolated from *Punica granatum.*

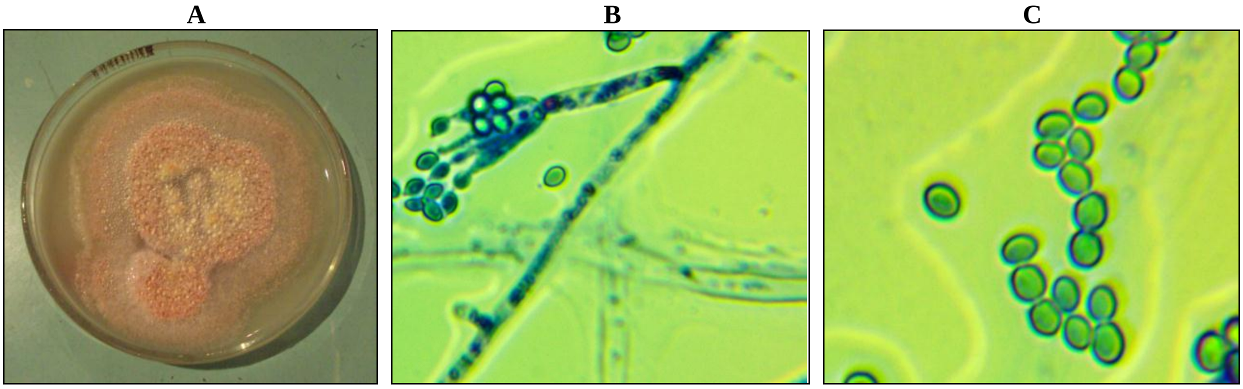

Fig. 5. Macroscopic (A) and microscopic (x960, B, C) view of the colony of the fungi *Paecilomyces lilacinus* isolated from *Ficus carica.*

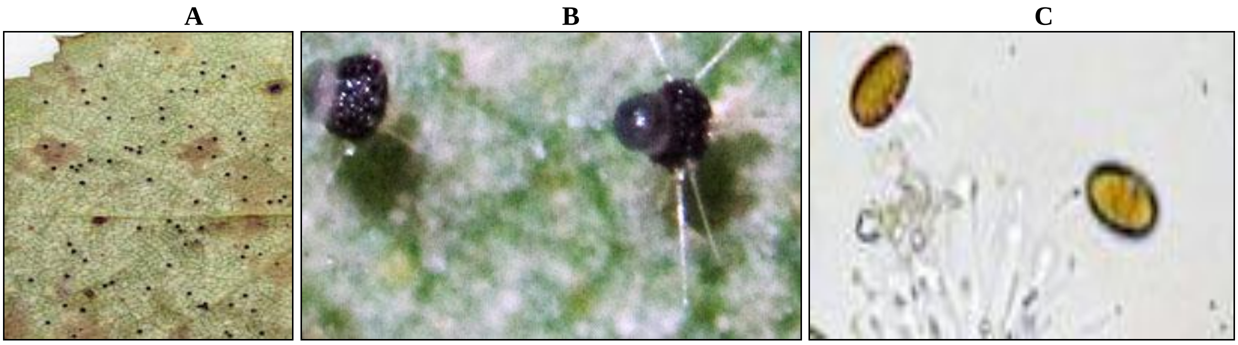

Fig. 6. General view of the observation form (A), sac (B) and ascospores (x960, C) on the leaf of the fungi *Phyllactinia acaciae* isolated from *Prunus dulcis.*

It should be noted that in the Republic of Azerbaijan, work on the comprehensive study of the mycobiota of dry subtropical fruit plants was carried out 17-20 years ago(Ağayeva, 2007). When we compare the fungi recorded during those studies with the fungi recorded during our research according to their species composition, it is clear that although there are no significant differences between the species involved in the formation of epiphytic mycobiota, certain differences are revealed in phytopathogenic species. This manifests itself in the fact that fungi, which have not been registered in this or that plant, gain a new host. For example, fungi such as *Alternaria pruni* (fig. 1), *Diaporthe elaeagni* (fig. 2), *Fusarium equiseti*(fig.3), *F.xylarioides*(fig. 4), *Paecilomyces lilacinus* (fig. 5), *Phyllactinia acaciae* (fig. 6), etc. recorded in the researched plants, were not found in previous studies. The climatic factor, more specifically climate change can be mentioned as the reason, but it would not be correct to unambiguously show the quantitative expression of the influence of this factor. Thus, global climate change affects not only plants but also living things that interact with them in various aspects, including fungi. The full clarification of its nature should be the task of future research.

Thus, the results obtained in the conducted research are important from the point of view of providing the country's population with quality fruits, increasing production, increasing the quantity and quality of exported products from an economic point of view, as well as correctly predicting what will happen in the following years against the background of climate change.

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