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Mycobiota of Orchards Cultivated in Azerbaijan and the İmpact of These Fungi on Physiological Processes in Plants

Abstract

In the conducted studies, a number of fruits distributed in the Greater Caucasus part of Azerbaijan were analyzed according to fungal microbiota. The majority of recorded fungi, more precisely 96.3%, belong to true fungi (Mycota or Fungi), and 3.7% belong to fungus-like organisms (Chromista). Most of the recorded true fungi, more precisely 67.0% (64.4% of total fungi) belong to Ascomycota, 26.0% (25.0%) to Basidiomycota, 6.8 % (6.5%) belongs to zygomycetes (Mycormycota). Parasitic fungi such as *Alternaria, Erysiphe, Puccinia, and Phytophthora* damage plant tissues by causing diseases such as powdery mildew, rust, and root rot, respectively, and cover the leaf surface by causing necrosis and spots on the leaves, destroying tissues, and thus reducing the photosynthetic capacity of the plant. Fungi of the genus *Fusarium and Phytophthora* damage plant roots, impairing water absorption by the roots, disrupting the water balance and causing wilting. Some fungi also disrupt the hormonal balance in plants by secreting hormones and toxins.

Keywords: *mycobiota, plant physiology, phytopathogenic fungi, prevalence rate, physiological processes*

Introduction

The territory of the Republic of Azerbaijan consists of ecosystems of different nature, and each ecosystem carries specific characteristics along with the general signs of the nature of Azerbaijan. It should be noted that, 8 of the 11 climate types are found in the not so large territory of the Republic of Azerbaijan. Such diversity has also influenced the flora of Azerbaijan and in the studies carried out so far, the distribution of about 5000 plant species has been determined in the territory of the Republic of Azerbaijan. The recorded plants are characterized by a wide diversity according to their taxonomic structure, life forms, purposes, resources, areas of use and other features (MycoBank).

It's no secret that plant-based products are an indispensable component of people's diet. Therefore, in the studies conducted in terms of providing the population with fruits, fresh vegetables and melon products, plant varieties with high productivity have been created, and currently they are widely used in the purchase of targeted products. Nevertheless, a certain part of the products obtained every year is lost due to various reasons, among the main reasons for this, diseases caused by various living things occupy an important place (Ellis, Ellis, 1987). It is no coincidence that today there are extensive researches on its prevention all over the world, and today this issue is one of the tasks that cannot be solved within any specific country. Thus, the role of the border factor in the spread of diseases caused by microorganisms is not so great. sing microorganisms in various groups of plants are also being studied (Bakshaliyeva, Babashlı, Yusifova, 2021).

Research

Among these types of diseases, those caused by fungi are of particular importance, at least because the loss of yield during the epiphytoty of a disease caused by this or that fungi is sufficient, and sometimes even results in this product being completely useless. In general, it is estimated that at least 10% of the world's crop production is lost due to fungal diseases, which is expressed in millions of tons (Savary, Willocquet, Pethybridge, 2019). In addition to these negative effects that manifest against the background of various diseases, fungi also have properties that stimulate physiological processes in the plant body and have a positive effect on plant development.

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Therefore, the purpose of the presented work is to study the species composition of the mycobiota of fruits cultivated in Azerbaijani conditions and to investigate the changes occurring in the physiological processes of these fungi in the plant organism (Chatterjee, Kuang, Splivallo, 2016).

Material and methods

Research has been conducted since 2021 in various economic regions of the Republic of Azerbaijan. For this purpose, samples were taken from the vegetative and generative organs of fruit plants cultivated in the mentioned areas and were analyzed according to the set goal. In taking samples, were used methods of selecting permanent areas for planned route and stationary observations, which are widely used in the course of mycological research (Bilay, 1982). In total, more than 1050 samples were taken and analyzed during the research. For the taking fungi to the pure culture were used standard nutrient mediums - Suslo agar, Saburo agar, Potato agar and agarized Chapek medium. The media were prepared, sterilized and poured into Petri dishes according to known methods (Bilay, 1982). A sample suspected of having a fungi is transferred to a nutrient medium and placed in a thermostat (260 ^{0} C) for a certain period of time (up to 10 days) until a colony is formed. After a colony or clump of mycelium is formed, it is re-inoculated into a clean medium for visual purity, and this process is continued until a pure culture is obtained. The purity of the culture is monitored with the help of a microscope (Semenkova, Sokolova, 2003). During the whole process, the day of colony formation, shape, color, color of the back side, smell, shape of mycelia, formation of conidia and other derivatives and changes in their shapes, sizes, etc. are recorded, and identification of mushrooms is carried out based on the determinants (Khokhryakov, Dobrozrakova, Stepanov, Letova, 2003) drawn up on the basis of cultural morphological and physiological characteristics. The impact of fungi on physiological processes in plants was determined by clarifying observations made in studies and literature data (Fernando, 2012).

Results and discussion

From the result of the analysis of samples taken from fruit plants cultivated in different areas of Azerbaijan, became clear that the number of fungi distributed in the studied plants is equal to 216. The majority of recorded fungi, more precisely 96.3%, belong to true fungi (Mycota or Fungi), and a small number (3.7%) belong to fungus-like organisms (Chromista). Most of the recorded true fungi, more precisely 67.0% (64.4% of total fungi) belong to Ascomycota, 26.0% (25.0%) to Basidiomycota, 6.8 % (6.5%) belongs to zygomycetes (Mycormycota) (Sutton, Fothergill, Rinaldi, 2001). Among the recorded fungi, a number of genera participate in the formation of the mycobiota of the studied cultivated plants with a number of 10 or more species, here includs genera *Alternaria, Aschochyta, Aspergillus, Colletotrichum, Fusarium, Pencillium, Rhizopus, Septoria, Trichoderma, Verticillium* (Jain, Sarsaiya, Wu, Lu, Shi, 2019).

The fungi recorded in the studies differed from each other in terms of their ecotrophic relationship to the fruits studied. Thus, among the recorded fungi, both true biotrophs (*A. alternata, A. mellea, Asc. fagi, A. niger, A. versicolor, Botrytis cinerea, E. communis, E. deformans, E. amygdale, F. fomentarius, G. confusum, T. discolor, T. pruni-spinosae and U. salviae*) and polytrophs (*C. puteana, F. annosa, F. cyticinia, F. pinicola, G. lipinse, Ph. igniarus, P. ostreatus, Sch. commune, T. hirsuta and T. versicolor*), that is, those that do not have a true saprotrophic and biotrophic nature, were found. These fungi are mainly universal in terms of the nature of the pathology they cause in the studied plants, since the pathologies of the same name they cause are recorded in several or all of the plants (Levitin, Tyuterev, 2003; Din, Van Kan, Pretorius, 2012).

The fungi recorded during the research caused various pathologies in plants. Species belonging to the genera *Alternaria, Ascochyta, Botrytis, Fusarium, Phoma, Puccina, Septoria, Urocystis, Uromyces, Verticellium*, etc. caused mold, rust, wilting, black and brown spots, rot, powdery mildew, etc. in plants, causing serious changes in both their morphological and biochemical indicators. Many of the mentioned fungi have the ability to synthesize biologically active substances such as phytohormones or mycotoxins as secondary metabolites as a result of their life activities (Li, Gu, Wu, 2017; Methods of Experimental Mycology / Under ed. Bilay, 1982).

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Fungi can affect physiological processes in plants in a variety of ways. These effects include both negative effects that weaken plant health and positive effects that support growth and development. Negative effects can manifest in the form of parasitism, mycotoxin secretion, infection, and spread. For example, parasitic fungi such as *Alternaria, Erysiphe, Puccinia, and Phytophthora* damage plant tissues by causing diseases such as powdery mildew, rust, and root rot, respectively, and cover the leaf surface by causing necrosis and spots on the leaves, destroying tissues, and thus reducing the photosynthetic capacity of the plant. At the same time, it limits the supply of oxygen to the plant and weakens energy production (Marin-Menguiano, Morenosanchez, Barrales, 2019). Fungi of the genus *Fusarium and Phytophthora* damage plant roots, impairing water absorption by the roots, disrupting the water balance and causing wilting. Some fungi also disrupt the hormonal balance in plants by secreting hormones and toxins. The hormone gibberellin, produced by the fungus *Gibberella*, causes abnormal growth of plant tissues. Toxins produced by fungi of the *Alternaria* genus increase the amount of abscisic acid, leading to premature leaf drop. Aspergillus species secrete a variety of mycotoxins, including aflatoxins, ochratoxins, and sterigmatocystin, which cause oxidative stress in leaves, damaging the structure of chloroplasts, and inhibiting electron transfer in Photosystem II (PSII), which reduces the conversion of light energy to chemical energy. This process is observed by the oxidation and inactivation of proteins, especially in PSII (Dance, 2017). Aspergillus toxins direct plant resources to defense mechanisms. This reduces the energy and nutrients available for photosynthesis and other metabolic processes (Muradov, Shirinova, Asgerli, 2019).

Conclusion

The positive effects of fungi on plant organisms have also been widely studied. Mycorrhizal and symbiotic fungi stimulate the absorption of nitrogen, phosphorus, water, and other minerals in the soil by plant roots. Beneficial fungi stimulate the production of plant hormones (auxin, cytokinin), which accelerate the growth of roots and shoots. They also decompose dead plant and animal remains, enriching the soil with nutrients that can be absorbed by plants. Fungi also participate in the fight against harmful microorganisms. For example, fungi of the genus *Trichoderma* protect plant roots from harmful bacteria. Fungi such as *Trichoderma* make plants more resistant to biotic and abiotic stresses. They protect plant cells from harmful effects by activating antioxidant defense mechanisms.

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