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Research Article

Spread of Fungal Powdery Mildew and Rust Diseases among Large Plants in the Denov Arboretum - a Case Study in the Surkhandarya Region of Uzbekistan

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Abstract

Present study reports on the spread of 142 different Micromycetes infecting 125 large plant species preserved in southern Uzbekistan. Over 22 among those belonging to 16 families and 19 genera were found to be susceptible to powdery mildew (Erysiphe spp.) caused by 21 species and 4 forms of those fungi. We have observed their distribution chiefly among the following plant families: Rosaceae-3 species, Oleaceae-2, Salicaceae-2, Fagaceae-1, Juglandaceae-2, Sapindaceae-1, Ulmaceae-1, Fabaceae-2, Convolvulaceae-1, Platanaceae-1, Polygonaceae-1, Moraceae-1, Vitaceae-1, Bignoniaceae-1 and Grossulariaceae-1. We also noticed the spread of this fungal genus to some other fruit and ornamental plants, prominently including Vitis vinifera, Quercus robur, Robinia pseudoacacia. and Platanus orientalis, found to be highly susceptible with powdery mildew.

From the results of our research, 8 species of rust causing Micromycetes fungi were also detected infesting the tall plants of the Denov Arboretum, damaging 5 different types of higher plants belonging to 3 families and 4 genera in the Arboretum. Consequent to this study, we have recommended appropriate control measures, including application of the fungicide "Score 250 EC" (difenoconazole) 0.15-0.2 L/ha, for effective (77.4-89.9%) prevention of damage and subsequent spread.

Keywords: *Micromycetes, powdery mildew, fungal rust, Arboretum.*

Introduction

The Denov Arboretum established in 1935, represents major fauna in the territory of Denov District of Surkhandarya, the southernmost tip of Uzbekistan bordering Tajikistan and Afghanistan. It covers 16.92 hectares of land and consists of perennial groves that are home to a unique Ecopark, as also to an *in vitro* laboratory. In this Arboretum, notably more than a thousand species and varieties of plants have been introduced from Russia, the Mediterranean countries, Australia, Asia Minor, China, Japan, Black Sea bogs and the Caucasus, Tajikistan, Turkmenistan, Azerbaijan Republics and India, Pakistan, the states of Afghanistan, Cuba and other countries. Currently, the Arboretum totaling about 3500 native and exotic plant species, includes about 1,000 pine trees and about 500 other types of precious ornamental trees, thereby preserving more than 130 diverse and unique plant species.

Following our ecological investigation about a decade ago (Sadikova *et al.*, (2022, 2024), we have initated taxonomic and analyses of Micromycetes and other pathogenic agents prevalent at the Denov Arboretum. The present report elaborates the results of further investigation comprising critical diseases, aiming to device specific preventive measures against the most destructive among the various pathogens identified in the region, quantifying the degree of their widespread infections.

Economic Importance of Fungal Diseases

As pointed out in a recent study conducted elsewhere in Uzbekistan by Sherimbetov and Djumaniyozova (2016), collection of microorganisms is essential for improvement in disease diagnosis, and development of bacterial antagonists intended for biocontrol and protection of plants. Thorough study on phenotypic properties, including pathogenicity, virulence, and genetic diversity of the essential cultures, is therefore necessary for identification of disease resistant farm crops breeds and lines.

Fungi are heterotrophic organisms that do not absorb organic substances independently. According to K.V. Popkova *et al.* (2005), through the effect of phytopathogenic species on the host plant are divided into bio and necrotrophs. While biotrophs sustain their hosts to extract nutrients over time, the necrotrophs kill host cells to feed on the dead tissue. About 300,000 species of flowering plants are globally infested by pathogenic fungi. The manifestation of the observed disease symptoms indicates that they are biotrophs or necrotrophs (Kirk *et al.*, 2008). The biotrophic feeding parasite is adapted equally well to inhabit living plant tissues. As a result of evolution, high levels of specialization among such phytopathogenic fungi with preference for certain plant species and different levels of specialization in plant-fungi interactions can be observed (Seifbarghi, *et al.*, 2009). Absorbing nutrients from living plant tissues until a certain stage of its development, they do little or no harm to the host plant. Only at the last stage of mycelial development and before spore formation, they show obvious parasitism and kill select plant tissues. Interestingly so, a single plant species can be the host plant for only a few fungal species, and similarly, most fungi generally have a limited host range.

In plants, powdery mildew is caused by fungi belonging to the division *Ascomycota*, order *Erysiphales*, family *Erysiphaceae*, as they damage leaves, stems, branches, and fruits of the host plant. Initially, on the surface of the affected organs (mostly leaves) of the infected plant, a smooth, mesh-like mold layer (mycelium of the fungus) appears. Later, because of advanced development of the disease, the leaf surface is completely covered with the mold.

Symptoms and Pattern of Infection

The disease is most common on the upper leaves of the plant, but it also affects the lower part of the leaves, young shoots and stems, flowers, and young fruits. Powdery mildew diseases are always present and very common among cultivated and ornamental plants. They affect the development and productivity of the crop plants. A large part of the total annual loss of all crops is due to powdery mildew, which rarely kills the host plant. On the contrary, it uses their nutrients, reduces photosynthesis, increases respiration and transpiration, slows down plant growth and reduces yield. After a certain time, fruiting bodies of the fungus (*Cleistotetsia*) in the form of small black dots develop on the mold layer. *Cleistothecs* play a key role in wintering and reproduction of the fungus.

Rust diseases in plants are caused by fungi belonging to the order *Pucciniales.* Fungi of the order *Pucciniales* (Fungi, *Basidiomycota*, *Pucciniomycotina*) represent the largest group of plant pathogens. They are characterized by orange, brown or reddish spore masses that appear on the surface of host plant tissues. Rust fungi are obligate biotrophs, which are completely dependent on living cells to complete their vital developmental stages. Rust fungi are highly specialized pathogens with a generally narrow host plant range, so they share a common evolutionary history with their host plants. Rust fungi can infect most plant families, including conifers, ferns, and mosses, and are major crop and forest plant diseases worldwide.

Materials and methods. Herbarium samples were collected to study the species composition of Micromycetes found in higher plants, elucidating the distribution of disease-causing pathogens. Special attention was paid to pathogenic fungi, and the symptoms of diseases caused by them, their development and damage levels on host plants were studied. The degree of damage to diseased plants was determined on a 5-point scale or percentage following Costa *et al*. (2019).

0 point - healthy plant
1 - 10% infected plant
2 - 11-25% infected plant
3 - 26-50% infected plant
4 - more than 50% infected plant

Results and discussion

Based on mycological analysis of herbarium samples and study in laboratory conditions, 143 species and 4 forms of Micromycete species belonging to 3 sections, 9 classes, 17 orders, 34 families, 56 genera were identified (Table 1). From the analysis of micromycetes detected amongst the higher plants of the Denov Arboretum, 124 types were found to be parasitic Micromycetes, accounting for 86.7% of the total detected fungi, while 19 types were saprotrophs, accounting for 13.3%.

Scoring Flour-dew (Powdery mildew) disease

Typical symptoms of powdery mildew were recorded, which is a common, easily visible, widespread and easily recognizable plant disease. As obligate biotrophs, powdery mildew fungi receive nutrients from living plant cells through special feeding organs - haustoria. Powdery mildew fungi have developed efficient stealth methods of nutrition and pathogenesis, defense mechanisms that neutralize host plant defenses, or efficient methods of defense signaling [2].

Results and Discussion

During our study, we identified 21 species and 4 forms of fungi that chiefly cause powdery mildew in tall plants of the Denov Arboretum.

Table 1. Taxonomic analysis of Micromycetes of higher plants of the Denov Arboretum

Phylum	Taxa number					
	Class	Order	Family	Genus	Specific Epithet	Form
Ascomycota	5	1 3	28	4 7	125	4
Basidiomycota	3	3	5	7	16	
Oomycota	1	1	1	2	2	
Total	9	17	34	56	143	

These infected 22 species of higher plants belonged to 16 families and 19 genera in the arboretum [3], as follows. *Rosaceae-3 species, Oleaceae-2, Salicaceae-2, Fagaceae-1, Juglandaceae-2, Sapindaceae-1, Ulmaceae-1, Fabaceae-2, Convolvulaceae-1, Platanaceae-1, Polygonaceae-1, Moraceae-1, Vitaceae-1, Bignoniaceae-1, and Grossulariaceae-1.* It was found that the 21 fungal species damage host plants in different degrees. The highest indicator on a 5-point scale damage scored up to 4 points in *Vitis vinifera, Quercus robur L., Robinia pseudoacacia L. and Platanus orientalis L.* (Image 1).

Image 1: *Sawadaea bicornis* infested with fungi *Acer pubescens*

Fungal Rust Disease

Leaves, branches, stems, flowers and fruits of many of the scored plants were also found to be affected by fungal rust disease. The specific symptoms of this disease are the appearance of brown, yellow-reddish pads that break the epidermis in the tissues of the infected plant. From the results of our research, 8 species of rust fungi were also identified from the tall plants of the Denov Arboretum. It was found that these fungi damage 5 types of higher plants belonging to 3 families and 4 genera in the arboretum, as follows: *Salicaceae* - 3 species, *Rosaceae* - 1, and *Malvaceae* - 1. It was noted that these identified species damage tall plants to different degrees. The highest indicator on a 5-point scale was 4 points in *Populus bollea*na Mast., *Salix alba* L., *Rosa canina* L. plants.

Consequent to this study, we have recommended specific control measures to eradicate and prevent Micromycetes infection agents that we have identified. Chiefly those measures include application of the fungicide "*Score 250 EC*" (difenoconazole) 0.15-0.2 L/ha, which effectively prevented the development of the disease by 77.4-89.9%.

Conclusion

The present collection of plant species at the Denov Arboretum represents a treasure house of native and rare plant species known to possess considerable medicinal and ornamental value. Through this first of its own kind study, we have launched the effort to quantify the damage caused by the most predominant fungal diseases and recommend effective and immediate control measures, aiming at long-term preservation.

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