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Bud and Leaf Diseases of Some Woody Plants in Some Private and Public Nurseries of Istanbul

Zeki SEVEROGLU

Marmara University, Faculty of Arts and Science, Biology Department, Istanbul, Turkey

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Abstract
This study was carried out between the years 2007-2008 and 2017-2018, embraces a number private and public nurseries including those in the Municipality of Istanbul and some of the local administrations, as well as administered by the Ministry of Forestry. 91 types of infectious disease factors have been determined in the nurseries. The study, conducted in four seasons, has revealed various plant diseases such as anthracnose, fungus blight, corrosion and decomposition, respectively. Despite being few in numbers, five different diseases related to 11 bacteria and three types of virus were also seen. Besides the infectious diseases, 5 types of non-infectious diseases on 11 plants were discovered.

Keywords: Plant disease, Bacteria, Fungus, Istanbul.

İstanbul'un Bazı Özel ve Halk Fidanlıklarındaki Bazı Odunsu Bitkilerin Dal ve Yaprak Hastalıkları

Öz
Bu çalışma, 2007-2008 ve 2017-2018 yılları arasında İstanbul Belediyesi ve Orman Bakanlığı tarafından yönetilen özel ve halk fidanlıklarında yürütülmüştür. Fidanlıklarda 91 bulaşıcı hastalık etmeni tespit edilmiştir. Dört mevsim boyunca yürütülen çalışma antraknoz, mantar yanıklığı, korozyon ve çürüme gibi çeşitli bitki hastalıklarının varlığını ortaya çıkarmıştır. Sayıları az olmasına rağmen 11 bakteri ile ilişkili beş farklı hastalık ve üç tip virus de görülmüştür. Bulaşıcı hastalıkların yanında 11 bitkide bulaşıcı olmayan beş hastalık tipi ortaya konmuştur.

Anahtar Kelimeler: Bitki hastalığı, Bakteri, Mantar, İstanbul

1. Introduction

Plants, through their ability to fix carbon dioxide by photosynthesis, are the primary producers of the food that feeds the world's population as well as the many animals and other organisms that are heterotrophic for carbon compounds (Strange, 2003). Plants, whether cultivated or wild, grow and produce well as long as the soil provides them with sufficient nutrients and moisture, sufficient light reaches their leaves, and the temperature remains within a certain "normal" range (Agrios, 2005). All those features above make plants favourable hosts for many organisms, especially harmful for the plant kingdom (parasitic mode of life). It is known that, 11 groups of organisms cause plant disease: parasitic angiosperms, fungi, nematodes, algae, Oomycetes, Plasmodiophoromycetes, trypanosomatids, bacteria, phytoplasmas, viruses and viroids (Strange, 2003). Not only the biotic factors, but also some environmental factors cause disease in plants, such as drought, temperature, moisture, mineral nutrients, salinity, heavy metals, herbicides and

*Correspondence to: zseveroglu@marmara.edu.tr

pollutants (Rakhmankulova et al., 2001; Jansen et al., 2004; Sekmen et al., 2004; Efeoglu and Terzioglu, 2007; Worku and Astatkie, 2010; Ahemad and Khan, 2010). However, all those biotic and abiotic factors could be tolerated by some plants above or below a certain range.

The enormous diversity of pathogenic interactions between fungi and plants is reflected by the establishment of parasitic interactions in the Lower Devonian (400 million years ago) (Agrios, 2005; Horbach et al., 2011). Fungal diseases cause more economic damage (catastrophic harvest failures) than any other group of microorganisms, with annual losses estimated at more than 200 billion $US especially, in crop plants (Kamoun, 2001; Birren et al., 2002). Fungal plant pathogens are many and diverse and occur in most taxonomic groups. While most plant pathogens are necrotrophs, which kill plant tissues for their nutrition, only a few are obligate parasites (biotrophs) such as rusts (Uredinales) and powdery and downy mildews (Erysiphaceae and Peronosporaceae), which obtain their nutrition directly from living plant tissue (Waller et al., 2002). A wide variety of fungi, ranging Ascomycetes to Deuteromycetes and Phycomycetes, are responsible for the majority of foliage plants diseases (Chase, 1987).

Bacteria are ubiquitous and physiologically diverse; those that are found in association with plants exist as epiphytes, endophytes and pathogens (Kado, 1982; Sigee, 1993). All bacterial phytopathogens described to date fall within the Domain Bacteria (formerly known as the Eubacteria) (Waller et al., 2002). Bacteria causing plant disease were originally classified in five genera - the Gram-positive Corynebacterium and the Gram-negative Agrobacterium, Erwinia, Pseudomonas and Xanthomonas - but to these must be added the Actinomycetes. In the last two decades the classification has begun to be extensively revised. For example, the plant pathogenic coryneform bacteria are generally classified in the genera Curtobacterium, Arthrobacter, Rhodococcus and Clavibacter although some authors still retain the old nomenclature (Davis, 1986; Strange, 2003).

When fungal mycelia and spores, or bacteria, are present on the affected area of a diseased plant, they may be the actual cause of the disease or may be one of the many saprophytic fungi or bacteria that can grow on dead plant tissue once the latter has been killed by some other cause, possibly by even other fungi or bacteria (Agrios, 2005). Some of the fungal diseases emerges only after seedling and tree wounds despite being present (Severoğlu et al., 2017)

Viruses are obligate parasites of submicroscopic size and consist of segments of double or single-stranded RNA or DNA encased in protein structures, in some cases with lipid and additional substances (Waller et al., 2002). There are over 700 known plant viruses, many of which cause catastrophic diseases and have wide host ranges. They have been classified into three families and 32 groups (Martelli, 1986). Most plant viruses have single-stranded RNA genomes in nature, serious disease symptoms normally occur only when a virus has invaded the host plant systemically. The ‘local lesions’ frequently seen following experimental inoculation of the leaves of test plants have little impact on growth or yield. Virus infection disturbs host cell metabolism; commonly occurring changes include a decrease in photosynthesis, an increased respiration rate, higher phenol oxidase activity, and frequently the abnormal accumulation of metabolic products. As it is known, phenolics are mainly important mechanisms of plants against pathogen infection. Visible symptoms vary with the interaction of the particular strain of the virus and the genotype of the host plant, and may

be modified by environmental conditions (Waller et al., 2002).

Leaf or foliar diseases occur in most species of landscape trees and shrubs. The main foliar disease problems of trees and shrubs are commonly known as: powdery mildews, rusts, scabs and spots, blotches, blights, or anthracnose, blisters or curls, needle casts, sooty molds and galls (Beckerman, 2009).

2. Materials and Methods

2.1. Study Area

This study was carried out in some private and public nurseries of Istanbul Metropolitan Municipality. Istanbul located in the north-west part of Turkey (41° 01.2' N, 28° 58.2' E) is one of the most populated cities of Eurasia and is Turkey's cultural and financial center. It extends both on European (Thrace) and Asian (Anatolia) sides of Bosphorus, therefore the only metropolis in the world, which is situated on two continents (Kaya and Curran, 2006; Altay et al. 2010; Osma et al., 2010). Istanbul having approximately 5,100 km2 land area and the highest population density (15,029,231) shows a continuing fastest population increase in Turkey. In addition to its rich history, high population and productive economy, Istanbul also has unique variety of ecological features (Altay et al., 2010)

The main topographic structure of Istanbul is to be having a low plateau at 100-200 m elevation rate. The geological structure of Istanbul comprises the formations originated from the Silurian, Devonian, Carboniferous and Tertiary ages. There are different kinds of rocks and structures consisting of granitic plutons, quartzes, greywackes, clayed schists and radiolarites (Yaltirik et al., 1997). Although many different soil types are present in Istanbul, the brown forest soil covers the largest area followed by the non-calcareous brown soil as the second, suitable for plants. The rendzinas mostly were found on the European Side of the city. The alluvial soil type also are seen in Istanbul (Altay et al., 2010, Yaltirik et al., 1997).

Istanbul is in a kind of transition zone between less rainy Mediterranean and Oceanic climates. Less precipitation and high temperature are usually observed in the summer. The annual mean temperature was measured as 14.5 ^{o}C in last two decades. Between May and September, the temperature is generally above 30 oC and between November and April; it is rarely below 0 ^{o}C. In the vegetation period, the daily mean temperature is approximately 8 oC and this period is about 280 days (between 15 March and 20 December).

The total precipitation for Istanbul averages 640 mm per year and 40% of the total precipitation falls in winter. December and January are the most precipitated months. The precipitation ratio in summer is more than the typical Mediterranean stations hence; this characteristic is related with the Oceanic climate. The minimal rain falls in July and August and its ratio is about 8%. Precipitation is less in spring (about 20-21%), while it increases in autumn (about 28-29%). Additionally, snow rarely falls in Istanbul. The rain regime is Winter-Autumn-Spring-Summer (W. A. Sp. Su) and the rain type is “Central Mediterranean Rain Type” The relative humidity is between 73-77% in the city and these values decrease to 65-68% in summer despite the effect of the seas. The lower relative humidity, especially in the dry period, forms the xerophytic vegetation. The dominant wind in the city is the North-east originated wind (Altay et al., 2010; Akman, 1990).

2.2. Sample Collection and Preparation

The diseased bud and leaves of plant samples were the materials for this work. For the collection of the study materials, eight public nurseries controlled by Istanbul Metropolitan Municipality, and 22 private nurseries working for Municipality were visited in

both Asian and European sides of Istanbul and the plant samples having diseases were located and collected. Photographs were taken from the bud and leaves having diseases of the plant samples found in the nurseries and then they were put into sterile plastic bags. Later they were transported to Microbiology and Plant Diseases Laboratory in the Department of Biology at Marmara University.

2.3. Identification

A preliminary identification was made considering the general symptoms of different diseases and samples were separated as bacteria, virus, fungi and stress originated diseases. To verify this identification, diseased bud and leaves were isolated, scraped and cross sections were prepared from those parts and then searched by using OlympusCX-41stero microscopy and Imagine 5.0 Micropublisher. Some of the fungi were directly identified according to their mycelium and spores. Others were cultured on PDA-Potato Dextrose Agar and MEA-Malt Extrakt Agar (Merck) and then identified under the microscope according to the structure of their mycelium and spores. Morphology and Taxonomy of Fungi (Bessey, 1950), Dematiaceous Hyphomycetes (Ellis, 1971), British Ascomycetes (Dennis, 1978), Diseases and Pests of Ornamental Plants (Pirone, 1978) and Microfungi on Land Plants (Ellis and Ellis, 1997) used for identification.

For bacteria samples, Nutrient Agar, YDC-Yeast Dextrose Agar and King B media were used for inoculation. Purified bacteria were observed under microscope after proper staining (Simple, Gram and Spore staining). Essential biochemical tests were carried out as per standard methods (Collins and Lyne, 1984; Krieg and Holt, 1984; Sneath et al., 1986). For identification, characterized bacterial strains were compared with the standard strains of Bergey's Manual (Krieg and Holt, 1984; Sneath et al. 1986). The key proposed by Bradbury (1986) was also followed.

For viral and stress disease, identification was made according to the macroscopic changes on bud and leaves. For this purpose, Diseases and Pests of Ornamental Plants (Pirone, 1978), Diseses of Trees and Shrubs (Sinclair et al., 1987) and Diseases of ornamental plants (Sumer, 2008) were used.

3. Results

A total of 91 types of infectious disease factors have been determined in nurseries in addition to five types of non-infectious disease factors. Identified fungal disease factors are listed in Table 1, bacterial disease factors are listed in Table 2, viral disease factors are listed in Table 3 and non-infectious disease types are listed in Table 4. All disease factors are matched with its host plant in all tables.

Table 1. Fungal diseases.

FUNGAL DISEASES		
	Pathogen Organism	**Host Plant**
POWDERY MILDEW	*Microsphaera berberidis*	*Berberis thunbergii*
	Microsphaera berberidicola	*Berberis thunbergii*
	Microsphaera euonymi-japonici	*Euonymus japonicus*
	Microsphaera platani	*Platanus orientalis*
	Microsphaera alphitoides	*Quercus frainetto*
	Microsphaera alni var. *vaccinii*	*Catalpa bignonioides*
	Erysiphe lagerstromiae	*Lagerstroemia indica*
	Podosphaera leucotricha	*Malus sylvestris*
	Sphaerotheca pannosa var. *rosae*	*Rosa* sp.
	Uncinila necator	*Vitis vinifera*
	Phyllactinia corylea	*Acer platanoides*
	Phyllosticta platani	*Platanus occidentalis*
	Erysiphe convolvuli	*Convolvulus arvense*
	Erysiphe cichoracearum	*Buxus microphylla*
	Uncinila circinata	*Acer platanoides*
	Uncinila bicornis	*Acer negundo*
	Podosphaera sp.	*Cydonia oblonga*
DOWNY MILDEW	*Plasmopara viticola*	*Parthenocissus* sp.
		Vitis vinifera
ANTHRACNOSE	*Gnomonia platani (Gloeosporium nervisequum)*	*Platanus orientalis*
	Gnomonia veneta	*Acer negundo*
	Gloeosporium apocryptum	*Acer negundo*
	Gloeosporium nobile	*Laurus nobilis*
	Gloeosporium quercinum	*Quercus rubra*
	Gloeosporium berberidis	*Berberis thunbergii*
	Gloeosporium frigidum	*Euonymus* sp.
	Elsinoe parthenocissi	*Parthenocissus* sp.
	Septoria hippocastani	*Aesculus hippocastanum*
	Colletotrichum sp.	*Agave americana*
BROWN LEAF SPOT	*Gnomonia leptostyla (Marssonia juglandis)*	*Juglans regia*
	Gnomonia quercina	*Quercus frainetto*
LEAF SPOT	*Phyllosticta mahoniana*	*Mahonia aquifolium*
	Fabraea maculata	*Cotoneaster horizontalis*
	Phyllosticta hydrangeae	*Hydrangea macrophylla*
	Cercospora pittospori	*Pittosporum tobira*
	Cercosporella chionea	*Cercis siliquastrum*
	Cercospora neriella	*Nerium oleander*
	Cercospora circumscissa	*Laurocerasus officinalis*
	Sphaceloma viburni	*Viburnum tinus*
	Septoria hippocastani	*Aesculus hippocastanum*
	Mycosphaerella effigurata	*Fraxinus ornus*

	Alternaria catalpae	*Catalpa bignonioides*
	Leptosphaeria sp.	*Yucca filamentosa*
	Coniothyrium sp.	*Yucca filamentosa*
BLIGHT	*Botrytis cinerea*	*Camellia sinensis* *Rosa* sp. *Albizia julibrissin*
LEAF CURL	*Taphrina deformans*	*Prunus persica*
WILT	*Verticillium albo-atrum*	*Catalpa bignonioides*
	Fusarium nervisequum	*Juglans regia*
DIEBACK	*Melanconium juglandis*	*Juglans regia*
	Diplodia pinea	*Pinus pinea*
	Botryosphaeria dothidea	*Platanus occidentalis*
	Ceratocystis fimbriata var. *platani*	*Platanus acerifolia*
BLACK SPOT	*Diplocarpon rosae*	*Rosa* sp.
	Cercospora sp.	Lagerstroemia indica
LEAF BLISTER	*Taphrina sacchari*	*Acer saccharinum*
RUST	*Phragmidium mucronatum*	*Rosa* sp.
	Gymnosporangium clavarioforme	*Malus sylvestris*
	Gymnosporangium juniperi var. *virginiana*	*Cedrus libani*
	Gymnosporangium globosum	*Crataegus monogyna*
	Peridermium pini f. aecicola	*Pinus nigra*
	Melampsorella sp.	*Abies nordmanniana* subsp. *nordmanniana*
GALL	*Sphaeropsis tumefaciens*	*Nerium oleander*
SCAB	*Venturia inaequalis*	*Malus sylvestris*
	Fusicladium pyracantha	*Pyracantha coccinea*
CANKER STAIN	*Ceratocystis fimbriata* var. *platani*	*Platanus acerifolia*
WOOD-ROT DISEASE	*Schizophyllum commune*	*Prunus serrulata*

Fungi That Isolated From Fall Out By Kindly Leaf But Not Seen On Any Host

Ascotremella faginea	*Glomerella cingulata*
Alternaria alternata	*Lophodermium juniperinum*
Alternaria tenuissima	*Lophodermium pinastri*
Aspergillus niger	*Microsphaera penicillata*
Aspergilus fumigatus	*Monilinia fructigena*
Bispora antennata	*Monilinia laxa*
Bispora betulina	*Monilinia mespili*
Botrytis cinerea	*Mucor mucedo*
Cladosporium aecidiicola	*Pestalotia macrotricha*
Colletotrichum gloeosporioides	*Penicillium notatum*
Diaporthe carpini	*Rhizopus stolonifer*
Diplodia lonicera	*Tubercularia* sp.

Table 2. Bacterial Diseases.

BACTERIAL DISEASES		
	Pathogen Organism	**Host Plant**
BACTERIAL LEAF SPOT	*Pseudomonas savastanoi* var. *nerii*	*Nerium oleander*
	Xanthomonas campestris pv. *hederae*	*Hedera helix*
	Xanthomonas pruni	*Prunus laurocerasus*
	Pseudomonas syringae	*Rosa* sp.
		Syringa vulgaris
FIRE BLIGHT	*Erwinia amylovora*	*Pyracantha coccinea*
		Cotoneaster horizontalis
		Chaenomeles sp.
BACTERIAL WILT	*Pseudomonas solanacearum*	*Hydrangea macrophylla*
	Pseudomonas savastanoi	*Prunus cerasifera*
	Pseudomonas savastanoi var. *nerii*	*Nerium oleander*
	Pseudomonas aceris	*Acer platanoides*
SHOT HOLE	*Xanthomonas pruni*	*Prunus cerasifera*
		Prunus serrulata
CROWN GAL	*Agrobacterium tumefaciens*	*Forsythia* sp.

Table 3. Viral Diseases.

VIRAL DISEASES	
Pathogen Organism	**Host Plant**
Mosaic virus	*Rosa* sp.
Yellow mottle virus	*Camellia sinensis*
Apple mosaic virus	*Malus sylvestris*

Table 4. Non-Infectious Diseases.

Stress	**Host plant**
Drought Stress (Lack of Water)	*Albizia julibrissin*
	Acer palmatum
	Pittosporum tobira
	Tilia platyphyllos
	Robinia pseudoacacia
Extreme Soil Ph	*Camellia sinensis*
	Magnolia grandiflora
Fasciation	*Berberis thunbergii*
High Light	*Hydrangea macrophylla*
Die-back	*Fraxinus excelsior*
	Pyracantha coccinea

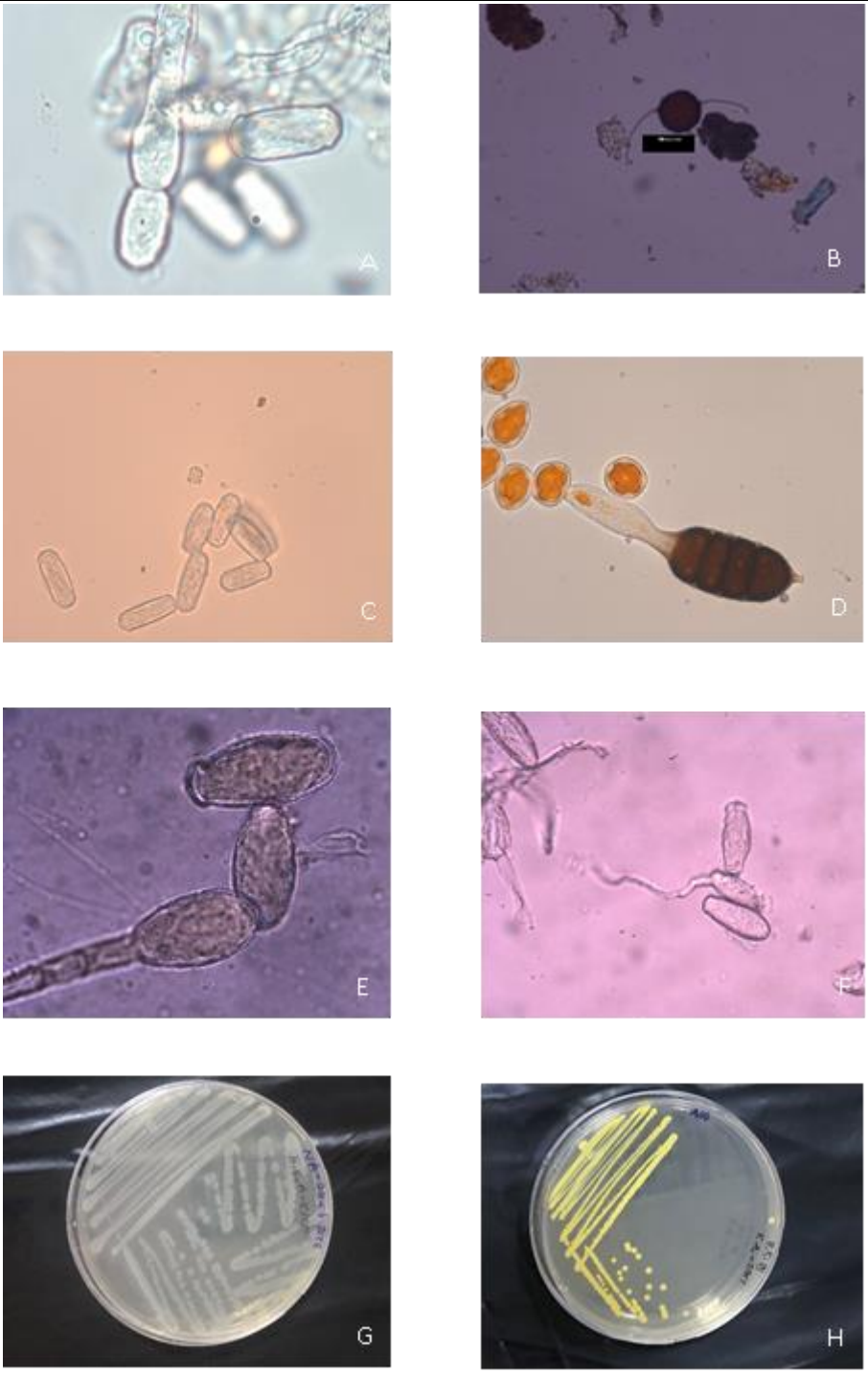

Figure 1. Microscope images of disease factors A. *Sphaerotheca pannosa* var. *rosae oidiospores* on *Rosa* sp. leaf B. *Microsphaera alni* on *Catalpa bignonioides* leaf C. *Eryspihe lagerstromiae oidiospores* on *Lagerstromia indica* leaf D. *Phragmidium mucronatum* urediniospores on *Rosa sp.* leaf E. *Phragmidium sp. mycelia* and *spores* F. Germination of *Phragmidium sp. oidium* G. *Xanthomonas sp*. in nutrient agar H. *Pseudomonas sp*. in nutrient agar

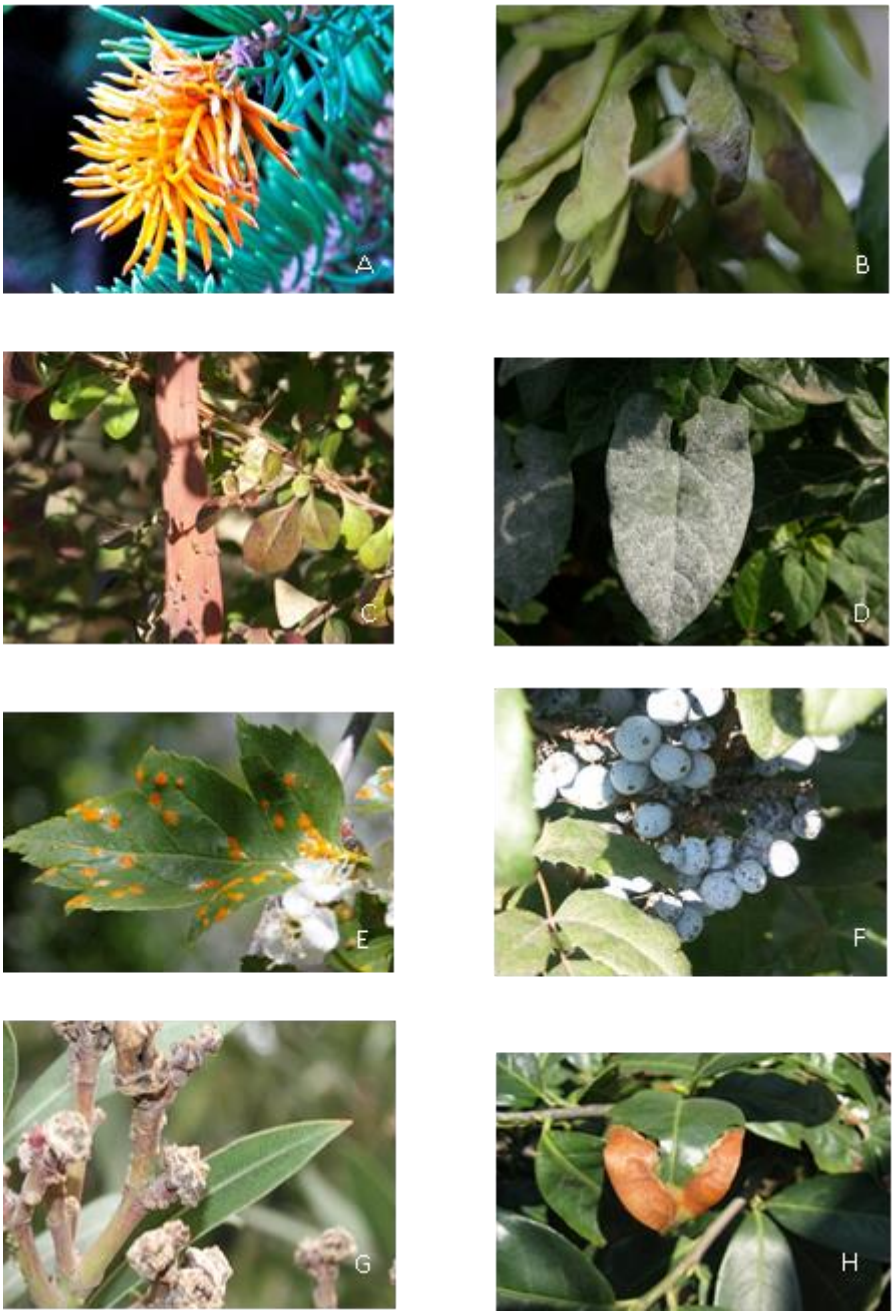

Figure 2. Fungal diseases on plant parts A. *Melampsorella sp*. on *Abies nordmanniana* subsp. *nordmanniana* shoot B. *Uncinila bicornis* on *Acer negundo* fruit C. Fasciation on *Berberis thunbergii* D. *Erysiphe convolvuli* spores and mycelia on *Convolvulus arvense* shoot E. *Gymnosporangium globosum* on *Crataegus monogyna* leaf F. *Erysiphe berberidis* on *Mahonia aquifolium* fruit G. *Pseudomonas savastonoi* var. *neri* on *Nerium oleander* shoot H. *Cercospora circumcissa* on *Laurocerasus officinalis* leaf.

Figure 3. Fungal diseases on plant parts A. *Cercospora sp.* on *Pittosporum tobira* B. *Microsphaera platanoides* of *Platanus occidentalis* C. *Schizophyllum commune* on *Prunus serrulata* D. *Diplocarpon rosae* on *Rosa sp*. E. *Leptosphaera sp.* on *Yucca filamentosa* F. *Coniothyrium sp*. on *Yucca filamentosa G. Colletotrichum sp.* on *Agave americana* H. *Podosphaera clandestina* on *Cydonia oblonga* I. *Oidium euonymi-japonica* on *Euonymus sp.*

4. Discussion

It is observed that powdery mildew diseases became very common in Istanbul due to high temperature and moisture rates emanate from global warming. Result from infecting leaves and shoots of Angiospermae, powdery mildew usually causes heavy damage and even death of the plant. For instance, *Erysiphe lagerstromiae* is determined as a serious and common cause of powdery mildew disease on Lagerstromia indica (Severoglu, 2005). *Erysiphe platani* is also observed as a dangerous factor to be struggled with as it causes powdery mildew disease on sycamores, which has a remarkable place in historical flora of Istanbul. Additionally, defoliation is

observed on powdery mildew affected L. indica and Acer seedlings in nurseries before 1 or 2 months before autumn. This disease has also significant infection rate on Berberis, Catalpa, Vitis and Rosa seedlings. Besides, it is thought that mycelium and spores emanated from fungal tissue can cause allergic reactions, asthma and bronchitis.

According to our study, antrachnosis diseases have serious effects on Aesculus hippocastanum and sycamore trees. Gnomonia platani causes serious defoliation on Platanus species that leads to a decrease in value for landscaping. A. hippocastanum can also be affected as same as Platanus species. Necrotic tissues from leaf tips to roots are observes on A. hippocastnum seedlings. Further investigations showed that Septoria hippocastani is also responsible for antrachnose on young shoots of seedlings. Seedlings infected with these type of fungi should be determined and eradicated to reduce infection risk.

Leaf spot diseases also decreases availability rate of seedlings for landscaping. Cercis siliquastrum is a symbolic tree of Bosporus that is observed to be suffered from Cercosporella chionea which causes brown spots on leaves and a brownish colour all over the tree. In addition, leaf spot diseases are also observed on Mahonia, Cotoneaster, Hydrangea, Pittosporum, Nerium and Yucca species.

Botyritis cinearea is very common corrosive fungi that causes blight on wide range of plant species (Severoglu, 2005). In our study, B. cinearea is observed on Albizia julibrissin, Rosa sp. and Camellia sinensis.

Diplodia pinea is a die-back disease factor charachterized with death of shoots and root rot (Severoglu, 2005). It is observed in our previous studies that D. pinea causes serious damage on cedar trees and emerges after tissue damages. According to our field work in 2008, D. pinea was determined on almost every pruned Gymnospermae species. Similarly, after heavy hail in July 2017, D. pinea devastated pine and firs in Istanbul, especially in Taksim, Besiktas, Umraniye and Uskudar districts.

In recent years, climate-sensitive plants are commonly used for landscaping in Istanbul. Prunus persica can be considered as a sensitive plant under climatic conditions of Istanbul and due to stated reason, P. persica seedlings are commonly infected with an aggressive type of fungus, Taphrina deformans. In a different way, exhaust gases can cause various type of diseases and even death of Taxus baccata trees after landscaping near main roads despite of being well-grown seedlings in nurseries.

Shoot deaths on seedlings are observed in some of private nurseries caused by Ceratocystis fimbriata and these infected seedlings were eradicated due to our report. Hence, this disease factor is thought to be brought in our country with imported sycamore trees in 2010 and caused wilt disease on sycamore trees in Taksim and Besiktas. This disease factor was determined and a scientific report was published by our research team in the same year.

Rose plants are widely used in landscaping especially in touristic regions of Istanbul and are almost totally infected with Diplocarpon rosae that is a black-spot disease causing fungus. Similarly, this disease is observed in nurseries.

Bacterial diseases are also observed in nurseries. Oozing, tumors, galls and leaf-spot diseases can be caused by bacteria. For instance, Pseudomonas savastonii var. nerii is a bacterium that is growing on flower and leaf of Nerium oleander that is very common ornamented tree. The crown gall by Agrobacterium tumafaciens is very harmful for tree that we are observed on the leaf and buds of Forsythia sp. but the bacterium can be cause crown gall on different parts of other plants.

Non-infectious diseases caused by extreme conditions such as soil pH, high temperature,

draught and over-fertilization are observed in nurseries.

According to all these data stated, it is thought that almost all of these infections are remain hidden under favourable conditions of nurseries and emerges after being used for landscaping in different types of hard conditions. Furthermore, despite of being eradicated through pesticides in nurseries, these seedlings may be infected from other plants on field.

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