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Importance of *Cytospora* damage in relation to health state of birch trees in urban greenery – demonstrated by example of the Nitra town

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Abstract

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Over the years 2005–2007, the health state of *Betula* species in urban environment of Slovakia was evaluated with prime emphasis on occurrence and harmfulness of *Cytospora betulicola* Fautr. on example of the Nitra town. Damage degree to selected birch trees in five different greenery types of usage/location (street plantings, plantings in residential areas – neighbourhood plantings, main-roadside plantings, park plantings, special-purpose greenery) was determined in relation to incidence of the *Cytospora* fungus, wood destroying fungi and unknown factors. The one-way ANOVA did not confirm generally a significant influence of greenery type of usage/location on the damage degree of birch trees. Significant differences in the damage degree values were confirmed between some greenery types by using t-test. *Cytospora* fungus and wood destroying fungi significantly influenced birch health state decrease. Results of multifactorial variance analysis have confirmed a significant influence of two factors, *Cytospora betulicola* and wood destroying fungi on increase of damage degree.

Key words

Betula, *Cytospora* cankers, damage degree, wood-decay fungi

Introduction

Cytospora canker, caused by fungi of *Cytospora* genus, is a worldwide problem and affects more than 70 species of woody shrubs and trees, including aspen, cottonwood, poplar, spruce, willow, ash, maple, elm, cherry, peach, plum, apple and birch (Agrios, 1997). *Cytospora* fungi are widely distributed throughout the range of their hosts in many parts of Europe (Ginns, 1986; Chapela, 1989; Sinclair et al., 1987). Several studies have confirmed *Cytospora* occurrence on a wide spectrum of host woody plants in horticultural plantings and urban environment (Kochman, 1981; Bennell and Millar, 1984).

Six genera (*Betula, Corylus*, *Carpinus*, *Alnus*, *Ostrya*, *Ostryopsis*) and more than 150 species of deciduous trees and shrubs of *Betulaceae* family grow in the nature. Species of the *Betula* genus belong to trees often grown as markedly decorative woody plants in urban plantings. Several fungi cause canker diseases on birch, infect and kill sapwood and cause sunken dead areas in the bark of trunks and larger branches. Infection causes dieback of twigs and branches, with small black fungal structures embedded in the dead outer bark. Disease occurs on trunks, branches and twigs, forming elongate cankers, regular or irregular in outline, generally with well-defined borders.

Some recent studies have demonstrated damage caused by *Cytospora* pathogens to many birch species (Gregorová et al., 1995; Barengo et al., 2000). Based on the recent studies, some *Cytospora* species are host specific and will not spread to other tree species (Chen, 2002). Since the last years, an increasing number of birch trees in Slovakia have been damaged

by *Cytospora* (Juhásová et al., 2005). Juhásová (2004) reported the species *Cytospora betulicola* Fautr. on *Betula* sp. that caused trunk and branche necrosis and withering of branches in tree crowns.

Many factors can influence health of trees, impair their aesthetic value, or cause even death: environmental stresses, location problems, animal injury, infectious diseases and insect infestations. In many cases, more than one factor may be involved. A correct diagnosis of the problem is the first important step for saving unhealthy trees as a valuable part of the environment. In individual cases, the specific causes of birch dieback are often difficult to determine. Several environmental conditions are known to cause the dieback (Allen et al., 1996).

Results of many studies on tree health state in Slovakia indicate that premature death, leaf spots, yellowing and falling leaves and other damage can be caused by higher concentrations of liquid and solid immisions, salting along roads, poorly areated or unaerated soil or by influence of parasitic fungi, viruses and bacteria (Juhásová and Gáper, 1986; Juhásová, 1997; Juhásová et al., 2003). According to Juhásová et al. (2004), Juhásová and Ivanová (2001), the present health state of woody plants in urban environment is strongly disturbed and the stressed trees are less able to resist insect and disease attack.

Parasitic fungi are one of the very important factors that cause disturbances in the vital processes of plants. Such fungal diseases are manifested as variously spotted leaves and tumour malformations on trunks and branches, often followed by drying of whole tree crowns or even whole affected trees. Important damage caused by *Cytospora* fungi to woody plant species in urban settings was noticed in Slovakia by Juhásová and Ivanová (2003).

The present work was aimed at evaluation of health state of *Betula* sp. in urban plantings on the basis of determination of damage degree to birch trees with the main respect to damage caused by the parasitic fungus *Cytospora betulicola* Fautr. that presents an important problem for withering and dieback of birches in Slovakia. This study wants to extend knowledge on *Cytospora* pathogenicity on the basis of phytopathological evaluation of the investigated tree species.

Material and methods

Field evaluation

Over the years 2005–2007, the health state of *Betula* sp. div. with regard to *Cytospora* incidence was evaluated in urban plantings of Nitra. The various locations of evaluated trees were selected to represent different types of usage/location of urban greenery (terminology according to Juhásová and Ivanová, 2001): street plantings – SP, neighbourhood plantings – NP, main roadside plantings – MRP, park plantings – PP, special-purpose greenery – SPG. Altogether 300 birch trees grown in these five different types of usage/location were evaluated, 60 trees for each greenery type. Trees mechanically injuried, especially wounded by human activities (cut and broken branches, injured trunks) were excluded from the evaluation. The age of evaluated trees was between 10 and 35 years.

Disease symptoms caused by common fungal pathogens, especially leaf diseases were observed, however in context of withering and subsequent decline of birch trees, they were unimportant. Incidence of wood destroying fungi [*Piptoporus betulinus* (Bull. et Fr.) Karst., *Fomes fomentarius* (L.ex Fr.) Kickx and *Armillaria* sp. div.] that cause more important injury in our conditions (wood rots and canker disease) was recorded individually. Damaged trees without symptoms caused by commonly known fungal pathogens of birch were classified as trees damaged by unknown factors.

Presence or absence of *Cytospora betulicola* as an important causal agent causing damage to birch trees in urban environment was recorded based on the typical disease symptoms, especially crown changes and characteristic bark necrosis on branches and stems of affected trees. Scale also includes symptoms caused by common wood destroying fungi to birches.

Damage degree of the evaluated trees in the particular greenery types of usage/location was determined according to a six-point scale modified for the purpose of birch health state evaluation:

H: tree healthy, without visual symptoms of damage

1st degree: foliage decline in natural colour, leaf withering, sporadic incidence of thin dry branches in tree crown ⇨ *Cytospora*; light brown discoloration, the wood remaining quite firm, tree withering, yellowing leaves ⇨ wood decay fungi

2nd degree: $^1/_3$ of the crown volume with dry branches, yelow-orange to orange-brown discoloration on bark tissues, elongate sunken necrosis on the bark of trunk and branches (>5 cm in length) ⇨ *Cytospora*; decayed wood is yellowish-brown and cracks into cubes with thin white mycelial mats forming in the cracks, sporadical incidence of grey to brown or black, woody or leathery and usually hoof shaped fruiting bodies, crown becomes more withered, reduction in tree growth ⇨ wood decay fungi

3rd degree: $^1/_2$ of the crown volume with dry branches, necrosis on the bark of stem and branches (>10 cm in length), the inner bark turns dark brown to black and the sapwood underneath light brown ⇨ *Cytospora*; wood in advanced stages of decay is light in weight and easily crumbles to powder, frequent incidence of perennial fruiting bodies, resinous exudation and presence of white fanlike syrrocium under the bark ⇨ wood decay fungi

4th degree: $^{2}/_{3}$ of the crown volume with dry branches, necrosis on the bark of trunk and branches (>15 cm in length), formation of fruiting bodies (pycnidia) as short grey-black cones within the cankers ⇨ *Cytospora*; leathery, off-white or light brown fruiting bodies with a short, stout stipe grown out of the bark, wood with decay is yellow-white, strong white syrrocium under the bark of trunks, decayed wood is yellow with numerous black lines ⇨ wood decay fungi

5th degree: tree dying, crown dry with sporadically living branches, large necrosis on the bark of trunk and branches, strong pycnidial exudation of orange to red-coloured sticky masses of conidia in hairlike coils, dead bark lifts away from the trunk and falls off in large pieces ⇨ *Cytospora*; large annual fruiting bodies with darker brown and scaly upper surface, wood with advanced decay is soft and spongy, frequently containing brown to black zone lines, small radial cracks filled with yellow mycelium may develop, fruiting bodies in the immediate surroundings of affected trees, frequent incidence of black rhizomorfs under the bark of died trees and in the soil ⇨ wood decay fungi.

Statistical analysis

The one-way ANOVA was used to evaluate the influence of locality (greenery type of usage/location) on damage degree of selected birch trees. Then all localities were compared with respect to damage degree using t-test (independent groups) including all 10 locality combinations.

Three factors were monitored occurring on birch trees (*Cytospora* fungus, wood destroying fungi, unknown factors). For determination of their influence on birch damage degree values the multifactorial analysis of variance (ANOVA) was applied.

The statistical package STATISTICA-7 (StatSoft) was used for all analyses.

Results

Data on phytopathological evaluation on birch trees in particular types of greenery usage/location were supplemented with damage degree categorization (Table 1). No disease symptoms were observed on 208 trees altogether from the total number of evaluated birch trees (300). Nearly 1/3 of the evaluated trees showed certain damage degree by disease symptoms. By the type of greenery usage/location, the most affected trees occurred in the main-roadside plantings (22 trees) and street plantings (21 trees).

On 62 trees altogether, disease symptoms caused by *Cytospora* fungus were recorded. The incidence of wood decay fungi was observed on 27 birches.

The one-way ANOVA did not confirm generally a significant influence of the locality ($F = 2.31$, $p = 0.058$; Fig 1) on the damage degree to birch trees. Significant differences in the damage degree values were confirmed between some greenery types by using t-test (Table 2). Only the type SPG differed from the SP ($t = 2.70$, $p = 0.01$), NP ($t = 2.20$, $p = 0.03$) and MRP ($t = 2.60$, $p = 0.01$).

Cytospora fungus and wood destroying fungi significantly influenced birch health decrease (damage degree increase). Using the multifactorial ANOVA, a significant influence of two factors, *Cytospora* fungus ($F = 13.24$, $p = 0.0003$) and wood destroying fungi ($F = 4.20$; $p = 0.04$) on damage degree increase was confirmed (Table 3, Fig 2a, b).

The unknown factor alone did not produce an important damage ($F = 0.07$, $p = 0.79$). It displayed only in combination with wood destroying fungi ($F = 52.10$, $p = 0.00$), Fig 2c. All effects are presented in Table 3.

Table 1. Results of phytopathological evaluation of birch trees in particular types of greenery usage/location in Nitra by damage degree

Damage degree	Number of trees in particular greenery types of usage/location														
	Street plantings			Neighbourhood plantings			Main roadside plantings			Park plantings			Special- purpose greenery		
	CB	WD	UF	CB	WD	UF	CB	WD	UF	CB	WD	UF	CB	WD	UF
1	2	–	–	3	–	–	2	–	–	8	–	–	3	–	–
2	6	1	2	7	–	–	10	1	1	4	2	–	2	–	–
3	4	4	1	1	5	–	–	3	–	1	2	–	2	2	–
4	3	3	1	–	–	2	2	4	2	1	–	–	–	–	–
5	1	–	3	–	–	3	–	–	2	–	–	2	–	–	1
Number (in 1–5)	16	8	7	11	5	5	14	8	5	14	4	2	7	2	1
H	39	40	38	41	50										

CB – *Cytospora betulicola*; WD – wood destroying fungi; UF – unknown factors; H – healthy trees

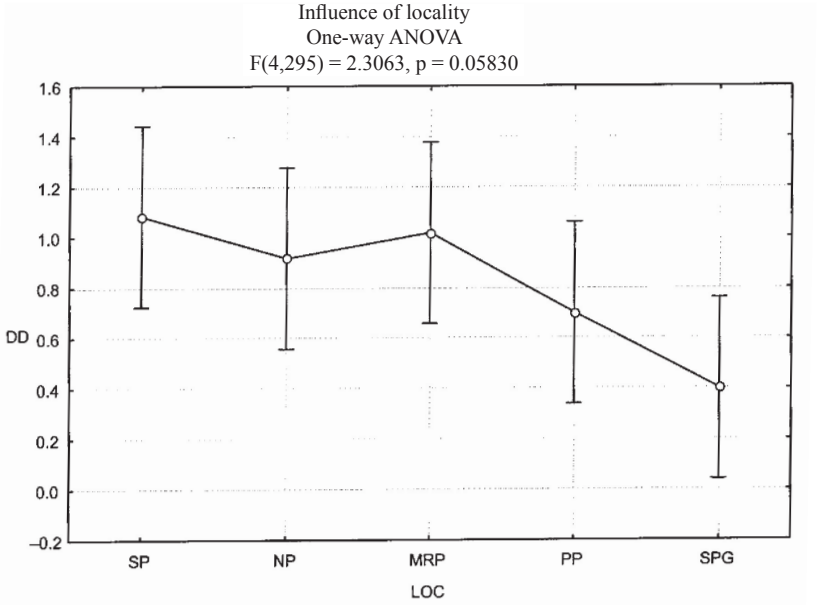

Fig 1. Influence of greenery usage/location type on damage degree to evaluated birch trees

x-axis: LOC – location (SP – street plantings; NP – neighbourhood plantings; MPR – main roadside plantings; PP – park plantings; SPG – special-purpose plantings)

y-axis: DD – damage degree (0–5)

Table 2. Comparison of particular types of greenery usage/location with respect to damage degree. Significant differences between relevant greenery types are in bold

Greenery type	Average damage degree	Standard deviation	SP	NP	MRP	PP	SPG
SP	1.08	1.67	×	t = 0.58 p = 0.57	t = 0.23 p = 0.82	t = 1.42 p = 0.16	**t = 2.70** **p = 0.01**
NP	0.92	1.50		×	t = –0.36 p = 0.72	t = 0.86 p = 0.39	**t = 2.20** **p = 0.03**
MRP	1.02	1.52			×	t = 1.24 p = 0.22	**t = 2.60** **p = 0.01**
PP	0.70	1.27				×	t = 1.42 p = 0.16
SPG	0.40	1.03					×

SP – street plantings; NP – neighbourhood plantings; MPR – main roadside plantings; PP – park plantings; SPG – special-purpose plantings

Table 3. Effects of all factors included in the analysis and their combinations. Significant factors are in bold

Significance tests for damage degree		
ANOVA	F	p
CB	13.2372	**0.000324**
WD	4.1957	**0.041421**
UF	0.0716	0.789140
CB*WD	8.1368	**0.004647**
CB*UF	0.2878	0.592024
WD*UF	52.0995	**0.000000**
CB*WD*UF	41.6398	**0.000000**

CB – *Cytospora betulicola*; WD – wood destroying fungi; UF – unknown factors

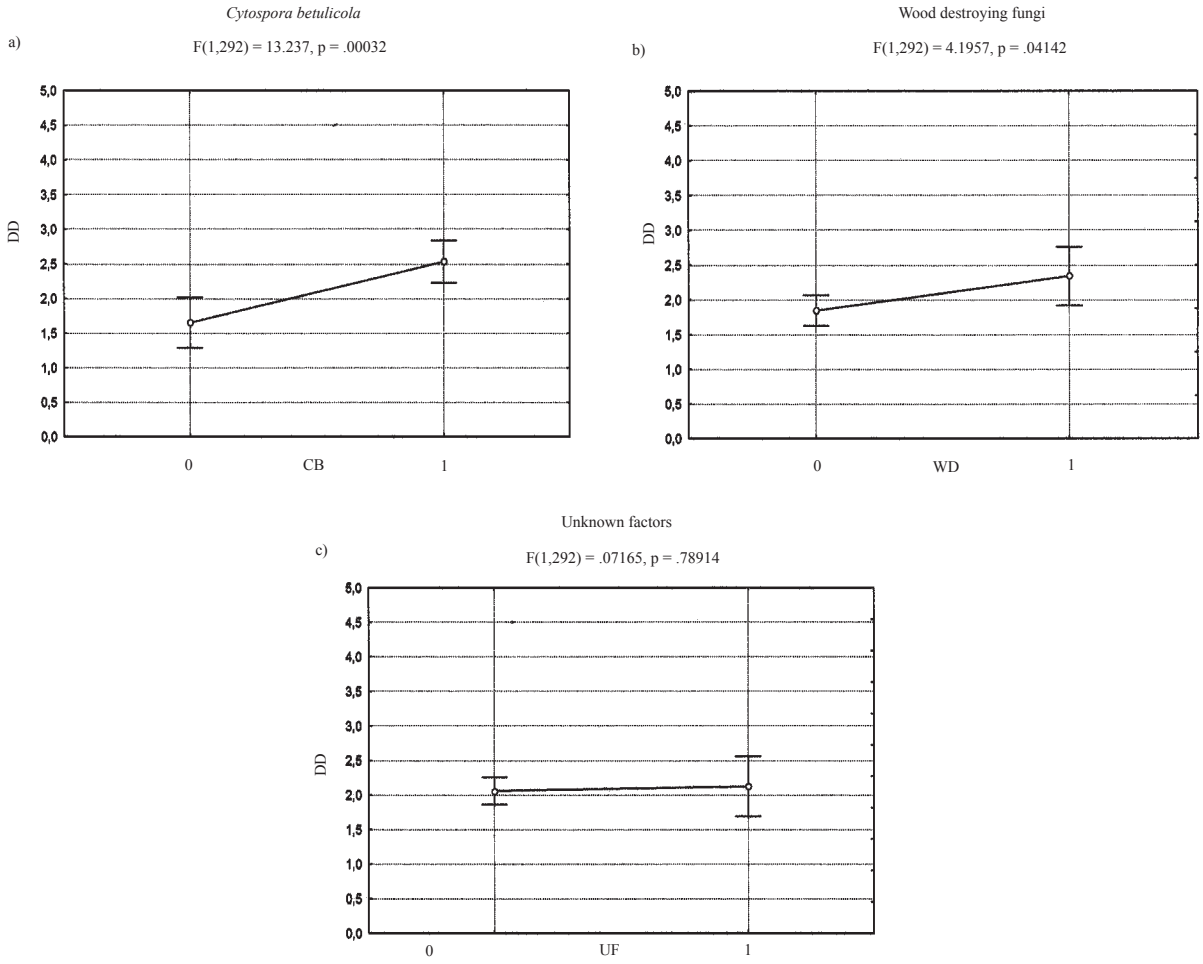

Fig 2a, b, c. Influence of three factors on damage degree to evaluated birch trees
x-axis: CB – *Cytospora betulicola*; WD – wood destroying fungi; UF – unknown factors
y-axis: DD – damage degree (0–5)

Discussion

Species of the *Betula* genus belong to trees often grown as markedly decorative woody plants in urban plantings. On a considerable number of birch species, *Cytospora* damage has been recorded. Disease caused by *Cytospora* is rarely a problem of economic importance in natural stands, but can cause serious damage to forest nurseries, young plantations, horticultural settings and to urban plantings in many countries (Allen et al., 1996). According to Cejp (1957), Spaulding (1961), Peace (1962), Ubrizsy and Vörös (1968), many species of *Cytospora* have been associated with tree damage and several species with dieback of trees. Many *Cytospora* species are only weak parasites and attack a wide range of trees and shrubs, including birch species with various injuries. Several studies (Juhásová and Gáper, 1986; Juhásová and Ivanová, 2003; Juhásová et al., 2005) on this problem in Slovakia have confirmed *Cytospora* fungi as an important cause of branch dieback and tree decline.

Juhásová (2004) states the fungus *Cytospora betulicola* Fautr. as a relatively common parasitic fungus of *Betula* sp. div. in urban plantings in Slovakia. The first disease symptoms appear as sudden chlorosis, withering and premature leaf fall shortly after foliation of the crown. Affected branches or whole trees die gradually. Trunk and branches are spread with abundant fungal stromata visible to the unaided eye after bark removal. Pycnidia with pycnospores – a source of the next infection are formed in stromata under the bark. Various damages caused mechanically by breaking of branches for decorative purposes, animals activity, strong hail and frost, unsuitable management measures and other activities are potential contributory factors of infection.

Quality and quantity of trees in the relevant greenery is influenced by bio-ecological factors. Healthy woody plants, without disturbances in physiological processes show high adaptative ability to the environment and have proportionally developed organs. On the contrary, unhealthy woody plants manifest quantitative

and qualitative changes in their normal vital functions. The correct and timely classification and determination of these changes is the primary precondition for the effective practical protection (Heagle, 1970).

According to Kůdela et al. (1989), it is not possible to explain the spread of the disease and resistance of trees with a single factor. The connection between pathogen and host is a dynamic relation of two living systems which depends on physiological condition of both partners. It also can contribute to clarification why the damage degrees to birch trees evaluated in this study in various greenery types of usage/location in urban environment are different.

In the Czech Republic, Gregorová et al. (1995) confirmed the damage by *Cytospora* pathogens to many birch tree species. On birch trees, *Cytospora* has been shown to inhabit healthy bark, causing disease only in case of low-vigourous trees or branches or when the hosts are stressed by drought, injury, sunscald, fire or other pathological disorders. Presence of this pathogen generally indicates that the trees are under the stress (Allen et al., 1996).

According to Pataky (2000, 2003), each birch in decline is different because the stress varies with each tree and the particular site. There is no current epidemic disease on birch. In most cases, it appears that the early drought stress couples with a high soil pH value has probably stressed trees, predisposing them to infection by canker and dieback fungi. The appropriate treatment is not easy: it is necessary to remove dead branches to avoid problems with wood rot, water the trees in periods of drought stress, test the pH of soil. Basing on these observations, it is possible to determine whether an acidic fertilizer is needed, remove cankered areas from the wood where possible and last, study the particular needs of the planted birch species. Preventive measures include keeping tree healthy and avoiding wounding.

Physiological, chemical and biochemical processes which take place in plant organisms are needful to study together with the health condition of trees and influence of polluted urban environment on them (Heagle, 1970). Environmental conditions as well as ecological requirements of woody plants and their resistance to polluted environment also have influence on selection of tree species for urban plantings. Trees weakened physiologically and injured mechanically succumb to pests and fungal disease attacks easily. It is generally known that the woody plants grown in urban environment are in consequence of the polluted environment and other adverse factors weakened and more predisposed to infections. On the other hand, there is only a limited knowledge on influence of the changed environment on fungal organisms, especially on the parasitic fungi. Some fungal species become weaker and on the contrary, growth of others is activated (Příhoda, 1969). According to Heagle (1970), besides different responses to the polluted environment corresponding to the fungus species, there are also intraspecific differences connected with different host woody plants.

Cytospora is usually considered to be a problem for plants that are under stress with the fungal pathogen gaining entry through dead wood and wounds. Healthy, vigorous trees and shrubs seldom manifest *Cytospora* canker. For that reason, detection of basic causes of their injuries and the plan of effective protective measures should improve general health condition of the greenery in the changed environmental conditions (Juhásová, 1997).

This study aims at fungi of *Cytospora* genus seriously damaging trunks and branches of many broad-leaved tree species, including birch. Many of them are planted in towns. Their withering in consequence of *Cytospora* is characterized by formation of typical cankers on trunk, branches, leafstalks and buds. Affected trees wither gradually and die back prematurely.

Damage degree to trees can be influenced by many factors. Generally, in urban environment woody plants are stressed, which results in withering and increased predisposition to fungal diseases. According to our observations, the worst health state and the highest damage degree was observed on birch trees growing in street plantings and along main roads, thus in conditions that affect the growth, development and tree vitality in an adverse way.

In this study pathogenic impact and harmfulness of the fungus *Cytospora betulicola* has been confirmed as influencing the health state of *Betula* species in urban environment. The damage degree increase depended more markedly on *Cytospora betulicola* presence than on presence of wood destroying fungi.

Since we observed disease caused by *Cytospora* mainly on trees of greenery type of usage/location in unsuitable conditions, we can confirm the presence of this disease as a factor generally indicating the birch trees being under the stress. For example, in Nitra, root systems of trees situated along pavements or directly in asphalt or stone pavings in street plantings are reduced in development. Spreading of roads with salts with heavy metals content also influence negatively health state of woody plants grown in the immediate vicinity of the roads (mainroad plantings). Tree plantings between building blocks are often damaged mechanically by breaking and cutting of branches and destructions of trunks (vandalism). It causes increased susceptibility of the damaged trees to many harmful agents.

Occurrence of disease symptoms caused by other common fungi, especially occurrence of leaf diseases was observed, too. In aspect of withering and subsequent decline of birch trees, however, these symptoms belong to less important ones.

This study aimed at fungi of *Cytospora* genus on *Betula* sp. div. has confirmed importance of the fungus *Cytospora betulicola* Fautr. as the agent seriously

damaging birch trees growing in urban greenery in Slovakia. Further experimental work in the field and in laboratory conditions is needed for more specific determination of pathogenicity of *Cytospora betulicola* Fautr.

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Význam cytospórového poškodenia vo vzťahu k zdravotnému stavu briez v mestskom prostredí – demonštrovaný na príklade mesta Nitra

Súhrn

V priebehu vegetačného obdobia rokov 2005–2007 bol s primárnym dôrazom na výskyt huby *Cytospora betulicola* Fautr. zhodnotený zdravotný stav druhov rodu *Betula* na príklade hodnotenia výsadieb briez v meste Nitra. Stupeň poškodenia vybraných stromov v piatich typoch funkčnej zelene (uličné výsadby; výsadby obytných častí mesta; výsadby popri hlavných cestných komunikáciách; parkové výsadby; špeciálne účelová zeleň) sme určili vo vzťahu k výskytu troch faktorov: huby *Cytospora betulicola* Fautr.,drevokazných húb a neznámych faktorov podieľajúcich sa na zhoršení zdravotného stavu drevín. Jednofaktorová analýza variancie vo všeobecnosti nepotvrdila štatisticky významný vplyv typu funkčnej zelene na stupeň poškodenia hodnotených briez. Signifikantné rozdiely v hodnotách stupňa poškodenia boli potvrdené medzi niektorými typmi funkčnej zelene použitím t-testu. Z výsledkov t-testu vyplýva, že *Cytospora betulicola* a drevokazné huby sa na zhoršovaní zdravotného stavu briez podieľajú významnou mierou. Výsledky multifaktoriálnej analýzy variancie potvrdili signifikantný vplyv oboch faktorov, huby *Cytospora betulicola* a drevokazných húb na zvýšenie stupňa poškodenia hodnotených drevín.

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