Importance of the Fungus *Cytospora rubescens* Fr. in Relation to Dieback of *Sorbus aucuparia* L.

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Abstract

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During 1997–1999 the health condition of *Sorbus aucuparia* L. in the urban environment of the town Nitra was evaluated in relation to the type of usage or location of the trees, and occurrence, spread and harmfulness of the parasitic fungus *Cytospora rubescens* Fr. The developmental stages of the fungus in field and laboratory conditions, the virulence and growth rates of the mycelium isolated from trees of different usage or location was determined. The degree of damage by *C. rubescens* to *S. aucuparia* in Nitra was determined. No direct relation between degree of damage and the content of nine elements in the fungus *C. rubescens* was found.

Keywords: *Sorbus aucuparia*; *Cytospora rubescens*; health condition; urban environment

The physiological, chemical and biochemical processes which take place in a plant organism have been studied together with an investigation of the health condition of trees and the influence of a polluted urban environment on them (GORDIENKO 1978). Results of other studies into the health condition of trees acknowledged that premature death, spot disease, yellowing and falling leaves, and other damage can be caused by higher than average concentrations of liquid and solid immisions, salting along the roads, poorly or un-aerated soils or by the influence of parasitic fungi, viruses and bacteria (JUHÁSOVÁ & GÁPER 1986).

The aim of our work was to evaluate the health condition of Mountain Ash (*Sorbus aucuparia* L.) in an urban environment, with respect to types of usage or location of the trees. In addition, we evaluated the occurrence, spread, and harmfulness of the parasitic fungus *Cytospora rubescens* L. and its content of important trace elements including heavy metals.

MATERIAL AND METHODS

The localities of the trees were selected so that different types of usage or location (along main roads, streets, around public and private buildings, between blocks of houses, in parks and botanical gardens) were represented. From damaged trees we took samples for laboratory testing by common phytopathological methods. The degree of damage on stems and branches was evaluated according to changes in the crown of the tree and on a six-point scale:

Z = 0 – no symptoms of damage;
1. degree – few dry branches (20%);
2. degree – one quarter of the crown is dry (40%);
3. degree – half the crown is dry (60%);
4. degree – three-quarters of the crown are dry (80%);
5. degree – whole crown is dry (100%).

Phenological observations were taken according to BENČAŤ & TOKÁR (1978) by three replicated observations of the respective phenomenon (i.e., observed on three buds, three leaves, three branches and three seeds).

Growth rates of the hyphae of the fungus *C. rubescens* was evaluated after isolation from the host in the following periods: dormancy (isolation from stromata on the stem and branches); before budbreak (isolation from free visible formations on the stem and branches); budbreak (isolation from stromata on a living part of a branch, from stromata on a dry part, from the transition zone between healthy and damaged parts of the stem, from the necrotic part of the stem, from the tissue without symptoms of damage), and fruit maturation (isolation from the transition zone between healthy and damaged part of stem tissue).

Growt rate of hyphaes was evaluated after isolation from the host on various temperatures for fungus culture (20°C, 22°C, 24°C, 26°C) and on different media – 2% maltose agar (2% MA), 2% Czapek-Dox agar (2% Cz-D), 2% Czapek-Dox-maize agar (2% Cz-Dk), 2% Czapek-Dox-glucose agar (2% Cz-Dg), 2% Czapek-Dox-sacharose agar (2% Cz-Ds), 2% Potato-dextrose agar (2% PDa). Fungal stromata excised from damaged parts of the stem and branches were used to determine the content of some elements (Ca, Mg, K, Na, Fe, Zn, Cd, Cu, Pb in mg/g) in *C. rubescens* after drying the stromata at 105°C, mineralisation and assay by AAS.

RESULTS AND DISCUSSION

Cytospora rubescens is a very harmful parasitic fungus on *Sorbus aucuparia* growing in an urban environment. The degree of damage to this species in Nitra differs with particular types of usage or location (Table 1). 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 conditions of both partners. That explains why the degree of damage to trees of this species in various types of usage or location in the urban environment is different. Infection causes the leaves of trees to lose their natural green colour soon after crown leafing, to wither and dry prematurely. Gradually the attached branch and sometimes the whole tree will dry. On infected branches and stems stromata of the fungus occur which, after pulling off the bark, are readily visible and can present a large amount of infectious material. For example, depend-

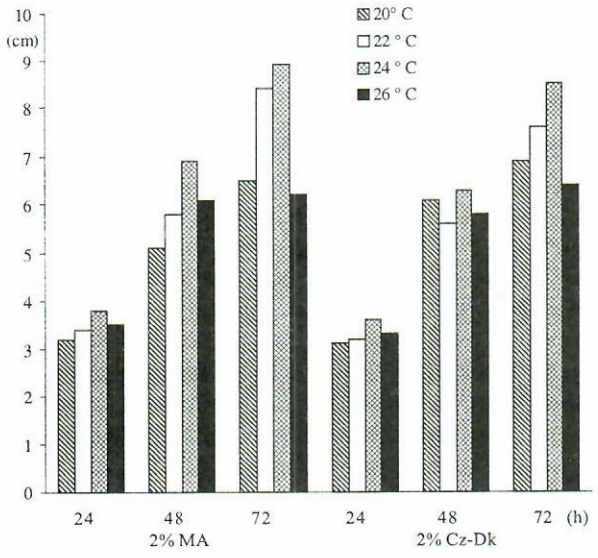
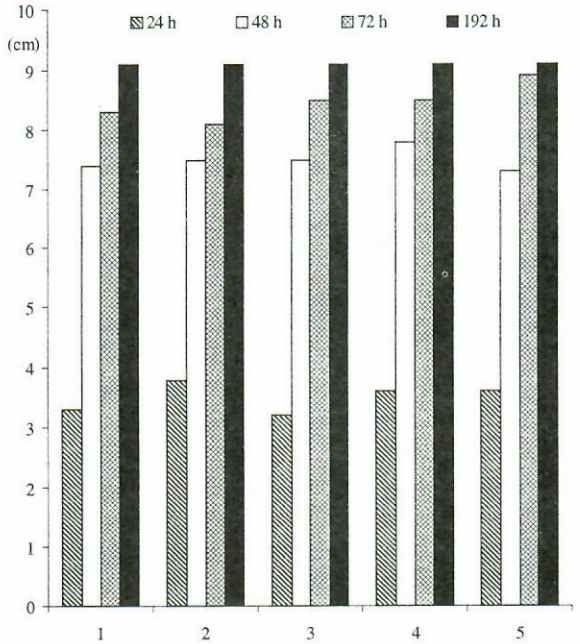


Fig. 1. Growth rates of hyphaes of *Cytospora rubescens* Fr. at various temperatures on 2% MA agar and 2% Cz-D agar

Table 1. Degree of damage on *Sorbus aucuparia* L. by *Cytospora rubescens* Fr. in Nitra

Usage/Location of trees	Number of trees (N) and degree of damage (D)			
	N	D	N	D
Street planting	77	5	41	3
	15	5	5	3
	7	1	5	2
	18	5	1	3
	20	4	13	4
Public planting between blocks of houses	2	2	2	2
	1	2	1	2
	4	2	4	2
	10	2	10	2
	5	1	5	2
Main roads planting	4	1	4	1
	4	1	4	1
	130	4	92	5
Park	2	2	2	2
	3	2	3	2
	3	1	3	1
	28	3	25	3
Special-purpose	10	2	10	2
	6	4	0	5



Types of usage or location: 1, 2 – street greenery, 3 – special-purpose greenery, 4 – greenery between the blocks of houses, 5 – main road greenery

Fig. 2. Growth rates on MA medium and 24°C of hyphaes of *Cytospora rubescens* Fr. isolated during winter from trees with different types of usage or location

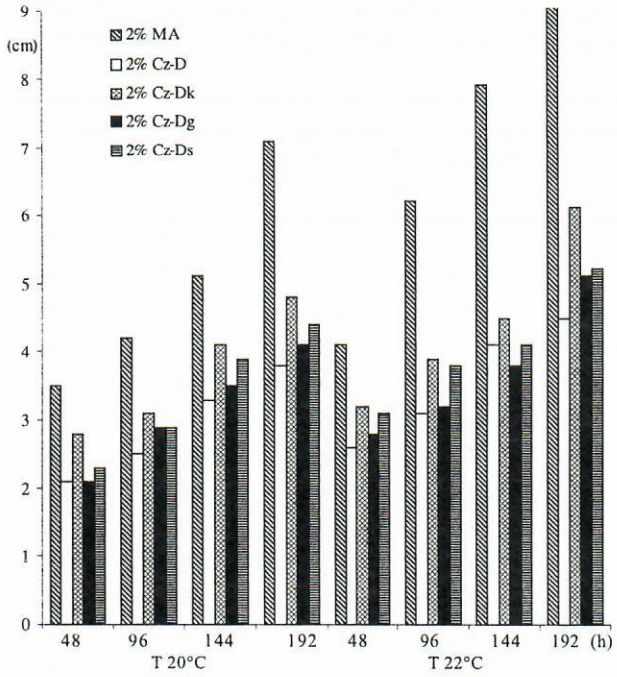
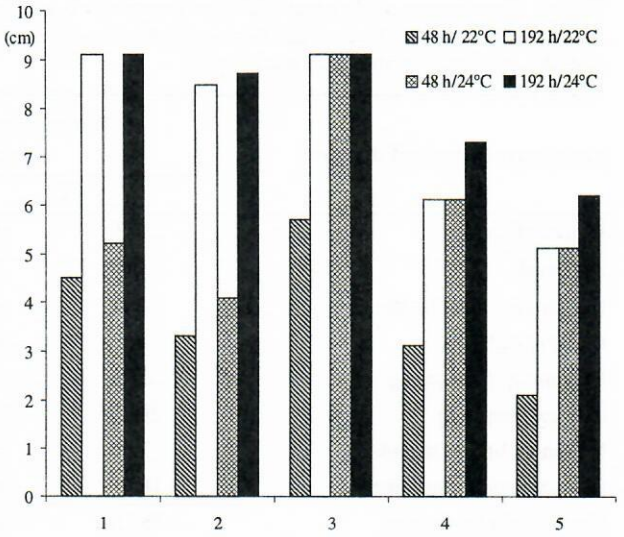


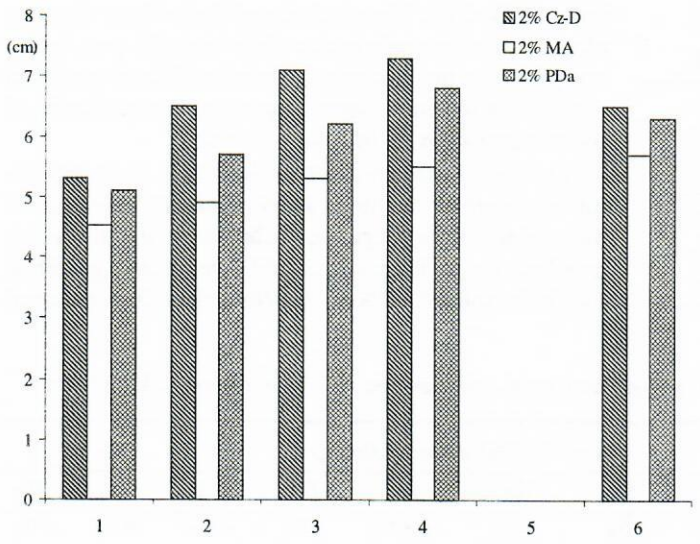
Fig. 3. Growth rates on different media and at 20–22°C of hyphaes of *Cytospora rubescens* Fr. isolated during spring from stromata



Infection material: 1 – from stromata on the living tree, 2 – from stromata on the dry tree, 3 – from part between healthy and damage tissue, 4 – from necrotic part of the tree, 5 – from tissue without damage

Fig. 4. Growth rates on 2% MA agar and 22°C and 24°C of hyphaes of *Cytospora rubescens* Fr. isolated from various infection material during spring

ing on the degree of damage, it is possible to count up to 20 stromata on 1.0 cm^2. Inside a stroma arise several thousand viable germinated conidia which cause infection during the vegetative period. In optimal conditions, conidia are released from the stroma in the shape of pink-red filiform 5–6 mm long structures. These conidia are the source of subsequent infection and penetration of tissues of the tree at the points of different injuries. These could be caused by mechanical damage, insects, hailstorms, frost, unsuitable cultivation measures, or branches get broken off for various decorative purposes, mainly during flowering and fruit maturation. Under our conditions the ascospore stage is formed rarely and, therefore, has little chance to initiate and spread the infection.



Different types of the functional greenery: 1 – street greenery, 2 – park greenery, 3, 4 – main roads greenery, 6 – park greenery

Fig. 5. Comparison of growth rates on different media of hyphaes of *Cytospora rubescens* Fr. between isolates from trees with different usage or location at Nitra and trees in the park of Arborétum Mlyňany

The study of *C. rubescens* in laboratory conditions showed that it can be successfully isolated from the transition zone between healthy and damaged parts of the tissue, from seemingly healthy tissue 10–15 cm from the necrosis, and also from stromata on living and dry trees. Isolation of the fungus is successful throughout the winter (Fig. 3), in spring (Figs. 4 and 5) and also in summer (Fig. 1). The optimal temperature for its culture is about 24°C (Fig. 1), although the hyphaes also grow intensively between 20 and 26°C. Temperatures below and above these limits reduce the growth rate of a colony, which ranges from 0.9 to 1.6 cm in 24 h (Fig. 1). There were no significant differences between the growth rates of hyphae isolated from trees with different types of usage or location (Fig. 2).

Table 2. The phenological phases of *Sorbus aucuparia* L. and developmental stages of the fungus *Cytospora rubescens* Fr. (K) and *Valsa sorbi* Fr. (A) on trees with different types of usage or location in Nitra – street planting (I), special-purpose planting (II), and planted between blocks of houses (III)

Phenological phase of the host	Date of the phenological phase and developmental stage of the fungus on trees with different types of usage or location					
	I.		II.		III.	
Bud swelling	15. 3.	K	24. 3.	K	21. 3.	K
Budbreak	11. 4.	K	15. 4.	K	19. 4.	K
Beginning of leaf burst	24. 4.	K	25. 4.	K	25. 4.	K
General leaf burst	18. 5.	K	22. 5.	A+K	27. 5.	K
Beginning of blooming	22. 5.	K	25. 5.	A+K	30. 5.	K
General blooming	29. 5.	K	1. 6.	A+ K	6. 6.	K
Blooming begins to end	7. 6.	K	7. 6.	A+K	11. 6.	K
General end of blooming	18. 6.	K	20. 6.	A+K	20. 6.	K
Fruits begin to mature	19. 7.	K	25. 7.	A+K	27. 7.	K
General maturing of fruit	15. 8.	K	20. 8.	K	25. 8.	K
Leaves begin to yellow	30. 8.	K	5. 9.	K	5. 9.	K
General yellowing of leaves	25. 9.	K	30. 9.	K	30. 9.	K
Leaves begin to fall	1. 10.	K	10. 10.	K	10. 10.	K
General falling of leaves	5. 11.	K	12. 11.	K	18. 11.	K
Period of dormancy	15. 12.–12. 2.	K	15. 12.–12. 2.	K	15. 12.–12. 2.	K

Table 3. Increase in size of necrotic spots on *Sorbus aucuparia* L. in Nitra

Usage/Location of trees	Date	Size of necrotic spots (cm)	
		Width	Length
Special-purpose	25. 4. 1997	7	40
	1. 3. 1998	11	180
	1. 3. 1999	14	230
Between blocks of houses	25. 4. 1997	4	11
	1. 3. 1998	6	30
	1. 3. 1999	9	42
Street planting	25. 4. 1997	10	53
	1. 3. 1998	14	120
	1. 3. 1999	21	145

The observation of the developmental stages of *C. rubescens* (stage of asci *Valsa sorbi* Fr.) in field and laboratory conditions showed that stromata of the fungus occur on the host tree during the whole year (Table 2). The fungus forms marked necrotic spots on smooth stems and on branches, which are quite apparent as concave areas on the bark. The virulence of the pathogen became clear from the increase in size of the necrotic spots during one year. This increase ranged from 1 to 7 cm in width and 8 to 140 cm in length, depending on age and thickness of the affected stem or branches (Table 3).

In relation to the study of the influence of changes in the environment on fungi, several authors have studied the content of heterogenous substances, mainly heavy metals, in fungi. There was 30–50 times more Hg in fungi than in the soil (SEEGER & NÜTZEL 1977). They observed

Table 4. Content of elements in *Cytospora rubescens* Fr. isolated from stems and branches of *Sorbus aucuparia* L. in Nitra

Usage/Location of trees	P (%)	Quantity of the elements (mg/g)								
		Ca	M	K	Na	Fe	Zn	Cd	Cu	Pb
Street planting	100	32.40	4.37	5.98	0.33	0.84	0.03	0.00	0.01	0.00
Special-purpose	80	25.10	3.68	5.37	0.80	0.71	0.00	0.00	0.04	0.00
Main road planting	20	28.20	2.03	2.89	0.67	0.81	0.05	0.00	0.14	0.00
Street planting	100	25.80	3.41	0.00	0.71	2.41	0.00	0.00	0.04	0.00
Street planting	60	80.72	1.57	15.19	0.45	0.33	0.00	0.00	0.14	0.00
Park	20	41.26	3.33	3.74	0.68	0.64	0.00	0.00	0.02	0.00

that fungi are more sensitive to the presence of Cd during sporulation than during the stage of mycelial growth. Sporulation is inhibited by a concentration of Cd that does not influence growth of the mycelium (LODENIUS *et al.* 1981).

After evaluating the content of elements in stromata of *C. rubescens* taken from stems and branches of *S. aucuparia*, it can be concluded that there was no correlation between the content of elements and the type of usage or location of the trees or the degree of damage to them, even though the latter ranged from 20% to 100%. The content of Cd and Pb was zero in all localities, while that of Cu ranged from 0.01 to 0.14 mg/g. Generally, the content of elements, especially heavy metals, in the analyzed samples was low or on the limit of detection. No interdependence between a single element and the degree of host damage was observed (Table 4).

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Súhrn

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V prostredí mesta Nitry sa v rokoch 1997–1999 hodnotil zdravotný stav jarabiny vtáčej – *Sorbus aucuparia* L. vo vzťahu k typu funkčnej zelene (zeleň v blízkosti dopravných ciest, parková a špeciálna zeleň, verejná a medziblokova zeleň). Sledoval sa výskyt, rozšírenie a škodlivosť parazitickej mikroskopickej huby *Cytospora rubescens* Fr. Zaznamenali sa jej vývojové štádiá v terénnych aj laboratórnych podmienkach, ďalej jej agresivita a rýchlosť rastu hýf mycélia jednotlivých izolátov, ktoré sa získali z rôznych typov funkčnej zelene. Určil sa stupeň napadnutia *S. aucuparia* L. hubou *C. rubescens* Fr. v Nitre, pričom sa nepozorovala priama súvislosť medzi stupňom poškodenia a obsahom sledovaných prvkov v hube *C. rubescens* Fr.

Kľúčové slová: *Sorbus aucuparia*; *Cytospora rubescens*; zdravotný stav; mestské prostredie

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