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The diversity of pathogenic fungi in the rhizosphere of pot-plants of different phytopathologic state

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Abstract. The mycological research works of two groups have shown that pathogenic fungi species, potentially dangerous for plants, from genera *Fusarium* (4 species), *Pythium* (5), *Verticillium* (4) and *Thielaviopsis basicola* functioned in the rhizosphere of 8% of healthy-looking plants and 76% of sick plants. After a long unfavourable treatment easily adapting plants were injured most slightly and plants of a hard adaptation group were injured most strongly.

Key words: rhizosphere, pot-plants, pathogenic fungi

INTRODUCTION

A large variety of decorative pot-plants which originated in the tropics and subtropics are presently grown indoors for decorative purposes. Plants, depending on their adaptability and care complication, are divided into three adaptation groups: easily adapting, of medium adaptation and hardly adapting (Juronis et al., 2001; Snieskiene et al., 2003). The majority of plants belonging to the hard adaptation group originated in tropical forests where they have high humidity and a steady hot temperature. Plants grown primarily indoors (more than 50%) belong to the medium adaptation group. They originate from the subtropic climatic zones which have typical seasonality: winter – resting time with lower temperature and humidity. Plants of the easily adapting group originate from the savannah or steppe, where temperature is changeable and humidity is rather low (Snieskiene et al., 2004).

If growth conditions for plants from tropics and subtropics grown indoors are not similar to those in their places of origin, they begin to wilt, loose strength, and develop injuries in their aboveground parts. The causes of the injuries are primarily of physiological, rather than of infective character, caused by pathogenic micromycetes (Brandenburger, 1985; Sinadskij et al., 1990; Juronis et al., 2001; Snieskiene et al., 2004). Microbiological operations proceeding in the environment, especially in the rhizosphere, are becoming an essential and deciding factor influencing the plant's state (Beckman, 1988; Sinadskij et al., 1990). Fungi play an important role in the soil ecosystem. The plant rhizosphere is a dynamic environment in which many parameters may influence the structure of the fungi population, diversity and activity of the microbial community (Rovira, 1956; Killham, 1994; Garbeva et al., 2007). The character of the developing pathogenic mycobiota depends mostly on plant state (Beckman, 1988), and species (Rovira, 1956). A real danger for plants can occur due to

spreading and intensive development of pathogens in the rhizosphere (Stankeviciene & Varkuleviciene, 2006).

The aims of the work were to determine and compare pathogenic microscopic fungi species in the rhizosphere of healthy-looking and injured pot-plants.

MATERIALS AND METHODS

In 2000–2008 the mycological research works were performed in rhizosphere of pot-plants belonging to 6 families, 14 genera, and 22 species. Depending on their adaptation to the environmental conditions, the examined plants belonged to the three groups (according to V. Snieskiene et al., 2004) (Table 1).

Table 1. Systemic state and status in the adaptation group of the examined plants.

Family	Genus, species, ([I] – Hardly adapting; [II] – Of medium adaptation; [III] – Easily adapting)
Agavaceae	***Cordyline*** *terminalis* (L.) Kunth. [I]; ***Dracaena*** *deremensis* Engl. [III], *D. fragrans* (L.) Ker-Gawl. [III], *D. marginata* Lam. [III], *D. reflexa* (Decne.) Lam. [II]; ***Yucca***: *Y. elephantipes* Reg. [III]
Araceae	***Alocasia*** *x amazonica* André [I]; ***Anthurium*** *adreanum* André [II]; ***Dieffenbachia*** *maculata* (Lodd.) Bunting. [I], *D. seguine* (Jacq.) Schott. [I]
Bromeliaceae	***Ananas*** *comosus* (L.) Merr. [III]; ***Guzmania*** *lingulata* (L.) Mez. [I]; ***Vriesea*** *splendens* (Brongn.) Lem. [I]
Marantaceae	***Calathea*** *crocata* E. Morr. & Joriss. [I], *C. lancifolia* Boom [I], *C. makoyana* (E. Morr.) E. Morr. [I]; ***Ctenanthe*** *pilosa* (Schauer) Eichl. [I]; ***Maranta*** *leuconeura* E. Morr. [I]
Moraceae	***Ficus*** *benjamina* L. [II], *F. binnendykii* (Miq.) Miq. [II], *F. elastica* Roxb. ex Hornem. [II]
Malvaceae	***Hibiscus*** *rosa-sinensis* L. [III]

Two groups of plants growing in pots in peat substrate enriched with slowly melting mineral fertilizers were investigated:

The 1st group included the plants grown under optimal conditions which satisfied the environment temperature and substrata humidity needs of every single plant species.

The 2nd group encompassed the same plants grown under unfavourable conditions (low air humidity, too low temperature, over-dried substrata) and the emerged injuries in their aboveground parts.

Soil samples for microbial analyses were taken from the rhizosphere of these plants and treated following general microbiological methods (Mirczink, 1988). Pathogenic fungi were identified according to the descriptors of cultural and morphological characteristics (Domsch et al., 1980; Filipov et al., 1980; Gerlach & Nirenberg, 1982; Plaats-Niterink, 1981).

Relative density (RD) of fungi species, i.e. the relationship, in percent, of the number of propagules of one species with that of all species isolated in the same sample, was calculated.

RESULTS AND DISCUSSION

During the research, from the rhizosphere of healthy-looking plants growing under optimal growth conditions and of plants of the same taxonomic groups but growing under unfavourable conditions, on which the above-ground injuries were observed (leaves were spotty, slightly dried, yellowed, tended to fall), we isolated the potentially dangerous agents of plant diseases, microscopic fungi belonging to the following four genera: *Fusarium* (*F. culmorum* (W. G. Sm.) Sacc., *F. equiseti* (Corda), Sacc., *F. oxysporum* Schltdl., *F. redolens* Wolenw.), *Verticillium* (*V. album* (Preuss) Pidopl., *V. dahliae* Kleb., *V. fusisporum* W. Gams, *V. nigrescens* Pethebr), *Pythium* (*P. acanthicum* Drechsler, *P. aristosporum* Vanter, *P. debaryanum* R. Hesse, *P. flavoense* Plaats-Nit., *P. irregulare* Buisman). The rhizosphere of the host plants and their relative density (RD) is presented in Table 2.

The mycological research of two groups has shown that pathogenic fungi species potentially dangerous for plants functioned in the rhizosphere of 8% of healthy-looking plants and 76% of sick plants.

Ten (10) species of the investigated fungi functioned in the rhizosphere of healthy-looking plants and 13 species in the rhizosphere of plants with injured above-ground parts. Relative density (RD) of fungi found in the rhizosphere of plants belonging to the hardly adapting group was the highest: 2.1–6.8% (of healthy-looking plants) and 3.3–10.8% (sick plants). The smallest quantity of fungi was found in the rhizosphere of plants of the easy adaptation group: 2 species were isolated from healthy-looking plants and 9 from sick plants (RD was 1.5–1.7 and 4.0–8.0 respectively); in the rhizosphere of the medium adaptation group 3 species from healthy-looking plants and 9 species from sick plants were found, but their RD was 2.0–2.5% and 3.0–10.2%.

During the research quick deterioration of the phytopathological state of plants belonging to the hardly adapting group was observed. *Bromeliacea* family plants and *Alocasia x amazonica* lost their decorative quality after a month. From one sample of the mentioned plants' rhizosphere a few pathogens were isolated (*Fusarium equiseti*, *Pythium acanthicum* from *Guzmania*; *Fusarium oxysporum*, *F. equiseti* from *Maranta*; *Fusarium oxysporum*, *Verticillium album* from *Calathea makoyana*; *Fusarium oxysporum*, *Verticillium album*, *V. nigrescens* from *Alocasia x amazonica*).

After a longer period of time (4 months) of being under unfavourable conditions, leaf yellowing, spottiness, and root decaying were observed in the plants (belonging to easily adapting group) of two species of *Dracaena*. Three agents of root rot were also isolated from one sample of these plants. From the rhizosphere of *D. fragrans* the following pathogens were isolated*: Fusarium sambucinum, F. oxysporum* and *Pythium flavoense.* From *Dracaena marginata* the pathogens isolated were *Fusarium equiseti*, *Verticillium album*, *Pythium* sp.

Rarely detected was the agent of black dry-rot *Thielaviopsis basicola* (Berk et Br.). Ferraris from the rhizosphere of healthy-looking *Cordyline terminalis;* the roots of sick *Dracaena deremansis* (RD, 10%) were injured significantly.

Table 2. Microscopic fungi potential agents of plant diseases, isolated from the rhizosphere of plants belonging to three adaptation groups.

Adaptation group	Plants host	Fungi species; RD,%	
		Healthy-looking plants	Sick plants
Hardly	*Cordyline terminalis*	*Fusarium redolens*; 5.2 *Thielaviopsis basicola*; 2.1	*Fusarium redolens*; 7.1
	Alocasia x amazonica		*Fusarium oxysporum*; 9.1 *Verticillium album*; 10.8 *V. nigrescens*; 6.5
	Dieffenbachia maculata	*Verticillium fusisforum*; 3.2	*Pythium debaryanum*; 7.4 *Fusarium oxysporum*; 9.1
	D. seguine		*Fusarium oxysporum*; 8.7 *Verticillium album*; 10.5
	Guzmania lingulata	*Pythium acanthicum*, 4.0 *P. acanthicum*; 4.3	*Fusarium equiseti;* 6.4 *Pythium acanthicum*; 6.4
	Vriesea splendens	*P. debaryanum*; 3.3	*Pythium debaryanum*; 3.3
	Calathea crocata		*Pythium irregulare*; 6.9
	C. lancifolia		*Pythium debaryanum*; 5.5
	C. makoyana		*Fusarium oxysporum*; 7.0 *Verticillium album*; 7.5
	Ctenanthe pilosa	*Pythium* sp. *Verticillium album*; 6.8	*Pythium* sp.
	Maranta leuconeura	*Verticillium dahliae*; 6.8 *Pythium debaryanum*; 4.8	*Fusarium oxysporum*; 9.5 *F. equiseti*; 6.5
Medium	*Dracaena reflexa*		*Verticillium album*; 6.4 *Pythium flavoense*; 6.4
	Anthurium adreanum		*Fusarium oxysporum*; 6.9
	Ficus benjamina	*Fusarium oxysporum*, 2,5 *Verticilliumn* sp.	*Pythium debaryanum*; 3.4 *Verticillium album*; 10.2
	F. binnendykii		*Fusarium redolens*; 3.0
	F. elastica	*Fusarium redolens*; 2.0	
Easily	*Dracaena deremensis*		*Pythium aristosporum;* 6.3 *Thielaviopsis basicola*; 8.0
	D. fragrans		*Fusarium sambucinum*; 4.0 *F. oxysporum*; 4.0 *Pythium flavoense*; 4.0
	D. marginata	*Pythium flavoense*; 1.5	*Fusarium equiseti*; 5.3 *Verticillium album*; 5.3 *Pythium* sp.; *Fusarium* sp.
	Yucca elephantipes	*Fusarium culmorum*; 1.7	*Fusarium culmorum*; 6.6 *Pythium* sp.
	Hibiscus rosa-sinensis		*Fusarium* sp. *Fusarium redolens*; 6.3
	Ananas comosus		*Fusarium* sp.

Verticillium album (RD to 10.8%) was most frequently isolated from taxons of 5 plants but it did not cause any disease (Barbara & Clewes, 2003). Plants could have been injured, however, by *V. album* and by a complex of *Acremonium*, *Alternaria*, *Gliocladium* and *Mortierella* species colonizing the rhizosphere.

When plants are kept under unfavourable conditions for a period of time, they become weaker and more susceptible to pathogenic fungi, therefore plants wilt or die (Beckman, 1988). For introduction of tropical plants, growth conditions similar to those in their places of origin (temperature, air and substrata humidity, light) are essential. Plant status impairment caused by unfavourable growth conditions is closely related with microbiological processes occurring in their environment (especially in the rhizosphere). Pathogenic fungi started to dominate in the growth substrata inhibiting development of other microorganisms.

CONCLUSIONS

1. During the research fungi potentially dangerous to plants belonging to 4 genera, *Fusarium* (4 species), *Pythium* (5), *Verticillium* (4) and *Thielaviopsis basicola* were isolated from the rhizosphere of decorative pot-plants.
2. Pathogenic fungi species functioned in the rhizosphere of 8% of healthy-looking plants (10 species) and 76% of sick plants (13 species).
3. After long unfavourable treatment, plants of easy adaptation were injured most slightly; however, plants of a hard adaptation were injured most strongly. Relative density (RD) of pathogenic fungi species of hard adaptation group plants was the highest (2.1–6.8% of healthy-looking plants and 3.3–10.8% of sick plants), the lowest RD was of plants of easy adaptation group (1.5–1.7% and 4.0–8.0%) and RD of plants of medium adaptation group was 2.0–2.5% and 3.0–10.2%.

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