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Water as the source of *Phytophthora* spp. pathogens for horticultural plants

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Using rhododendron leaf blades, *Phytophthora* spp. was recovered from 4 rivers, 3 reservoirs and 3 canals located in different parts of Poland. Independently of water sources location, *P. citricola* was found in rivers, reservoirs and canals. Detection period and different sources of water had no big influence on *Phytophthora* spp. population density. Occurrence of *P. cactorum*, *P. cambivora* and *P. cinnamomi* in sampling water was influenced by presence of potential host plants near river and in nurseries. Under conditions favourable to the development of *Phytophthora* spp., *P. citricola* dispersed with sprinkling water in 2 hardy ornamental nursery stocks, caused shoot and tip blight of boxwood and thuja.

Key words: density, dispersal, harmfulness, leaf bait, *Phytophthora*, recovery, water.

Introduction. Most of *Phytophthora* species are known as economically important plant pathogens causing mainly root and stem base rot, leaf spots, fruit necrosis and tip blight. Development of disease symptoms is favoured by wet soil or substratum conditions and temperature above 20 °C resulting rapid dispersal of that group of pathogens achieved by zoospores. The most actual example of zoospores spread in water is *P. alni* known since 1999 on *Alnus glutinosa* firstly in England and during the next few years in many countries of Europe (Cech, 2004; Gibbs et al., Orlikowski et al., 2003). The occurrence of *Phytophthora* species in rivers, streams, canals and water reservoirs is well documented. At least 20 *Phytophthora* spp. were detected in water mainly in the USA and Europe including the most known species like *P. cactorum*, *P. cambivora*, *P. capsici*, *P. cinnamomi*, *P. citricola*, *P. citrophthora*, *P. cryptogea*, *P. drechsleri*, *P. lateralis*, *P. megasperma*, *P. nocotianae*, var. *nicotianae*, *P. ramorum*, *P. syringae* (Fergusson and Jeffers, 1999; Orlikowski, 2006; Themann et al., 2002). Hong and Moorman (2005) characterized *Phytophthora* spp. as significant crop health destructor, which increased greatly and will remain as agriculture problem. The authors concluded that contaminated water irrigation is a primary, if not a sole, source of inoculum for Phytophthora diseases of numerous nursery,

fruit, and vegetable crops. This conclusion is the key for studying of *Phytophthora* detection methods, population densities in relation to water sources and weather conditions and economic thresholds.

The aim of this study is to present some results connected with the occurrence of *Phytophthora* species in Polish rivers, canals, water reservoirs and harmfulness of *P. citricola* to some ornamental nursery plants.

Object, methods and conditions. Sources of water. *Phytophthora* spp. was detected in 4 rivers, 3 water canals and 3 reservoirs. Rivers were situated in different parts of Poland. One of them (Korabiewka) is flowing through forest area, the second one (Rawka) – through agricultural area and partly forest, whereas the next two – through horticultural area with hardy nursery stocks and greenhouse farms (Kurówka and Ner). Water canals and reservoirs are situated in 3 hardy ornamental nursery stocks in different parts of the country.

Recovery of *Phytophthora* from water. Rhododendron leaflets baits cv. 'Nova Zembla' were used. Baits containing at least 8 leaves secured with about 3 m pieces of string were held in water about 2–3 m from benches. After 4–7 days of incubation, in relation to part of the year, baits were removed from water, washed under tap water and number of necrotic spots on each leaf blades was counted. Chosen leaves were rinsed in distilled water, blotted dry, sterilized over a burned flame and about 2–5 mm in diameter pieces of leaves with brown or dark-brown spots were placed on PDA medium and incubated at 25 °C in the dark. After 24–48 h small parts of possible *Phytophthora* colonies were transferred to PDA slants. After segregation and cleaning of chosen isolates they were identified with species on the base of morphology and using molecular methods (Trzewik et al., 2006).

Harmfulness of *Phytophthora cotricola* to boxwood and thuja. Observations were done in two hardy nursery stocks. In both of them plants were regularly sprinkled with water taken from reservoirs situated in the lowest part of nurseries. Part of water was taken from wells but during summer time also from local rivers. Additionally surplus of water from nurseries was flowing to both reservoirs. First symptoms of leaf yellowing were observed on boxwood (Buxus sempervirens) in the beginning of June, whereas dying of thuja (Thuja occidentalis Fastigiata) tips – in the second decade of July. Within one week (thuja) and four months (boxwood) development of diseases were observed. Experimental design was completely randomized with 4 replications and 200 plants in each rep.

Results. Recovery of *Phytophthora* spp. from water. Results with baiting of Phytophthora from rivers indicated significantly higher population number of that group of organisms in August than in June only. In Rawka significantly more necrotic spots on baiting leaves were observed in June and Phytophthora population density was about twice higher than in other rivers (Fig. 1, A). The river runs mainly through forest and agricultural area, so probability of water refuse by chemical residues is much lower than in Ner and Kurówka flowing through horticultural localities (Fig. 1, A).

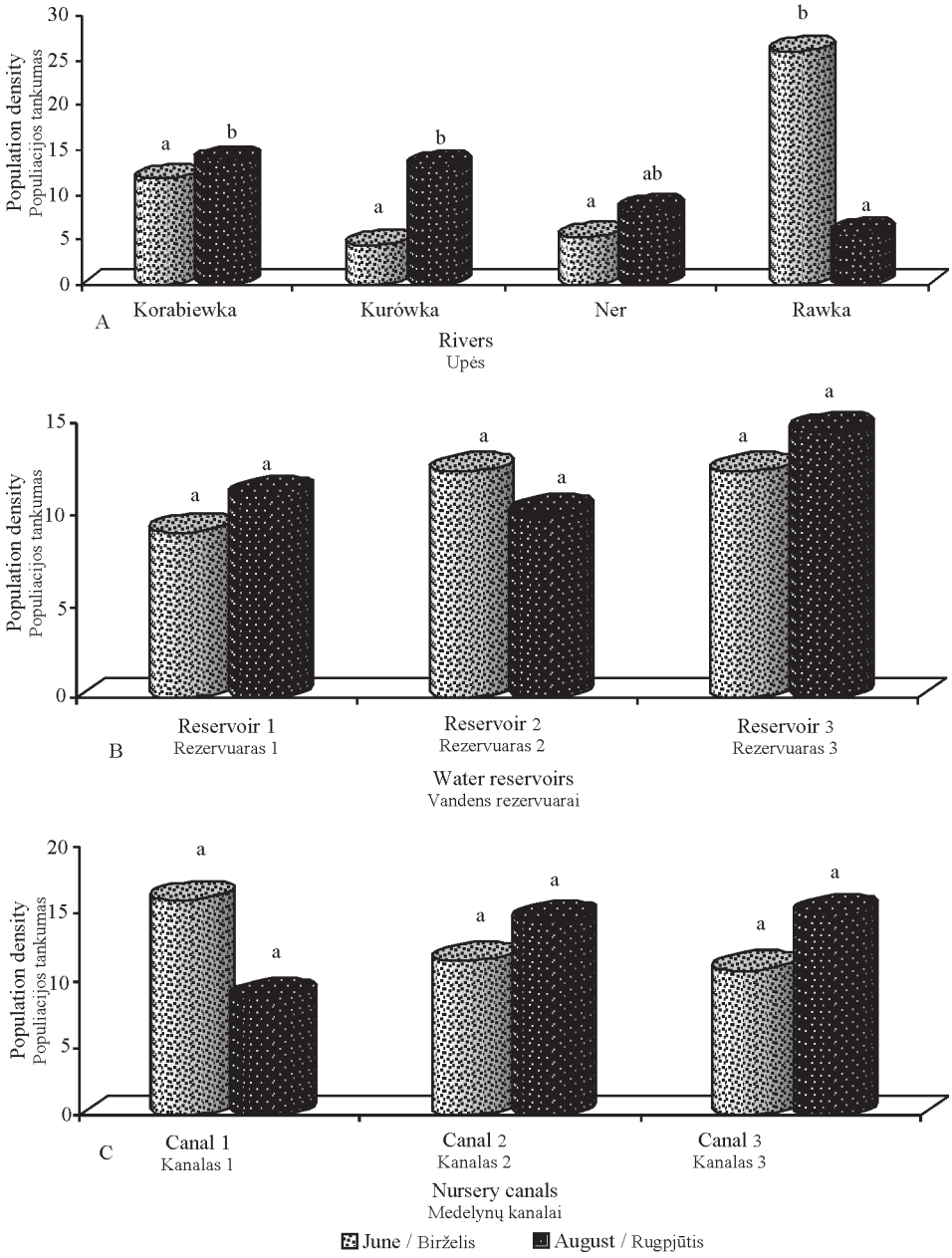

Fig. 1. Occurence of *Phytophthora* spp. in rivers (A), water reservoirs (B) and nursery canals (C); number of spots on rhododendron leaf blade

1 pav. *Phytophtora* spp. paplitimas upėse (A), medelynų kanaluose (B) ir vandens rezervuaruose (C); ligos požymiai ant rododendrų lapalakščių

Analysis of *Phytophthora* spp. detection from water reservoirs and nursery canals showed the lack of differences in population densities as well as between baiting period (Fig. 1, B, C). Four *Phytophthora* species were detected from sampling water sources. *P. citricola* was detected from all sampling water in June and August. *P. cinnamomi* was found only in Kurówka river, *P. cactorum* – in Ner, meanwhile *P. cambivora* – in Rawka.

Harmfulness of *Phytophthora citricola* to boxwood and thuja. The first yellowing of individual boxwood shoots was observed in the middle of June on about 1.5 of plants (Fig. 2). During the next 15 weeks disease symptoms were noticed on at least 10 % of plants. Besides yellowing, on about 5 % of plants most of shoots showed dark-brown discoloration (Fig. 2).

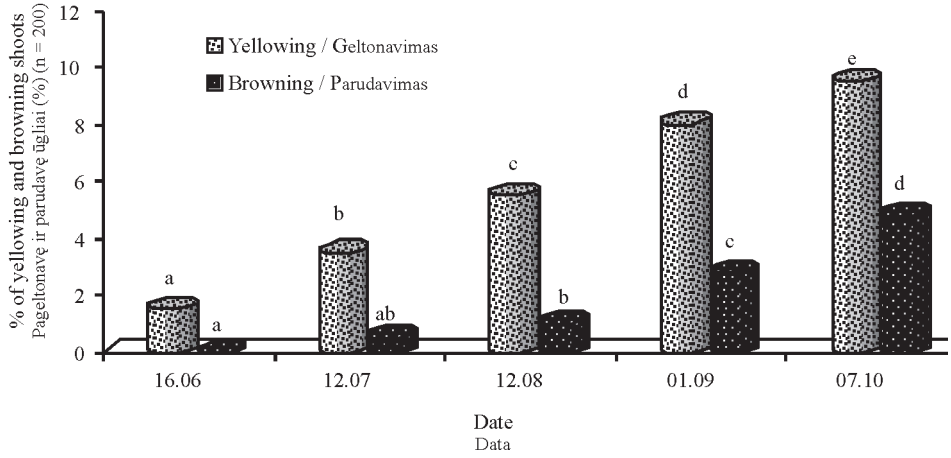

Fig. 2. Development of *Phytophthora* shoot rot (*P. citricola*) of Buxus sempervirens in hardy ornamental nursery stock
2 pav. Buxus sempervirens šaknų puvinio *Phytophtora* (*P. citricola*) vystymasis atspariame dekoratyvinių medžių medelyne

On tops of *T. occidentalis* disease symptoms were noticed after 2 days at relative air humidity above 90 %. Single tips changed colour to yellow-brown and dark-brown and the disease developed very quickly (Fig. 3). First observation showed about 7 % of diseased plants and within 8 weeks symptoms spread on about 40 % of plants (Fig. 3).

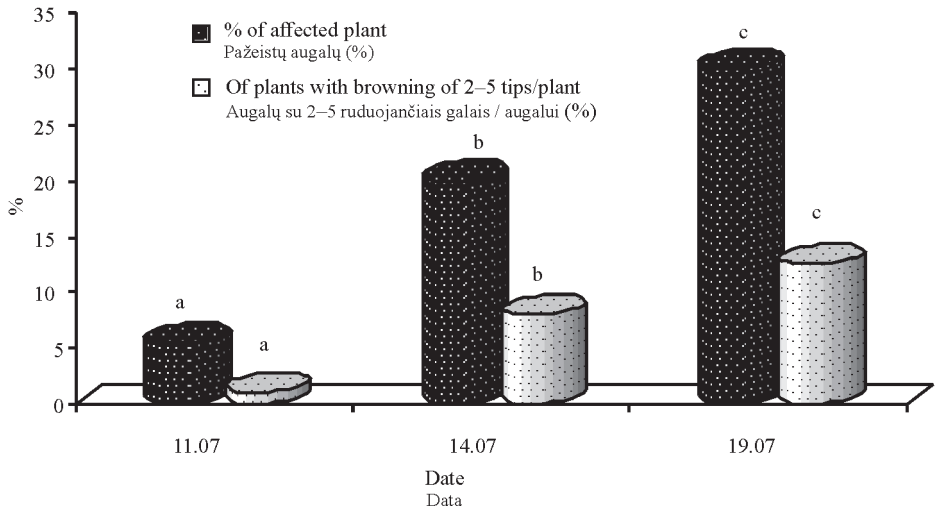

Fig. 3. Spread of *Phytophthora* tip blight (*P. citricola*) on *Thuja occidentalis* Fastigiata
3 pav. *Phytophthora P. citricola* galų rūdžių paplitimas tujose *Thuja occidentalis* Fastigiata

Discussion. Phytophthora species were isolated from rivers, water reservoirs and nursery canals all the year. Results are given for recovery of them in June and August because of available temperature for *Phytophthora* development, but also – the possibility of chemical residues transport from nurseries to water reservoirs, canals and rivers. In Themann and et al. (2002) studies detection rates of *Phytophthora* spp. from nursery drains were higher in most cases than from reservoirs. The authors found also great variation between nurseries and sampling sites. Studies of Orlikowski et al. (2007) indicated that *P. citricola* is the dominant water species. Occurrence of *P. cinnamomi* in Kurówka river was probably connected with running of surplus water from hardy nursery stocks where this species was causal agent of root and stem rot of *Chamaecyparis lawsoniana*, *Pinus mugho* var. *pumilo* and other coniferous plants (Orlikowski et al., 1995). *P. cambivora* occurs in forests, especially on European beech (Orlikowski et al., 2006), whereas P. cactorum – on ericaceous plants located near Ner river.

The thuja is the best example indicating on very fast spreading of *Phytophthora* tip blight with water and expanding of the disease on young plant tips and in nurseries (Orlikowski, 2006; Orlikowski et al., 2004). Our study showed an important role of water in the dispersal of *Phytophthora* diseases not only inside nurseries but also around the country.

Conclusions. 1. Rhododendron leaf baits were an excellent medium for recovery of *Phytophthora* species from different sources of water.

2. Location of rivers and surrounding area and recovery period had no great influence on population densities of *Phytophthora* spp. in water.

3. Similar spots number on rhododendron leaf baits were noticed independently of localization of water reservoirs and canals in the country.

4. From rivers, reservoirs and water canals *Phytophthora citricola*, *P. cinnamomi*, *P. cactorum* and *P. cambivora* were recovered with domination of the first species.

5. Under conditions favourable to the development of *Phytophthora* spp., *P. citricola* dispersal on plants with sprinkling water may cause high losses in the production of some ornamental coniferous and deciduous plants.

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Vanduo kaip sodo augalų ligų sukėlėjo *Phytophthora* spp. šaltinis

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Santrauka

Panaudojant rododendrų lapalakščius, *Phytophthora* spp. buvo išgauta iš 4 upių, 3 vandens rezervuarų ir 3 kanalų, esančių skirtingose Lenkijos vietose. Nepriklausomai nuo vandens telkinio vietovės, *P. citricola* rastas upėse, vandens rezervuaruose ir kanaluose. Aptikimo laikotarpis ir skirtingi vandens šaltiniai neturėjo didelės įtakos *Phytophthora* spp. populiacijos tankumui. Tam, kad vandens mėginiuose buvo rasta *P. cactorum*, *P. cambivora* ir *P. cinnamomi*, turėjo įtakos potencialiai užkrėsti augalai netoli upės ir medelynuose. Esant *Phytophthora* spp. vystymuisi palankioms sąlygoms, *P. citricola* paplitęs su laistomu vandeniu dviejuose atspariuose dekoratyvinių medžių medelynuose, sukėlė buksmedžių ir tujų šaknų bei viršūnių rūdis.

Reikšminiai žodžiai: išgavimas, kenksmingumas, lapų diskų metodas, paplitimas, *Phytophthora*, tankumas, vanduo.