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RELATIONSHIP BETWEEN SOURCE OF WATER USED FOR PLANT SPRINKLING AND OCCURRENCE OF *PHYTOPHTHORA* SHOOT ROT AND TIP BLIGHT IN CONTAINER-ORNAMENTAL NURSERIES

Leszek B. Orlikowski

Research Institute of Pomology and Floriculture
Pomologiczna 18, 96-100 Skierniewice, Poland
e-mail: leszek.orlikowski@insad.pl

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Abstract: *Phytophthora citricola* Sawada was detected from 3 water pools situated in 2 container- grown nurseries. The highest number of spots on rhododendron leaves were observed in June whereas the lowest in October. The use of water for plant sprinkling caused browning, yellowing of shoots and root rot of *Buxus sempervirens*, and blight of shoot tips of *Thuja occidentalis* and *Rhododendron* sp. The disease symptoms were observed already in June and the disease developed till the first decade of October. Losses caused by the species varied from 9 to 56%.

Key words: pool water, nursery, shoot rot, *Phytophthora citricola, Buxus, Thuja, Rhododendron*

INTRODUCTION

Among plant pathogens *Phytophthora* species may be agents of considerable significance. Several studies performed during past decades have indicated on water as the source of *Phytophthora* spp. Hunter and Kunimoto (1974), Keim et al. (1981) and Shea et al. (1983) concluded that periods of rainfall and sprinkler irrigation of plants susceptible to *Phytophthora* spp. enhance conditions which encourage disease to become epidemic. Especially rain is important for dispersal of *Phytophthora* propagules and also contamination of water in nursery containers (Kuske and Benson 1983). Occurrence and fast spread of *Phytophthora* root and trunk rot of alder (*Alnus glutinosa* L. Gaertn., *A. incana* L. Mnch.) caused by *Phytophthora alni* Brasier and S.A. Kirk in Europe from Greece to Sweden gave occasion to a wide discussion on the pathogen sources. River water was the main source of that agent in Germany but especially in the Spreewald biosphere (Schumacher 2003, 2004). The author found, that high infection rates occurred in stands flooded during the growing season but *P. alni* variants were not active from December to March. Cech (2004) found that high inoculum rate

of the pathogen was observed in one area where summer flood occurred. In Jung and Blaschke (2003) study *Phytophthora* root and collar rot of alder exceeded 50% of incidence along some rivers. The pathogen introduced to the river system, spreads downstream and infects the collar or bare roots of riparian alders via lenticels and adventitious roots. Results of Gibbs et al. (1999) provided evidence that propagules of *P. alni* are carried from diseased to new alder hosts via water. Hansen and Delatour (1999) recovered *Phytophthora* spp. abundantly in water streams and pools as well as plant debris in water. Among identified species *P. gonapodyides* (Petersen) Buisman occurred abundantly but *P. citricola* Sawada and *P. megasperma* Drechsler were also recovered a few times. In this study relationships between the recovery of *P. citricola* from pool water and occurrence *Phytophthora* tip blight or stem rot of some ornamental plants were investigated.

MATERIALS AND METHODS

Rhododendron leaflet baits for recovery of *P. citricola* in pond water

Sampling for *Phytophthora* spp. was carried out from June to the second decade of October, 2005 in 3 container-grown ornamental nurseries. Rhododendron baits about 15 cm long were prepared from branched tips of cv. Nova Zembla. Baits (at least 16 leaves of each) secured with about 2–3 m pieces of string were held in water up to 5 days. Afterwards they were removed from pools, washed under tap water and number of spots were counted on each leaf blade. Chosen leaves were rinsed 3 times in distilled water, blotted dry, sterilised over a burner flame and about 5 mm diameter brown or dark-brown part of tissues were placed on PDA medium (8 pieces/plate of four 90 mm diameter Petri dishes /sample). Plates were incubated at 25°C in the dark and examined daily. Possible *Phytophthora* colonies were transferred to PDA slants. Isolates were grouped by growth pattern and morphology and representative cultures were examined for identification.

Examination of *Buxus sempervirens* L., *Thuja occidentalis* L. "Fastigiata" and *Rhododendron* sp. "Nova Zembla" for the presence of *P. citricola* in diseased tissues

Three-years' old, surveyed plants were grown in new container and fresh peat. In case of transplanting to larger containers, fresh peat was used so probability of *Phytophthora* transmission with substratum was not possible. Since spring to the end of vegetation period plants were watered using sprinkling system. In hot summer time plants were sprinkled even 3–4 times per day. On all surveyed plant species disease symptoms, caused by *P. citricola,* were not observed in 2004. First disease symptoms on 3 plant species were found in June- July and *Phytophthora* rot has progressed till Oct. 7th (boxwood), when plants were prepared for sale. Different symptoms were observed on surveyed plants. On boxwood individual shoots were yellow, yellow-brown and at the last stage straw-coloured. Symptoms spread slowly onto the next shoots. About 50% of roots on the depth about 5 cm were dark-brown. On thuja single tops turned yellow and brown and necrosis spread downwards on the length to about 10 cm. The disease spread onto other tips of shoots. On rhododendron tips brown, often irregular spots on blades or dark-brown necrosis spreading from the leaf petioles along main vain in the shape of V were observed. Top stem parts became dark-brown and died. Both on thuja and rhododendron, rotting of roots was not observed.

On each species a number of diseased plants were observed. The presence of the pathogen in diseased shoot parts was detected by transferring affected tissue parts on PDA and to soil extract (Orlikowski 1979; Orlikowski and Szkuta 2002). Experimental design was completely randomised with 4 replications and 100 or 200 plants in each.

RESULTS AND DISCUSSION

Recovery of *Phytophthora citricola* in pool water

Using rhododendron leaf baits during 3 surveying periods was satisfactory for statement of *P. citricola* in pool water (Table 1). The species was recovered from water from June to October. Most of spots on rhododendron leaves were observed in June, especially on blades floated in pond L1 close to boxwoods. However the number of spots decreased in the middle of August, whereas in that container the pathogen was not recovered in October. In the second pond (L2), close to *T. occidentalis* growing place, a similar tendency in spot numbers on leaf baits as in the first pool was noticed but the pathogen was still found in water on October 20th. On leaf blades floated in the third pool (E) the lowest number of necrotic spots were recorded. The number of spots decreased at least twice in comparison to the first trial and in October spots were not observed on floated leaf baits (Table 1). *P. citricola* was isolated from about 80% of leaf inocula. Additionally *Pestalotiopsis* sp., *Botrytis cinerea* Pers. and *Fusarium avenaceum* (Fr.) Sacc. were isolated from diseased leaf parts. Transferring of pieces with spots into soil extract (Orlikowski 1979) resulted in production of zoosporangia, oogonia and anteridia of *P. citricola* during 2–3 day-incubation of tissues at 24°C in the dark.

Table 1. Contamination of water in nursery pools by *Phytophthora citricola* in relation to surveying period

Water containers	Number of spots/rhododendron leaf in surveying period		
	2005.06.16	2005.08.12	2005.10.20
L1	97.0 c	29.0 b	0 a
L2	63.8 b	19.8 a	8.5 b
E	35.0 a	16.5 a	0 a

Means in columns, followed by the same letter, do not differ with 5% of significance (Duncan's multiple range test)

Spread of *P. citricola* rot on surveyed plant species

On 1.5% of observed plants of *B. sempervirens* first yellowing of individual shoots was noticed in the middle of June (Table 2). During the next 15 weeks the disease occurred on almost 15% of plants but discoloration of most of shoots was noticed on about 5%. On tops of *T. occidentalis* disease symptoms occurred after 2 days at relative air humidity above 90%. Single tips of plants changed colour to yellow-brown and dark-brown and the disease developed very quickly (Table 3). The first observation showed the occurrence of the disease on about 7% of plants but within 8 days symptoms spread on about 40% of thuja. On *Rhododendron* sp. leaves necrotic spots were noticed on July 21st and during the next 2 months on about 13% of plants (Table 4).

Table 2. Spread of *Phytophthora* shoot rot on *Buxus sempervirens* in container-grown nursery

Observation date	Number of plants (n=200) with disease symptoms:	
	Yellowing of individual shoots	Browning, yellowing and straw-coloured shoots
2005.06.16	3.0 a	0 a
2005.07.12	7.0 b	1.0 ab
2005.08.12	11.3 c	2.0 b
2005.09.01	15.8 d	5.5c
2005.10.07	19.3 e	9.5 d

Means in columns, followed by the same letter, do not differ with 5% of significance (Duncan's multiple range test)

Table 3. Spread of *Phytophthora* tip rot of *Thuja occidentalis* in container-grown nursery

Observation date	Number of diseased plants (n=200) with symptoms:	
	Browning of single tips	Browning of 2–5 tips/plant
2005.07.11	10.8 a	4.3 a
2005.07.14	39.5 b	15.3 b
2005.07.19	55.8 c	25.0 c

Means in columns, followed by the same letter, do not differ with 5% of significance (Duncan's multiple range test)

Table 4. Spread of *Phytophthora citricola* on *Rhododendron* sp. cv. Nova Zembla in container-grown nursery

Observation date	Number of diseased plants (n=100) with symptoms:	
	Single tips with *Phytophthora* rot	3–4 tips with *Phytophthora* rot
2005.07.06	0 a	0 a
2005.07.21	2.5 a	1.3 a
2005.08.11	6.0 b	4.5 b
2005.08.26	9.0 c	3.8 b

Means in columns, followed by the same letter, do not differ with 5% of significance (Duncan's multiple range test)

From diseased tissues of boxwood, thuja and rhododendron transferred on PDA and to soil extract mostly *P. citricola* was isolated. From diseased shoot parts of thuja *Fusarium avenaceum* was additionally isolated whereas from thuja and rhododendron *Pestalotiopsis* sp. In laboratory trials both species did not colonise tip parts and leaves of both plant species.

The data obtained indicate that water used for sprinkling plants during vegetation period was the potential source of *P. citricola* in container-grown nurseries. This

species was most often recovered from water containers in other nurseries as well as from streams and rivers (Orlikowski et al., unpublished). Probably the pathogen is transferred to reservoirs of water and rivers with parts of soil and substrata, diseased leaves and root parts floated with rain and excess water outflow from containers. In nurseries where different plant species are grown they sometimes are invaded with *P. citricola,* almost every day in late spring and summer, zoospores released from zoosporangia are transported with excess water used for sprinkling, to reservoirs usually situated beneath nursery level. Increased propagule numbers in collected water and using it 2–4 times per day caused the accumulation of pathogen on plant shoots and in substratum surface. High plant density in nurseries and sometimes excess of water caused the increase of air humidity, especially among plants, and stimulated the formation of zoosporangia, release of zoospores and infection of plant tissues.

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POLISH SUMMARY

WSPÓŁZALEŻNOŚĆ POMIĘDZY ŹRÓDŁEM WODY UŻYWANEJ DO ZRASZANIA ROŚLIN, A WYSTĘPOWANIEM ZAMIERANIA I ZARAZY WIERZCHOŁKÓW PĘDÓW W POJEMNIKOWYCH SZKÓŁKACH OZDOBNYCH

Badania prowadzono w dwóch pojemnikowych szkółkach roślin ozdobnych. Z trzech zbiorników wodnych, usytuowanych poniżej poziomu szkółek, do których spływa nadmiar wody z kontenerowni, izolowano *Phytophthora citricola*. Stosując liście różanecznika jako pułapki do wykrywania tego czynnika chorobotwórczego, izolowano go z wody w okresie od czerwca do października. Najwięcej plam na liściach stwierdzano w czerwcu, natomiast najmniej w październiku. Na bukszpanie podlewanym wodą z jednego ze zbiorników stwierdzano symptomy żółknięcia pojedynczych pędów, rozszerzające się stopniowo, ich brązowienie i następnie słomkowe zabarwienie liści. Na żywotniku „Fastigiata" obserwowano brązowienie i zamieranie wierzchołków pędów na długości do 10 centymetrów. Na wierzchołkach pędów różanecznika występowały plamy na liściach rozszerzające się na całe blaszki oraz na łodygi. Z porażonych tkanek izolowano *P. citricola*. Objawy chorobowe zanotowano na 9–56% roślin, przy czym zgniliznę pędów obserwowano najczęściej na żywotniku.