European Journal of Plant Pathology **101**: 111–114, 1995.

Short communication

Root rot in *Campanula carpatica* caused by *Phytophthora cryptogea*

Kirsten Thinggaard
Danish Institute of Plant and Soil Science, Department of Ornamentals, Research Group for Plant Breeding and Propagation, Kirstinebjergvej 10, 5792 Aarslev, Denmark

Accepted 12 September 1994

Key words: bellflowers, ebb- and flow system, furalaxyl, *Gerbera jamesonii*, recirculating nutrient solution

Abstract

This is the first record of root rot in *Campanula carpatica* as well as in the genus of *Campanula* caused by *Phytophthora cryptogea*. An attack was observed in potted plants grown in a greenhouse on ebb- and flow benches and with recirculation of the nutrient solution. The fungus caused wilting of the leaves together with discoloration and rotting of the roots. Pathogenicity tests showed that the isolate of *P. cryptogea* from *C. carpatica* attacted *Gerbera jamesonii* and vice versa. Treatment with the fungicide furalaxyl was able to reduce disease development.

Introduction

Campanula (Bellflowers), especially *C. carpatica*, are important pot plants in Denmark. Plants are vegetatively propagated in the greenhouse and then grown in pots in the field. Afterwards, they are brought into flower in the greenhouse in the period from November to June. Root diseases caused by *Fusarium* [Mygind, 1986], *Rhizoctonia* and *Pythium* [K. Thinggaard, unpubl.] are common in potted *Campanula*. A serious epidemic attack of a new root disease caused by *Phytophthora cryptogea* Pethybridge & Lafferty on a pot plant crop of *C. carpatica* was observed in a commercial nursery in 1991.

The plants were grown on ebb- and flow benches, and the nutrient solution was recirculated. The symptoms were leaf discoloration followed by wilting of the leaves and stunted growth (Fig. 1). Roots were discoloured brown and rotten. The disease was observed to spread very quickly in the growing system where the plants were grown on ebb- and flow benches, and the nutrient solution was recirculated.

Isolation and identification of the fungus

A fungus was isolated from the roots of *C. carpatica* on selective medium (HMI) containing hymexaxol [Tsao and Guy, 1977]. It was also isolated on HMI from samples of the nutrient solution after incubation with leaves of *Cedrus deodara* as bait. Sporangia were produced two weeks after inoculation on V8 juice agar [Ribeiro, 1978] without $CaCO_3$, poured with autoclaved lake water 7 days after inoculation to stimulate sporangia production. The sporangia were non-papillated with internal proliferation (Fig. 2) and did not produce oogonia on V8-juice-, potato dextrose- or oogonia-agar media. The mycelium produced hyphal swellings in clusters. On the basis of the morphological structures, the fungus was determined to be *P. drechsleri* Tucker using the keys of Stamps et al. [1990] and Kröber [1985]. Because of lack of oogonia production the final identification was done at Centraalbureau voor Schimmelcultures, Delft in August 1993, and the isolate identified as *P. cryptogea* [A.W.A.M. de Cock, pers. comm.].

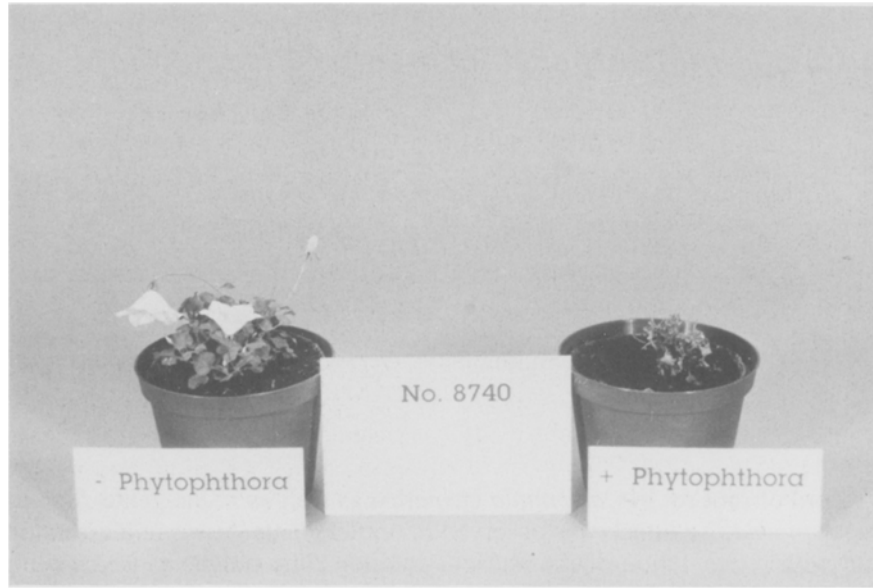

Fig. 1. ***Campanula carpatica*** 'no. 8740' showing symptoms of wilting caused by root rot after inoculation with *Phytophthora cryptogea* zoospores (right). Healthy *C. carpatica* plant (left).

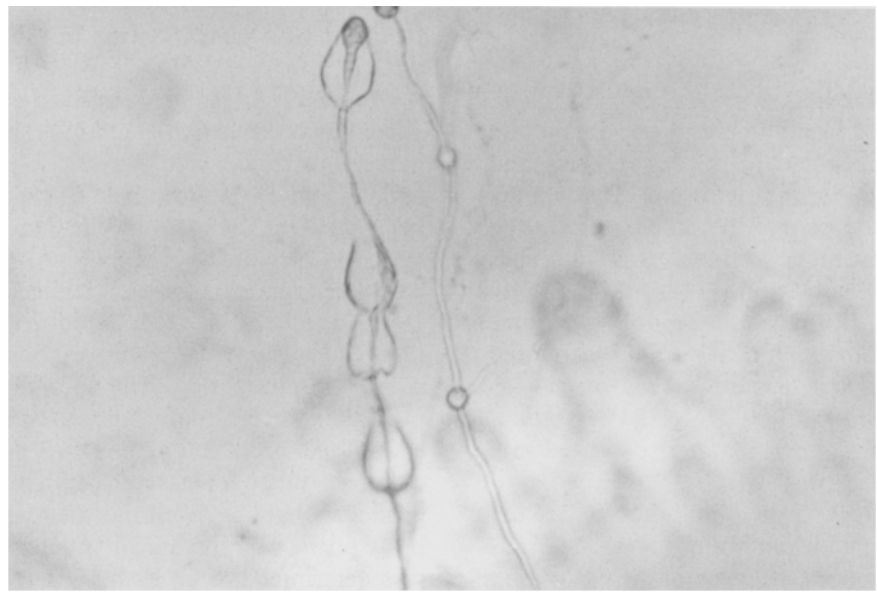

Fig. 2. Sporangium of *Phytophthora cryptogea* proliferated four times (magnification: 240 times, 1 mm = 4.2 µm).

Pathogenicity tests

40 *C. carpatica* '8740' plants vegetatively propagated in a greenhouse and then grown for a year in pots in the field were used. The inoculum of *P. cryptogea* isolated from *C. carpatica* was produced in Petri dishes (diameter: 8.8 cm) containing V8-juice agar [Ribeiro, 1978] without

$CaCO_3$, inoculated with *P. cryptogea* and grown for six days at 24 °C in the dark. Sterile lake water was poured over the cultures and 12 days later when the fungus had produced sporangia the dishes were placed in the refrigerator at 6 °C for 20 min to release the zoospores. The plants were inoculated with zoospores of *P. cryptogea*, using 10^5 (conc. a) or 10^6 (conc. b) zoospores per plant. The inoculum was added with a pipette to the soil around the basis of stems in each pot (twenty pot plants at each rate). After three weeks 65% (conc. a) and 85% (conc. b) of the plants died of root rot caused by *P. cryptogea*. The fungus was isolated from the roots of all dead plants using the selective medium HMI. No symptoms were observed in the twenty non-inoculated control plants.

Six plants of *Gerbera jamesonii* were inoculated with zoospores of *P. cryptogea* from *C. carpatica* at a concentration of 2.8×10^4 per plant. Root rot was recorded 3 weeks after the inoculation, when 83% dead plants were observed. *P. cryptogea* could be isolated from the dead plants and from plants with symptoms as brown rotten roots and hanging leaves. When 10 plants of *C. carpatica* were inoculated with *P. cryptogea* isolated from G. jamesonii (3.5×10^4 zoospores per plant), 50% of the plants died of root rot caused by *P. cryptogea* three weeks after inoculation. No symptoms of root rot were observed in non-inoculated control plants.

Control of the disease

To control the epidemic in the greenhouse the plants were treated with the systemic fungicide furalaxyl (Fongarid 25 WP Ciba-Geigy) supplied as a 0.2% aqueous solution with 50 ml per pot added as a top drenching. The crop was treated twice at 4 week intervals. One to two weeks after the first treatment the attack was much reduced. However, new epidemics emerged during the following seasons in the greenhouse.

Differences in susceptibility to *P. cryptogea* among varieties were observed. Therefore, breeding for resistance was initiated in 1992 and a screening test was developed [K. Thinggaard, unpubl.].

Discussion

This is the first record of *P. cryptogea* attack on *C. carpatica*. The only record of *Phytophthora* affecting *Campanula* is crown rot of *C. persicifolia* L. caused by *P. porri* [Legge, 1951]. No other reference to *Campanula* and *Phytophthora* could be found in the literature. It has been found that *Phytophthora*, as well as *Pythium*, may cause extensive damages to many pot plant species grown on ebb- and flow benches using recirculation of the nutrient solution [Thinggaard and Middelboe, 1989]. Now also *C. carpatica* is damaged by *Phytophthora* in this growing system.

P. drechsleri and *P. cryptogea* are very similar, both morphologically and immunologically, and some authors [Erwin, 1983] have proposed that an investigation on isolates collected at a world level should be made. Such an investigation based on isozyme and mitochondrial DNA analyses was carried out by Mills et al. [1991] and they found that *P. cryptogea* and *P. drechsleri* should not be merged into one species. Other authors separate the two species by the size of hyphal swellings, zoosporangia, oogonia, oospores and, in addition, by the cardinal temperatures for the growth of the two fungi [Kröber, 1981; Larsson and Gerhardson, 1990].

P. cryptogea has numerous hosts and Kröber [1981] found that *P. cryptogea* from *Gerbera jamesonii* and *Begonia-Elatior*-Hybrid were able to attack both hosts. This was also observed in the present study of *Campanula* and *Gerbera*. Therefore, it is suggested that infection of *C. carpatica* with *P. cryptogea* may be the result of a contamination from other pot plant crops in which root rot caused by *P. cryptogea* is a problem (e.g. *Gerbera jamesonii, Begonia Elatior*-Hybrid, *Dianthus*).

The fungus could be transported among contaminated and non-contaminated greenhouses by infected plant materials or contaminated media on plant containers. Also when the plants were grown in the field, attacks of *P. cryptogea* were observed especially in summers with high temperatures, as in 1994. Control of the disease with fungicides is now possible, but there exists a risk for development of resistance against the fungicides together with a risk for withdrawal of the fungicides from

the market. These circumstances makes it necessary to find such alternatives as plant resistance.

References

Erwin DC (1983) Variability within and among species of *Phytophthora*. In: Erwin DC, Bartnicki-Garcia and Tsao PH (eds) *Phytophthora*: Its biology, taxonomy, ecology, and pathology (pp 149–165) The American Phytopathological Society, St. Paul

Kröber H (1981) Vergleichende Untersuchungen vom Grundtyp *Phytophthora cryptogea* und *P. drechsleri* abweichender Isolate. Phytopath Z 102: 219–231

Kröber H (1985) Erfahrungen mit *Phytophthora* de Bary und *Pythium* Pringsheim. Mitteilungen aus der Biologischen Bundesanstalt für Land- und Fortwirtschaft Berlin-Dahlem 225: 175 pp. Paul Parey, Berlin

Larsson M and Gerhardson B (1990) Isolates of *Phytophthora cryptogea* pathogenic to wheat and some other crop plants. J Phytopathol 129: 303–315

Legge BJ (1951) A *Phytophthora* crown rot of *Campanula*. Trans Br mycol Soc 34: 293–303

Mills SD, Förster H and Coffey MD (1991) Taxonomic structure of *Phytophthora cryptogea* and *P. drechsleri* based on isozyme and mitochondrial DNA analyses. Mycol Res 95: 31–48

Mygind H (1986) *Fusarium* wilt in *Campanula isophylla*. Danish Journal of Plant and Soil Science 90: 3–14

Ribeiro OK (1978) A Source Book of the Genus *Phytophthora*. J Cramer, Vaduz

Stamps DJ, Waterhouse GM, Newhook FJ and Hall GS (1990) Revised tabular key to the species of *Phytophthora*. Mycological Papers 162: 28 pp. CAB International Mycological Institute

Thinggaard K and Middelboe AL (1989) *Phytophthora* and *Pythium* in pot plant cultures grown on ebb and flow bench with recirculating nutrient solution. J Phytopathol 125: 343–352

Tsao PH and Guy SO (1977) Inhibition of *Mortierella* and *Pythium* in a *Phytophthora*-isolation medium containing hymexazol. Phytopathology 67: 796–801