Abstract

Ganoderma sp. and Perenniporia sp. are two of the most important and dangerous root and butt rot agents, very aggressive and asymptomatic. Because of their polyphagy, they are very widespread on many ornamental tree species where they are frequently responsible for uprooting and collar breakages. Among the most common predisposing factors in urban environment, the chronic weakness of the trees increases the recurrence of these pathogens. In term of distribution into the soil and root infections, Ganoderma and Perenniporia seem to have a strong survival ability in the soil, causing a frequent carry over to the new tree generations. The aims of this study were:

i) the evaluation of the survival ability of the inoculum of some strains of Ganoderma adspersum (Schulzer) Donk and Perenniporia fraxinea (Bull.) Ryvarden in soils covered by some mulching, among the most common used in urban arboriculture;

ii) the evaluation of the infectivity of Ganoderma adspersum on young linden and horse-chestnut under different water regimes.

1. Introduction

Ganoderma sp. and Perenniporia sp. are two very important root and butt rot agents causing white rot, widespread on many ornamental tree species (Nicolotti et al., 2004). The loss of wood mechanical properties due to the degradation of these fungi is responsible for many tree failures or uprootings. In many cases, these two fungi are asymptomatic, particularly when they behave as root rot agents, because the canopy blight only arises when all the root system is rotted but, on the contrary, the tree stability becomes compromised earlier. In urban arboriculture, among the most common predisposing factors, the chronic weakness of the trees and the pruning wounds can increase the recurrence of these pathogens

2. Material and methods
2.1. Evaluation of the survival ability of *Perenniporia fraxinea* and *Ganoderma adspersum* in the soil.

In June 2005 6 strains for each species, among 15 isolates, were selected for their *in vitro* vegetative activity. 1200 linden wood sticks (2-5 cm diam.; 10 cm length) were inoculated and incubated for 40 days (200 sticks for each strain), then they were sunk at 50 cm depth into soils differently mulched (compost mulching, bark mulching, no mulching). In order to evaluate the survival ability of these fungi, samplings of 360 wood sticks/year (20/strain/type of mulching) were carried out in September 2005, 2006 and 2007. Attempts of fungal isolation in pure culture were carried out from each stick (Prospero et al., 2003). Data were expressed as percentage of positive isolations. Differences were tested through Kruskal-Wallis and Mann-Whitney U test (p < 0.05).

All the slices from which we were able to isolate our fungi were considered positive in term of inoculum vitality. The wood sticks not found anymore because completely decayed by the fungus, were considered negative.

2.2. Evaluation of the infectivity of *Ganoderma adspersum*

192 linden and horse-chestnut (96 trees per species) were inoculated in June 2005 with one of the strains of *Ganoderma adspersum* used for the survival test (par. 2.1). A randomized block design with two different water regimes (normal regime and dry regime) was used for the inoculation. Inoculations of the pathogen were carried out on the trunk through superficial and deep wounds, in order to simulate the air borne infections. For this inoculation we used spore water suspension, previously verified for its vitality. Inoculations at the collar were carried out through deep wounds, inserting 2 small wood sticks, inoculated with *Ganoderma*, into two holes drilled on the trunk (Figure 1).

48 trees (24 per species) block randomized with the two water regimes were not inoculated and used as control.

Figure 1 – Drilling at the collar followed by the inoculation with an infected wood stick.

27 months after the inoculation, all the trees were cut and dissected looking for the presence of wood stain or decay. The stem of each tree was dissected up to the upper and lower extension of the decay.
The trees inoculated at the collar were uprooted, cut 20 cm upper the inoculation point, the roots were washed and cleaned and then dissected in order to verify the presence and the extension (surface) of the decay.

The Tuckey HSD test and the Mann-Whitney U test were used to test differences in the size surface of the decay (p < 0.05).

Whenever we found wood discoloration or decay, trials were carried out to isolate *G. adspersum* from wood, if negative, the detection was carried out with biomolecular techniques (Nested PCR) (Gardes e Bruns, 1993; Guglielmo *et al.*, 2007).

3. Results

3.1. Evaluation of the survival ability of *Perenniporia fraxinea* and *Ganoderma adspersum* in the soil.

The mean percentage of wood sticks positive to *P. fraxinea* and *G. adspersum* decreased significantly (p < 0.05) three months after the stick burying, although *P. fraxinea* shows a survival ability higher than *G. adspersum*. *P. fraxinea* survived into the soil for more than two years. On the contrary *G. adspersum* inoculum almost disappeared 18 months after its burying.

The soil mulching increased the inoculum survival of both species.

With *P. fraxinea* the mulching particularly enhanced the inoculum survival after one year.

With *G. adspersum* the mulching increased the inoculum survival, just some months after burying and this influence increased significantly with the compost mulching (Figure 3).

![Figure 2 – P. fraxinea – Mean percentages of positive isolations for the three different soil mulching. Within the same period, means followed by different letters differ significantly.](image-url)
% of positive isolations / Ganoderma adspersum

Figure 3 – G. adspersum - Mean percentages of positive isolations for the three different soil mulching. Within the same period, means followed by different letters differ significantly.

3.2. Evaluation of the infectivity of Ganoderma adspersum
The G. adspersum spore vitality was about 80% and the concentration in the water solution was $2.66 \times 10^6$ spores/ml.
When cut, all the trees didn’t show any kind of symptoms and they looked healthy.
Wood discoloration and necrosis, arising from the inoculum point, were evident on the totality of the trees inoculated at the collar and on the trunk through a deep wound (Figure 4).
No symptoms were evident on the trees inoculated through superficial wounds and on the control trees, not inoculated.

Figure 4 – Necrosis and decay in the trunk (left) and at the collar (right)

The means of the decayed size surfaces don’t differ significantly for each species and within the same water regime.
No differences were also observed between the two water regimes both on linden and on horse chestnut deeply inoculated on the trunk and on the collar.

4. Bibliography