Genetics And Biodiversity Journal

Journal homepage: https://journals.univ-tlemcen.dz/GABJ/index.php/GABJ

ISSN: 2588-185X



Original Research Paper

Diversity of fungal communities in the soil of three nurseries in Tlemcen (North-West of Algeria)

SMAHI Hadjer¹, RIAHI Zineb², TEBBAL Rawane Soumicha², BELHOUCINE-GUEZOULI Latifa¹, GAOUAR Semir Bechir Suheil²

¹ Laboratory N°31: Conservatory management of water, soil and forests; Department of Forest Ressources, University of Abou Bekr Belkaid, Tlemcen, Algeria;

²Laboratory of Genetic applied in Agronomy, ecology and public health (GenApAgiE), Faculty SNV/STU, University of Abou Bekr Belkaid, Tlemcen, Algeria.

*Corresponding Author: Smahi Hadjer, Laboratory N°31: Conservatory management of water, soil and forests; Department of Forest Ressources, University of Abou Bekr Belkaid, Tlemcen, Algeria; Email: hadjerhadjer902@yahoo.fr/hadjer.smahi@univ-tlemcen.dz

Article history: Received: January 12 th 2022, Revised: March 20th 2022, Accepted: April 7th 2022

Abstract:

Fungi play a central role in most ecosystems and seem to dominate the microbial biomass in soil habitats, where they are important decomposers and occupy a notable position in the natural carbon, nitrogen and phosphorus cycles. Despite the fact that fungal species have been studied in several contexts, the diversity of some soil fungal species in nurseries is still unknown. This study aimed to explore the diversity of fungal species occurring in nursery soil of Tlemcen province (North-west of Algeria) and to test the antagonist effect of some isolates of Trichoderma sp. on species of the genus Pythium and those of *Diplodia*. Soil and root samples from young seedlings showing symptoms of oomycete infection and other fungal were collected in three nurseries of Tlemcen region. Following a soil baiting using fresh ornamental leaves, three Phytophthora species were isolated and identified based on morphology and microscopic observation. About the others groups, the dilution method using physiological water, revealed the presence of significant fungal biodiversity on the PDA medium. Twelve fungal species and five oomycetes have been isolated and identified, namely: *D. sapinea, Lasio. exigua, F. oxysporum, Aspergillus sp., Penicellium sp., Mucor sp., Trichoderma sp., Alternaria sp. P. cinnamomi, P. gonapodyides, P. ramorum, Py. ultimum and Py. Polare.* Significant antagonist activity was recorded for isolates of *Trichoderma sp. against Pythium sp.* and *Diplodia sp.*

Keywords: Fungi; Soil; Oomycetes; Nursery; Tlemcen

الملخص

تلعب الفطريات دورًا مركزيًا في معظم النظم البيئية ويبدو أنها تهيمن على الكتلة الحيوية الميكروبية في موائل التربة ، حيث تعتبر عوامل تحلل مهمة وتحتل مكانة بارزة في دورات الكربون والنيتروجين والفوسفور الطبيعية. على الرغم من حقيقة أن الأنواع الفطرية قد تمت دراستها في عدة سياقات ، إلا أن تنوع مكانة بارزة في دورات الكربون والنيتروجين والفوسفور الطبيعية. على الرغم من حقيقة أن الأنواع الفطرية قد تمت دراستها في عدة سياقات ، إلا أن تنوع بعض أنواع فطريات التربة في المشاتل لا يزال غير معروف. هدفت هذه الدراسة إلى استكشاف تنوع الأنواع الفطرية للموجودة في تربة المشتل في ولاية بعض أنواع فطريات التربة في المشاتل لا يزال غير معروف. هدفت هذه الدراسة إلى استكشاف تنوع الأنواع الفطرية الموجودة في تربة المشتل في ولاية بعض أنواع فطريات التربة في المشاتل لا يزال غير معروف. هدفت هذه الدراسة إلى استكشاف تنوع الأنواع الفطرية الموجودة في تربة المشتل في ولاية جمعت وينات التربة والجذور من الشتلات الصغيرة التي تظهر عليها أعراض الإصابة بالفطريات الفطرية في ثلاث مشاتل بمنطقة تلمسان. بعد تطبيق جمعت عينات التربة والجذور من الشتلات الصغيرة التي تظهر عليها أعراض الإصابة بالفطريات الفطرية في ثلاث مشاتل بمنطقة تلمسان. بعد تطبيق تقنية و تحديدها بناءا على الشكل المورفولوجي محاله واليه تظهر عليها أعراض الإصابة بالفطريات الفرية الطازجة، و بالتالي بمنطقة تلمسان. بعد تطبيق أنواع من تقنية و تحديدها بناءا على الشكل المورفولوجي مالالإطريات وخمسة من نوع استخدام أوراق نباتات الزينة الطازجة، و بالتالي تم عزل ثلاثة أنواع من بقنية و تحديد مرال و تحديد PDA حول المجموعات الأخرى ، كشفت طريقة التخفيف باستخدام المياه الفسيولوجية عن وجود بيوع بيولوجي فطري كبير على وسط و هي: وصرية و تحديد PDA حول المجموعات الأخرى ، كشفت طريقة التخفيف باستخدام المياه المازيدية الحازية بالمان و موي دوور بي و و بيقان الزر مان و فور بيوع بيولوجي فطري كبير على وسط و هي: وهنوا و المرفولوجي على الفرريات وخمسة من نوع عدماته من و و هي: وحود تنوع بيولوجي فطري كبير علي وحديد معان و لول عمن دولو و تحديد مرار و تمام من الفرريات وخمسة من نوع المولولي و المالي و و مي مالولولو و بيولو وي بيولو وي بير على و ممان و هي عشر و هي: عشر و و و و و يلان و و و و ي مان ثلاقة أنواع من و و و و و و و و و و و و و و و

الكلمات الرئيسية: الفطريات؛ تربة؛ Oomycetes، مشتلة، تلمسان

Introduction

Soil is not simply the medium in which plants take root and draw the nutrients essential for their development, but also a fantastic reservoir of Microorganisms (bacteria and fungi), in terms of diversity and density. In fact, one gram of vegetated soil contains about 1 billion bacteria divided into 5 to 25 000 species, most of which are not yet known or even cultivable in the laboratory (Curtis *et al.*, 2002). Thus, as much as 200 meters of hyphae per gram of dry soil (Leake *et al.*, 2004).

Fungi have many different functions in soils, which include either active roles, such as the degradation of dead plant material, or negative roles by degrading plant tissues (Roots, leaves, vascular tissues... (Yan *et al.*, 2019).

The complex interactions between these microbial populations and the soil determine the health of soil. The impact of these microorganisms on plant growth and health is still poorly understood. The rhizospheric microflora is naturally made up of a complex assembly of prokaryotic and eukaryotic microorganisms (Cardon and Gage, 2006; Kent and Triplett, 2002). Among these microorganisms, some are present in the rhizosphere without their influence on plant development, such as commensal fungi, some are favorable to plants, such as mycorhize fungi. While, others have deleterious effects on plants. They are known as parasitic or phytopathogenic fungi (Lepinay, 2013).

The majority of plant diseases are caused by this genus of soil-based fungi, widely distributed in the soil; causing crop rots damaging many plants, in forests, agricultural fields or nurseries which do not respect health measures. As other countries, diseases caused by soil fungi are encountered in Algeria. These fungal species growing in contact with earthy agglomerates or in cavernous interstices in the soil are, morphologically or biologically structured depending on the nature of the environment to which they are subjected. The survival of parasitic fungal species in the soil is also manifested by the production of particularly adapted organs such as mycelial encystments or clamydospore, mycelial nodules or sclerotic, cords or rhizomorphs originating from the collection of hyphae (Viennot-Bourgin *et al.*, 1970). According to Tschen *et al.* (1985), this is one reason why these telluric species are difficult to control. In addition, their infection process is rapid, either through the soil by root, irrigation water.

In order to deepen our knowledge on soil-based fungi associated with the mortality of young seedlings in North-west Algerian nurseries, a study was carried out, and aimed to: (i) Inventory the fungal mycoflora associated with the three nurseries of Tlemcen province; (ii) Identify and characterize isolated fungal species; and finally (iii) to demonstrate the antagonistic properties of some isolates of Trichoderma sp. on species of the genus *Pythium* and those of *Diplodia*.

Material and methods

Description of prospected sites

The study was conducted in Tlemcen province (North-west of Algeria) between January and March 2021. Three nurseries were selected in this region: Nursery 1 "The Growing Tree" (34°53'27"N; 1°20'35"W), it is a nursery type in which soil and its activity are based on intensive methods for growing different forest, fruit and ornamental species. Its area exceeds 5 ha. Nursery 2 "My garden" (34°54'16''N; 1°19'56''W). It is a nursery cultivating on soil, forest, fruit and ornamental trees, and exotic plants on the soil. The irrigation system is based on sprinkling with fresh water and precipitation. It is located at "Aboutachfine" -Tlemcen, and its area is more than 1 ha. Nursery 3: "La Rocade" (34°53' 49''N; 1°21'01''W). It is specialized in growing fruit trees and some forest trees, with an area exceeding 3 ha. The irrigation system is based on simple watering.

Sampling

The choice of these nurseries is based on the health status of the seedlings that exists, as well as on the presence of symptoms of *Phytophthora* and *Pythium* infections, as described by several authors (Brasier 1996; Scanu *et al.*, 2013 and Smahi *et al.*, 2017a), namely the thinning of the aerial part, discoloration or yellowing of the leaves, the presence of reduced leaves, and the progressive necrosis of the fine nourishing roots.

To inventory the fungal biodiversity involved in this state of degradation of young seedlings, we carried out random sampling, based on the visualization of diseased seedlings. A total of 42 samples were collected from the forest, fruit, and ornamental plants: (15 samples from the first nursery, 15 from the second nursery, and 12 from the third). Our sampling procedure was based on the method described by Scanu *et al.* (2013) and Smahi *et al.* (2017a):

For each seedling, roots and 500 g of rhizosphere soil were collected in opposite directions. Roots samples were cut from each seedling and placed in plastic bags, labeled and transported to the laboratory stored at 5 $^{\circ}$ C until use.

Isolation of pathogen

To detect oomycetes and other soil fungi from samples, two methods were used; the first was the baiting method, and the second was dilution with different concentration.

1. Rhizosphere soil and root pieces were water-flooded with fresh oak leaves acting as baits for Phytophthora zoospore infection (Jung *et al.*, 1996). According to our experience, the rose petals have been excellent bait for *Phytophthora* spores (Fig.1). After 3 to 5 days of incubation at room temperature, leaves showing necrotic lesions were carefully dried on sterile filter paper, cut into small squares (0.5x0.5 cm), and placed on a selective medium (Synthetic Mucor Agar) (Scanu *et al.*, 2014). Then, plates were incubated at 20 °C in the dark and monitored daily for any growth. All colonies representing typical morphology of *Phytophthora* spp. and *Pythium* spp. were subcultured separately on Potatoes dextrose Agar (PDA) for morphological and microscopic identification. The pure cultures were incubated at 20 °C in the dark.

2. The serial dilution method has been used to reliably quantify the bacterial, fungal, or viral load (Koch, 1883; Ben-David and Davidson, 2014). The dilution was performed with sterile physiological water as follows:

From each sample, 1g of soil is added to 9 ml of physiological water, which corresponds to the 10-1 dilution. Then, 1 ml of this dilution is added to 9 ml of sterile water to have the 10-2 dilution until reaching the 10-5 dilution. After, 1 ml of each dilution was placed on PDA (Potatoes Dextrose Agar). The plates were incubated for 5-7 days at 25 $^{\circ}$ C in the dark.

Identification of isolates

The pure cultures obtained were grouped according to their macroscopic characteristics to choose only representatives of each group for identification. These morphological characteristics are: The texture and macroscopic aspect of the thallus, its color (face and reverse), its elevation, the smell and the shape of the margin.



Figure 1. (Left) The appearance of blackish spots on the rose petals, (Right) The development of the mycelium surrounding the squares of the rose petal on PDA.

For some oomycetes, a sporulation technique has been implemented to produce sporangia: for each isolate, 4 to 5 squares of 1 cm2 were taken and placed in a petri dish containing about 10 ml of non-sterile distilled water as used by several authors (Scanu *et al.*, 2014; Smahi *et al.*, 2017b). The plats are incubated at laboratory temperature under permanent light to accelerate the appearance of sporangia, otherwise daylight. The small squares of mycelium were checked daily under a microscope for the presence of sporangia. The shape of sporangia, chlamydospores, hyphal swellings and pedicels were recorded using "Oxion Euromex" to identify each isolate.

The other fungal species were identified, based on microscopic criteria (The shape of the vesicle, the disposition and the shape of the spores and conidia, septation of conidia, the partitioning of the mycelium, etc). Guides used are: Barnett and Hunter (1975), Champion (1997); and Botton *et al.* (1990), Erwin and Ribeiro (1996), Phillips *et al.* (2012) and (2013), Jung *et al.* (2017), Smahi *et al.* (2017a, b),

Antagonist test

Two isolate of *Trichoderma* species (*Tri. Harzianum* and *Tri. Viride*) present in the three nurseries were evaluated for their ability to control *Pythium sp.* and *Dilplodia sp.* using the method described by Benhanou and Chet (1996): 5 mm discs of each culture of Trichoderma (5 days old culture) and the same of another agar disc containing tested fungi placed opposite to each other and close to the periphery of 90 mm Petri plates containing PDA. All pairing was carried out in two replicates and incubated at 25°C.

Data analysis

The statistical analysis was performed using the MINITAB.19. The number of each fungal species was evaluated through standard error (SE). Then, a parametric test (One way ANOVA) was performed to check differences among species. Fisher test was used for multiple comparisons (<0.05).

Results and discussion

Symptomatology

During the field survey, seedlings showing symptoms of dieback and root rot disease were observed in the three nurseries (Fig.2): The most common symptoms recorded in all sites prospected are wilting and leaf yellowing, typical of root rot disease.

At the leaf level, different symptoms have been observed. First, the leaves begin to dry out from the margin and progress to the leaf blade, as well as total or partial yellowing affecting only one side of the leaf blade in some plants. Then, wilting of the leaves and inflorescences occur with necrosis on the margins of the leaves. At the root level, different symptoms were observed. Indeed, rot and necrosis were reported in most of the seedlings. Sometimes, this root necrosis of a dark brown color tending to black, can go up to the aerial part of the plant and invade in the xylem tissues of the crown or those of the trunk.



Figure 2. Symptoms observed on infected seedlings in prospected nurseries: (A) spots on infected leaves; (B) Dieback and wilting of plants; (C) Death of young seedlings; (D) necrosis of the collar.

Fungal isolation and identification

Isolation carried out from 42 infected seedlings yielded a total of 12 fungal colonies belonging to different groups, and 5 Oomycetes (Table 1). Based on morphological features and microscopic characteristics, the species have been identified as: *Fusarium oxysporum, Alternaria solani, Alt. alternate, Trichoderma harzianum, Tri. viride, Aspergillus niger, Asp. fumigatus, Penicellium solitum, Phytophthora gonapodyides, P. cinnamomi, P. ramorum, Pythium ultimum, Py. polare, Mucor racemosus, Rhizopus stolonifer, Diplodia sapinea* and *Lasiodiplodia exigua* (Figure 3).

Bases 1Psidum guajeraSoilAlternara p., Psidimus ap., Macor s.p., Penicellium s.p., Trichoderma p.,ZR 2Nussey 1Copressus y.Collar-soil +Psychirmu, Aspergillus s.p., Macor s.p., Aspergillus s.p.,ZR 3Nussey 1Ecaconformum y.Soil +Psychirmu, Aspergillus s.p.,ZR 4Nussey 1Ecaconformum y.Soil +Psychirmu, Trichoderma y.,ZR 5Nussey 1Kas y.RolaPsychirmu, Aspergillus y.,ZR 6Nussey 1Copressus y.,Collar +D. sapinea, Alternaria y.,ZR 7Nussey 1Abie s.p.,SoilZR 8Nussey 1Copressus y.,Collar +D. sapinea, Alternaria y.,ZR 10Nussey 1Copressus y.,Collar +-ZR 11Nussey 1Copressus y.,Collar +-ZR 12Nussey 1Copressus y.,Collar +-ZR 13Nussey 1Quercus suber LSoil +-ZR 14Nussey 1Quercus suber LSoil +-ZR 15Nussey 1Quercus suber LSoil +-ZR 16Nussey 1Concessus due LSoil +-ZR 17Nussey 1Concessus due LSoil +-ZR 18Nussey 1Concessus due LSoil +-ZR 19Nussey 1Concessus due LSoil +-ZR 14Nussey 1Concessus due LSoil +-ZR 15Nussey 2Proindum, Rona due	N° Sample	Nursery	Host plant	Sampling part	+/-	Identified species
2R2 Nursey 1 Copressus sp. Collar scall Psychiane, Macor sp., Pericellium sp., Alternaria sp., Apergillus sp., 2R3 Nursey 1 Ficus corica Soil + Psychiane, Trichoderma sp., 2R4 Nursey 1 Rosa sp., Rost + Psychiane, Macor sp., Apergillus sp., Trichoderma sp., 2R4 Nursey 1 Abies sp., Soil + Dsaphea, Alternaria sp., 2R4 Nursey 1 Abies sp., Soil + Dsaphea, Alternaria sp., 2R4 Nursey 1 Abies sp., Soil - - 2R4 Nursey 1 Cercisus sp., Collar - - 2R4 Nursey 1 Cercisus sp., Soil - Isio.crigua, Macor sp., 2R4 Nursey 1 Quercus suber L Soil - Macor sp., Apergillus sp., 2R4 Nursey 1 Circa innon Soil - Macor sp., Apergillus sp., 2R4 Nursey 1 Circa innon Soil - Macor sp., Apergillus sp., 2R4 Nursey 1 Circa innon Soil - Alternaria sp., Anterenta sp.,	ZR 1	Nursery 1	Psidium guajava	Soil	+	Alternaria sp., Py.ultimum, Aspergillus sp., Mucor sp., Penicellium sp., Trichoderma sp.
2R 3 Nursery 1 Leucanthemum sp. Soil + Previolitions op. 2R 4 Nursery 1 Rous ap. Root + Previolitions op. 2R 5 Nursery 1 Rous ap. Root + Previolitions op. 2R 6 Nursery 1 Cupressus sp. Collar + D. sapinee. Alternaria op. 2R 7 Nursery 1 Previdian aquilitum Soil - D. sapinee. Alternaria op. 2R 8 Nursery 1 Previdian aquilitum Soil - - 2R 10 Nursery 1 Previdian aquilitum Soil + Lasio actigue. Mucor sp., 2R 11 Nursery 1 Quercus suber L Soil + Mucor sp., Aspergillus op., 2R 13 Nursery 1 Quercus suber L Soil + Mucor sp., Aspergillus op., 2R 14 Nursery 1 Ricine communis Collar + Mucor sp., Aspergillus op., 2R 14 Nursery 2 Cupressus sp. Collar + Mucor sp., Apergillus op., Putilinum, 2R 14 Nursery 2 Cupressus sp. Collar + Putilinum, Foxyporon	ZR 2	Nursery 1	Cupressus sp.	Collar+soil	+	Py.polare, Mucor sp., Penicellium sp., Alternaria sp., Aspergillus sp.,
\mathbb{Z} R 4Nursey 1Ficis caricaSoil+Penetellium sp., Trichoderma sp. \mathbb{Z} R 5Nursey 1Ross sp.Soil+ $P_{polare, Mucor g., Apergillus g., Trichoderma sp.\mathbb{Z}R 6Nursey 1Abies sp.Soil+D_{sapinea, Aleraria sp.}\mathbb{Z}R 8Nursey 1Pieridium aquilinumSoil\mathbb{Z}R 8Nursey 1Cupressus sp.Collar\mathbb{Z}R 10Nursey 1Cupressus sp.Collar\mathbb{Z}R 11Nursey 1Querces suber LSoil+Lavicous d.Macor sp.,\mathbb{Z}R 12Nursey 1Querces suber LSoil+Mucor sp., Apergillus g.,\mathbb{Z}R 13Nursey 1Querces suber LSoil+Mucor sp., Apergillus g.,\mathbb{Z}R 14Nursey 1Guerces suber LSoil+Mucor sp., Apergillus g.,\mathbb{Z}R 15Nursey 1Guerces suber LSoil+Mucor sp., Apergillus g.,\mathbb{Z}R 14Nursey 1Guerces suber LSoil+Mucor sp., Apergillus g., Proincellium sp.,\mathbb{Z}R 16Nursey 2Cupressas Sp.Collar+Mucor sp., Apergillus g., Proincellium sp.,\mathbb{Z}R 16Nursey 2Cupressas Sp.Collar+Mucor sp., Apergillus g., Proincellium sp.,\mathbb{Z}R 10Nursey 2Cupressas Sp.Collar+Provessillas g., Collar\mathbb{Z}R 11Nursey 2Cupressas Sp.Collar+Provessillas g., Collar\mathbb{Z}R 20N$	ZR 3	Nursery 1	Leucanthemum sp.	Soil	+	Py.ultimum, Trichoderma sp., Aspergillus sp.,
Zk 5Nursery 1Rost 9,Rost +Pyplare. Mucor 2p., Aspergillus 9p., Trichoderma 9p.,Zk 6Nursery 1Abies 9p.Soil +D. sapinea, Alternaria 9p.Zk 7Nursery 1Pieridun aquiliumSoil -Zk 8Nursery 1Preirdun aquiliumSoil -Zk 9Nursery 1Pieridun aquiliumRost +Zk 10Nursery 1Pieridun aquiliumRost +Zk 11Nursery 1Quereus suber LSoil +Zk 12Nursery 1Quereus suber LSoil +Zk 13Nursery 1Quereus suber LSoil +Zk 14Nursery 1Quereus suber LSoil +Zk 15Nursery 1Quereus suber LSoil +Zk 16Nursery 1Quereus suber LSoil +Zk 17Nursery 1Rician communisCollar +Alternaria p., Aspergillus p., Proviciulium p., Prustimm, p.,	ZR 4	Nursery 1	Ficus carica	Soil	+	Penicellium sp., Trichoderma sp.
$\mathbb{Z}86$ Nussey1 $Cugressus sp.$ Collar + $D.$ sapinea, $P.$ innamomi, $P.micellium sp.$ $\mathbb{Z}87$ Nussey1 $Preridum aquilinumSoil-D.\mathbb{Z}88Nussey1Cugressus sp.\operatorname{Collar}- \mathbb{Z}810Nussey1Dericsus sp.\operatorname{Collar}- \mathbb{Z}8110Nussey1Quercus suber L.Soil+Lasioesigua, Mucor sp.\mathbb{Z}8112Nussey1Quercus suber L.Soil+Mucor sp., Apregrillus sp.\mathbb{Z}8113Nussey1Quercus suber L.Soil+Mucor sp., Apregrillus sp.\mathbb{Z}8143Nussey1Quercus suber L.Soil+Mucor sp., Apregrillus sp.\mathbb{Z}8165Nussey1Cura linonSoil+Mucor sp., Apregrillus sp.\mathbb{Z}8165Nussey2Cugressus sp.\operatorname{Collar}+Alternaria gp. Aspregrillus sp.\mathbb{Z}8165Nussey2Cugressus sp.\operatorname{Collar}+Alternaria gp. Aspregrillus sp.\mathbb{Z}8165Nussey2Cugressus sp.\operatorname{Collar}+Lasioexigua. Foosyporation sp.\mathbb{Z}8175Nussey2Prendelitim aquilinumRost+P.\mathbb{Z}8185Nussey2Quercus suber L.Collar+Lasioexigua. Foosyporation sp.\mathbb{Z}8185Nussey2Quercus suber L.Collar+Lasioexigua. Foosyporation sp.\mathbb{Z}8240Nussey2Quercus suber L.Collar+P.$	ZR 5	Nursery 1	Rosa sp.	Root	+	Py.polare, Mucor sp., Aspergillus sp., Trichoderma sp.,
ZR 7 Nursery 1 Ables sp. Soil + D. septnea, P. cinamoni, Penicellium sp. ZR 8 Nursery 1 Copressus sp. Collar - - ZR 10 Nursery 1 Copressus sp. Collar - - ZR 10 Nursery 1 Opercus suber L Soil + Pryulinum, Trichoderma sp., Macor sp., ZR 11 Nursery 1 Opercus suber L Soil + Depictor, Penicellium sp., ZR 13 Nursery 1 Opercus suber L Soil + Macor sp., Appergillus sp., ZR 14 Nursery 1 Christs linon Soil + Macor sp., Appergillus sp., ZR 15 Nursery 2 Copressus sp. Collar + Macor sp., Appergillus sp., ZR 16 Nursery 2 Preridum aquinum Root + Proxyporan ZR 18 Nursery 2 Preridum aquinum Root + Proxyporan ZR 18 Nursery 2 Pranus dulcis Soil + Proxyporan ZR 18 Nursery 2 Opressus sp. Collar + Proxyporan ZR 20	ZR 6	Nursery 1	Cupressus sp.	Collar	+	D. sapinea, Alternaria sp.
ZR 8 Nursey 1 Percilium aquilinum Soil ZR 9 Nursey 1 Percilium aquilinum Rot + ZR 10 Nursey 1 Percilium aquilinum Rot + ZR 11 Nursey 1 Quercus suber L Soil + ZR 12 Nursey 1 Quercus suber L Soil + ZR 13 Nursey 1 Quercus suber L Soil + ZR 14 Nursey 1 Quercus suber L Soil + ZR 14 Nursey 1 Quercus suber L Soil + ZR 14 Nursey 2 Citrus limon Soil + ZR 16 Nursey 2 Citrus limon Soil + ZR 16 Nursey 2 Percialum aquilinum Rot + Psyalinum, F. oxyoporum ZR 18 Nursey 2 Citrus limon Soil + Psyalinum, F. oxyoporum Psyalinum, F. oxyoporum ZR 10 Nursey 2 Quercus suber L Collar + Lasio.exigua, Anory, Freicellium sp. Psyalinum, F. oxyoporum ZR 20 Nursey 2 Abies sp. Collar +	ZR 7	Nursery 1	Abies sp.	Soil	+	D. sapinea, P. cinnamomi, Penicellium sp.
ZR 9Nursey 1Cupressus sp. Derdian agailinamCollarZR 10Nursey 1Dericus suber LSoil+ZR 11Nursey 1Quercus suber LSoil+ZR 12Nursey 1Quercus suber LSoil+ZR 13Nursey 1Quercus suber LSoil+ZR 14Nursey 1Citrus linonSoil+ZR 15Nursey 1Citrus linonSoil+ZR 16Nursey 2Capressus sp.Collar+Alternaria sp. Aspergillus sp.Penciellium spZR 16Nursey 2Capressus sp.Collar+Alternaria sp.Penciellium spZR 16Nursey 2Perduin agailumRoot+ZR 17Nursey 2Penciellium spZR 18Nursey 2Penciellium spZR 19Nursey 2Penciellium spZR 10Nursey 2Penciellium spZR 11Nursey 2Penciellium spZR 12Nursey 2Quercus suber LCollar+-ZR 10Nursey 2Quercus suber LCollar+-ZR 20Nursey 2Quercus suber LCollar+-ZR 21Nursey 2Princial anneniacaSoil+-ZR 22Nursey 2Abies sp.Collar+-ZR 24Nursey 2Abies sp.Collar+-<	ZR 8	Nursery 1	Pteridium aquilinum	Soil	-	· · · · ·
ZR 10 Nursey 1 Pieridian aquilinum Rot + Pyulinum, Trichoderma gp., Mucor sp., ZR 11 Nursey 1 Quercus suber L. Soil + Laio exigua, Mucor sp., ZR 13 Nursey 1 Quercus suber L. Soil + Mucor sp., Aspergillus sp., ZR 14 Nursey 1 Cursus linon Soil + Mucor sp., Aspergillus sp., ZR 14 Nursey 1 Cursus linon Soil + Mucor sp., Aspergillus sp., Fusarium sp., Paicellium sp., ZR 16 Nursey 2 Cursus sp. Colar + Alternaria sp., Aspergillus sp., Fusarium sp., ZR 18 Nursey 2 Prenus ducis Soil + P.p., Mucor sp., Aspergillus sp., Fusarium sp., ZR 18 Nursey 2 Cursus suber L. Colar + P.gourance, Mucor sp., Aspergillus sp., Trichoderma sp., ZR 18 Nursey 2 Quercus suber L. Colar + P.gourance, Mucor sp., Aspergillus sp., Trichoderma sp., ZR 21 Nursey 2 Guras suber L. Colar + P.gourance, Mucor sp., Alternaria sp., ZR 23 Nursey 2 Ficus carica Soil + P.gourance, Muco	ZR 9	Nursery 1	Cupressus sp.	Collar	-	
ZR 11 Nursery 1 Quercus suber L. Soil + Lasio.exigua, Mucor sp., ZR 13 Nursery 1 Quercus suber L. Soil + Px polare, Penicellium sp., ZR 13 Nursery 1 Quercus suber L. Soil + Mucor sp., Aspergillus sp., ZR 14 Nursery 1 Ricinx communis Collar + Mucor sp., Aspergillus sp., Fusariam sp. Penicellium sp., ZR 15 Nursery 1 Ricinx communis Collar + Mucor sp., Aspergillus sp., Penicellium sp., ZR 16 Nursery 2 Curressus sp. Collar + Mucor sp., Aspergillus sp., Penicellium sp., ZR 17 Nursery 2 Piretidium aquilinum Root + P.commoni, Aspergillus sp., Penicellium sp., ZR 18 Nursery 2 Cluras linon Soil + P.commoni, Aspergillus sp., Pichoderma sp., ZR 20 Nursery 2 Guercus suber L. Collar + Lasio.exigua, F. oxysporum, Trichoderma sp., ZR 21 Nursery 2 Picus carica Soil + P. ganapadyides, Mucor sp., Alternaria sp. ZR 23 Nursery 2 Ables sp. Collar + D.spinea.	ZR 10	Nursery 1	Pteridium aquilinum	Root	+	Py.ultimum, Trichoderma sp., Mucor sp.,
ZR 12 Nursery 1 Quercus suber L. Soil + Prycolare. Pericellium sp., ZR 13 Nursery 1 Quercus suber L. Soil + Mucor sp., Aspergillus sp., ZR 14 Nursery 1 Citrus limon Soil + Mucor sp., Aspergillus sp., ZR 16 Nursery 2 Reirons communis Collar + Alternaria sp., Aspergillus sp., Penicellium sp., ZR 16 Nursery 2 Cupressus sp. Collar + Mucor sp., Aspergillus sp., Penicellium sp., ZR 18 Nursery 2 Prindium quilinum Root + F.oxyporum, Aspergillus sp., Penicellium sp., ZR 18 Nursery 2 Paruas ducis Soil + Ps.ultinum, F.oxyporum ZR 19 Nursery 2 Quercus suber L. Collar + Laio.exigua, F. oxyporum, Trichoderma sp., ZR 20 Nursery 2 Eucalyptus globulus Soil + P. gonapodyide, Mucor sp., Alternaria sp. ZR 21 Nursery 2 Abies sp. Collar + P.oxyporum, Trichoderma sp., Penicellium sp., ZR 24 Nursery 2 Abies sp. Collar + D.sapinea, Aluerorajn, Sp., Penicellium sp	ZR 11	Nursery 1	Quercus suber L.	Soil	+	Lasio.exigua, Mucor sp.,
ZR 13 Nursery 1 Quercus suber L. Soil + Mucor sp., Aspergillus sp., ZR 14 Nursery 1 Citrus limon Soil + Mucor sp., Aspergillus sp., Prestributes sp., ZR 15 Nursery 2 Cuprexsus sp. Collar + Mucor sp., Aspergillus sp., Prestributes sp., ZR 17 Nursery 2 Cuprexsus sp. Collar + Mucor sp., Aspergillus sp., Prestributes sp., ZR 17 Nursery 2 Prestributes sp., Collar + Mucor sp., Aspergillus sp., Prestributes sp., ZR 18 Nursery 2 Prestributes Sp., Collar + Prestributes sp., Prestributes sp., ZR 18 Nursery 2 Quercus suber L. Collar + Prestributes sp., Collar sp., ZR 20 Nursery 2 Fores carica Soil + Prestributes sp., Collar sp., ZR 21 Nursery 2 Abies sp. Collar + D. sopinea, Mucor sp., Trichoderma sp., ZR 23 Nursery 2 Abies sp. Collar + D. sopinea, Mucor sp., Trichoderma sp., ZR 24 Nursery 2 <t< td=""><td>ZR 12</td><td>Nursery 1</td><td>Quercus suber L.</td><td>Soil</td><td>+</td><td>Py.polare, Penicellium sp.,</td></t<>	ZR 12	Nursery 1	Quercus suber L.	Soil	+	Py.polare, Penicellium sp.,
ZR 14Nursery 1Citrus limonSoil+Mucor sp., Aspergillus sp.,ZR 15Nursery 1Ricinus communisCollar+Alternaria sp., Aspergillus sp., Fusarium sp. Penicellium sp.,ZR 16Nursery 2Cupressus sp.Collar+Mucor sp., Aspergillus sp., Penicellium sp.,ZR 17Nursery 2Prieridum aquilinumRoot+Foxysportm, Aspergillus sp., Penicellium sp.,ZR 18Nursery 2Prinus dulcisSoil+Prinulinum, FoxysportmZR 19Nursery 2Citrus limonSoil+Prinulinum, FoxysportmZR 20Nursery 2Quercus suber LCollar+Lasio.exigua, F. oxysportm, Trichoderma sp., Penicellium sp.ZR 21Nursery 2Ficus caricaSoilZR 22Nursery 2Forus armeniacaSoil+P. gonapodyide, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.,ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Olea surmeniacaSoil+Py.ultimum, Aspergillus sp., P. cinnamoni, Mucor sp.,ZR 27Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamoni, Mucor sp.,ZR 28Nursery 3Pieridium aquilinumRoot+Py.ultimum, Aspergillus sp., P. cinnamoni, Alternaria sp.,ZR 28Nursery 3Pieridium aquilinumRoot+Pienicellium sp., Mucor sp.	ZR 13	Nursery 1	Quercus suber L.	Soil	+	Mucor sp., Aspergillus sp.,
ZR 15Nursery 1Ricinus communisCollar+Alternaria sp., Aspergillus sp., Fusarium sp. Penicellium sp.,ZR 16Nursery 2Cupressus sp.Collar+Mucor sp., Aspergillus sp., Penicellium sp.,ZR 17Nursery 2Pteridium aquilinumRoot+F.oxsporun., Aspergillus sp., Penicellium sp.,ZR 18Nursery 2Ptrus limonSoil+P.ultinuum, F. oxysporunZR 19Nursery 2Quercus suber L.Collar+Lasio.exigua, F. oxysporun, Trichoderna sp., Penicellium sp.ZR 20Nursery 2Quercus suber L.Collar+Lasio.exigua, F. oxysporum, Trichoderna sp., Penicellium sp.ZR 21Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 23Nursery 2Fucus caricaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderna sp., Alternaria sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderna sp.,ZR 26Nursery 2Oldea europeaSoilZR 27Nursery 3Oldea europeaSoilZR 28Nursery 3Oldea europeaSoilZR 29Nursery 3Oldea europeaSoilZR 21Nursery 3Oldea europeaSoilZR 28Nursery 3Prediau maquilinumRoot+Penicellium sp., Cinnam	ZR 14	Nursery 1	Citrus limon	Soil	+	Mucor sp., Aspergillus sp.,
ZR 16Nursery 2Cupressus sp.Collar+Mucor sp., Aspergillus sp., Penicellium sp., Ps.ultimum,ZR 17Nursery 2Pretridium aquilinumRoot+F. oxysporum, Aspergillus sp., Penicellium sp.,ZR 18Nursery 2Pranus dulcisSoil+F. oxysporum, F. oxysporumZR 19Nursery 2Ottarus limonSoil+F. oxysporum, F. oxysporumZR 20Nursery 2Quercus suber LCollar+Lasoexigua, F. oxysporum, Trichoderma sp.,ZR 21Nursery 2Ficus caricaSoilZR 22Nursery 2Fucus armeniacaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp.,ZR 25Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp.,ZR 26Nursery 2Oties sp.Collar+P. pulnium, Aspergillus sp., P. cinnamomi, Mucor sp.,ZR 26Nursery 3Ficus caricaSoilZR 28Nursery 3Otea europeaSoilZR 29Nursery 3Pretridium aquilinumRoot+Penicellium sp., Mucor sp., Cinnamomi, Mucor sp.,ZR 31Nursery 3Quercus suber LCollar+Lasio exigua, Alternaria sp., P. cinnamomi, Alternaria sp.,ZR 29Nursery 3Otea europeaSoilZR 29Nursery 3Otea europeaSoilZR 31Nursery 3Quer	ZR 15	Nursery 1	Ricinus communis	Collar	+	Alternaria sp., Aspergillus sp., Fusarium sp. Penicellium sp.,
ZR 17Nursery 2Pteridium aquilinumRoot+F. oxysporum, Aspergillus sp., Penicellium sp.,ZR 18Nursery 2Pranus dulcisSoil+P. dutimum, F. oxysporumZR 19Nursery 2Citrus limonSoil+P. cinnamoni, Aspergillus sp., Trichoderma sp.,ZR 20Nursery 2Quercus suber LCollar+Lasio.exigua, F. oxysporum, Trichoderma sp.,ZR 21Nursery 2Ficus caricaSoilZR 22Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 23Nursery 2Pranus armeniacaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., enciclium sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Ole aeuropeaSoilZR 27Nursery 3Ficus caricaSoil+P. pultinum, Aspergillus sp., P. cinnamoni, Mucor sp.ZR 28Nursery 3Pricus caricaSoilZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Olea europeaSoilZR 32Nursery 3Pricus caricaRoot+Painea, Mucor sp., Trichoderma sp.,ZR 31Nursery 3Olea europeaSoilZR 32Nursery 3Prinus dulcisRoot+Alter	ZR 16	Nursery 2	Cupressus sp.	Collar	+	Mucor sp., Aspergillus sp., Penicellium sp., Py.ultimum,
ZR 18Nursery 2Pranus dulcisSoil+Py.ultimum, F. oxysporumZR 19Nursery 2Citrus limonSoil+P. cinnamoni, Asperzillus sp., Trichoderma sp.,ZR 20Nursery 2Quercus suber LCollar+Lasio.exigua, F. oxysporum, Trichoderma sp.,ZR 21Nursery 2Ficus caricaSoil+Lasio.exigua, F. oxysporum, Trichoderma sp.,ZR 22Nursery 2Ficus caricaSoil+P. gonapodyides, Micor sp., Alternaria sp.ZR 23Nursery 2Prinus armeniacaSoil+P. gonapodyides, Micor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Trichoderma sp.,ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Oltae suropeaSoil+Pry.oltimum, Aspergillus sp., P. cinnamoni, Mucor sp.,ZR 27Nursery 2Olea europeaSoil+Penicellium sp., Mucor sp., Trichoderma sp.ZR 28Nursery 3Picens caricaSoil+Penicellium sp., Mucor sp., Trichoderma sp.ZR 29Nursery 3Olea europeaSoilZR 31Nursery 3Olea europeaSoil+Penicellium sp., P. cinnamoni, Alternaria sp.ZR 31Nursery 3Olea europeaSoil+Alternaria sp., P. cinnamoni, Alternaria sp.ZR 32Nursery 3Pranus dulcisRoot+Alternaria sp., P. cinnamoni, Alternaria sp. <tr<tr>ZR 33<</tr<tr>	ZR 17	Nursery 2	Pteridium aquilinum	Root	+	F. oxysporum, Aspergillus sp., Penicellium sp.,
ZR 19Nursery 2Citrus limonSoil+P. cinnamomi, Aspergillus sp., Trichoderma sp.,ZR 20Nursery 2Quercus suber LCollar+Lasio.exigua, F. oxysporum, Trichoderma sp.,ZR 21Nursery 2Ficus caricaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 22Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 23Nursery 2Pranus ameniacaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp.,ZR 26Nursery 2Olea europeaSoil+Py.polare, Penicellium sp.,ZR 27Nursery 3Ficus caricaSoil+Py.polare, Penicellium sp.,ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 29Nursery 3Picue auropeaSoilZR 31Nursery 3Quercus suber LCollar+Lasio.exigua, Alternaria sp., P. cinnamomi, Alternaria sp.ZR 32Nursery 3Pranus ducisRoot+Alternaria sp., P. conapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Pranus ducisRoot+Alternaria sp., P. conapodyides, Sp., SoilZR 34Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 35Nursery	ZR 18	Nursery 2	Prunus dulcis	Soil	+	Py.ultimum, F. oxysporum
ZR 20Nursery 2Quercus suber LCollar+Lasio.exigua, F. oxysporum, Trichoderma sp., Penicellium sp.ZR 21Nursery 2Ficus caricaSoilZR 22Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 23Nursery 2Prunus armeniacaSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Trichoderma sp., Trichoderma sp.,ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Citrus limonSoil+Py.polare, Penicellium sp.,ZR 27Nursery 3Ficus caricaSoil-ZR 28Nursery 3Ficus caricaSoil-ZR 29Nursery 3Olea europeaSoil-ZR 30Nursery 3Olea europeaSoil-ZR 31Nursery 3Olea europeaSoil-ZR 32Nursery 3Olea europeaSoil-ZR 33Nursery 3Olea europeaSoil-ZR 34Nursery 3Prunus dulcisRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., Aspergillus sp., Sp.ZR 34Nursery 3Funcus suber LCollar+D. sapinea, Alternaria sp., Aspergillus sp., SoilZR 33Nursery 3Eucalyptus globulus<	ZR 19	Nursery 2	Citrus limon	Soil	+	P. cinnamoni, Aspergillus sp., Trichoderma sp.,
ZR 21Nursery 2Ficus caricaSoil-ZR 22Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 22Nursery 2Pranus armeniacaSoil+P. ramorum, Trichoderma sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp., and the sp.ZR 26Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp., and the sp.ZR 27Nursery 2Olea europeaSoilZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 31Nursery 3Quercus suber LCollar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Prunus armeniacaRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyides, S. f. oxysporum, Aspergillus sp., SoilZR 35Nursery 3Abies sp.Soil	ZR 20	Nursery 2	Quercus suber L.	Collar	+	Lasio.exigua, F. oxysporum, Trichoderma sp., Penicellium sp.
ZR 22Nursery 2Eucalyptus globulusSoil+P. gonapodyides, Mucor sp., Alternaria sp.ZR 23Nursery 2Prunus armeniacaSoil+P. ramorum, Trichoderma sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.ZR 26Nursery 2Citrus limonSoil+P. sapinea, Mucor sp., Trichoderma sp.,ZR 27Nursery 2Olea europeaSoilZR 28Nursery 3Ficus caricaSoil+Py.polare, Penicellium sp.,ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Prunus armeniacaRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Aspergillus sp.,ZR 34Nursery 3Prunus dulcisRoot+Alternaria sp., Ronopodyides, F. coxysporum, Aspergillus sp.,ZR 34Nursery 3Eucalyptus globulusSoil+D. sapinea, Alternaria sp., Nursery B., SoilZR 35Nursery 3Eucalyptus globulusSoilZR 36Nursery 3Eucalyptus globulusSoil-ZR 37Nursery 3Abies sp.Soil<	ZR 21	Nursery 2	Ficus carica	Soil	-	
ZR 23Nursery 2Prunus armeniacaSoil+P. ramorum, Trichoderma sp., Alternaria sp.ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp., Alternaria sp.ZR 26Nursery 2Citrus limonSoil+D. sapinea, Mucor sp., Trichoderma sp.,ZR 27Nursery 2Olea europeaSoil-ZR 28Nursery 3Ficus caricaSoil+Py.polare, Penicellium sp.,ZR 29Nursery 3Ficus caricaSoil+Pulutimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber LCollar+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Quercus suber LCollar+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 35Nursery 3Abies sp.Soil+Py.polare, P. cinnamomi, Alternaria sp.,ZR 34Nursery 3Abies sp.Soil+Py.polare, P. cinnamoni, F. oxysporum, Aspergillus sp.,ZR 35Nursery 3Abies sp.Soil+Py.polare, P. cinnamoniZR 36Nursery 3 </td <td>ZR 22</td> <td>Nursery 2</td> <td>Eucalyptus globulus</td> <td>Soil</td> <td>+</td> <td>P. gonapodyides, Mucor sp., Alternaria sp.</td>	ZR 22	Nursery 2	Eucalyptus globulus	Soil	+	P. gonapodyides, Mucor sp., Alternaria sp.
ZR 24Nursery 2Abies sp.Collar+D. sapinea, Alternaria sp., Penicellium sp.ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Citrus limonSoil+Py.polare, Penicellium sp.ZR 27Nursery 2Olea europeaSoil-ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamoni, Mucor sp.ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Prunus armeniacaRoot+Alternaria sp., P. gonapodyides, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+D. sapinea, P. gonapodyides, F. oxysporum, Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyides, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 36Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., <tr<< td=""><td>ZR 23</td><td>Nursery 2</td><td>Prunus armeniaca</td><td>Soil</td><td>+</td><td>P. ramorum, Trichoderma sp., Alternaria sp.</td></tr<<>	ZR 23	Nursery 2	Prunus armeniaca	Soil	+	P. ramorum, Trichoderma sp., Alternaria sp.
ZR 25Nursery 2Abies sp.Collar+D. sapinea, Mucor sp., Trichoderma sp.,ZR 26Nursery 2Citrus limonSoil+Py.polare, Penicellium sp.,ZR 27Nursery 2Olea europeaSoil-ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 34Nursery 3Prunus dulcisRoot+Alternaria sp., Aspergillus sp.ZR 34Nursery 3Eucalyptus globulusSoil+D. sapinea, Alternaria sp., Aspergillus sp.ZR 36Nursery 3Eucalyptus globulusSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 37Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alter	ZR 24	Nursery 2	Abies sp.	Collar	+	D. sapinea, Alternaria sp., Penicellium sp.
ZR 26Nursery 2Citrus limonSoil+Py.polare, Penicellium sp.,ZR 27Nursery 2Olea europeaSoil-ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 28Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus ducisRoot+Alternaria sp., Mucor sp., Aspergillus sp.,ZR 34Nursery 3Prunus ducisRoot+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 36Nursery 3Eucalyptus globulusSoil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 37Nursery 3Abies sp.SoilZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.,ZR 37Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp.,ZR 39Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., Prannorum, Aspergillus sp.,ZR 40<	ZR 25	Nursery 2	Abies sp.	Collar	+	D. sapinea, Mucor sp., Trichoderma sp.,
ZR 27Nursery 2Olea europeaSoil-ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber LCollar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoilZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.SoilZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 39Nursery 3Cupressus sp.CollarZR 39Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 40Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp. </td <td>ZR 26</td> <td>Nursery 2</td> <td>Citrus limon</td> <td>Soil</td> <td>+</td> <td>Py.polare, Penicellium sp.,</td>	ZR 26	Nursery 2	Citrus limon	Soil	+	Py.polare, Penicellium sp.,
ZR 28Nursery 3Ficus caricaSoil+Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. cinnamoni, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamoni, F. oxysporum, Aspergillus sp.ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. cinnamoni, F. oxysporum, Aspergillus sp.ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyides, F. oxysporum, Aspergillus sp.ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Chursery 3Collar+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 39Nursery 3Cupressus sp.CollarZR 40Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.<	ZR 27	Nursery 2	Olea europea	Soil	-	
ZR 29Nursery 3Pteridium aquilinumRoot+Penicellium sp., Mucor sp., Trichoderma sp.ZR 30Nursery 3Olea europeaSoilZR 31Nursery 3Quercus suber LCollar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 39Nursery 3Cupressus sp.CollarZR 40Nursery 3Cupressus sp.Collar+Alternaria sp., P. gonapodyides, Trichoderma sp.ZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Cupressus sp.Collar+P.	ZR 28	Nursery 3	Ficus carica	Soil	+	Py.ultimum, Aspergillus sp., P. cinnamomi, Mucor sp.
ZR 30Nursery 3Olea europeaSoil-ZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., Mucor sp., Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.,ZR 39Nursery 3Cupressus sp.CollarZR 40Nursery 3Cupressus sp.Collar+Alternaria sp., P. gonapodyides, Trichoderma sp.ZR 41Nursery 3Cupressus sp.Collar+P. vultimum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Cupressus sp.Collar+P. vultimum, Aspergillus sp., Mucor sp.	ZR 29	Nursery 3	Pteridium aquilinum	Root	+	Penicellium sp., Mucor sp., Trichoderma sp.
ZR 31Nursery 3Quercus suber L.Collar+Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., Mucor sp., Aspergillus sp.,ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., P. ramorum, Aspergillus sp.,ZR 39Nursery 3Cupressus sp.Collar-ZR 40Nursery 3Cupressus sp.Collar+ZR 41Nursery 3Cupressus sp.Collar+ZR 42Nursery 3Cupressus sp.Collar+ZR 42Nu	ZR 30	Nursery 3	Olea europea	Soil	-	
ZR 32Nursery 3Prunus armeniacaRoot+Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., Mucor sp., Aspergillus sp.ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoil-ZR 37Nursery 3Abies sp.Soil-ZR 38Nursery 3Citrus limonSoil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 39Nursery 3Cupressus sp.Collar-ZR 40Nursery 3Cupressus sp.Collar+ZR 41Nursery 3Cupressus sp.Collar+ZR 42Nursery 3Citrus limonSoil+ZR 42Nursery 3Citrus nonSoil+ZR 42Nursery 3Citrus non	ZR 31	Nursery 3	Quercus suber L.	Collar	+	Lasio.exigua, Alternaria sp., P. gonapodyides, P. cinnamomi, Alternaria sp.
ZR 33Nursery 3Prunus dulcisRoot+Alternaria sp., Mucor sp., Aspergillus sp.ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,ZR 40Nursery 3Cupressus sp.CollarZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Citrus limonSoil+P. ramorum, Aspergillus sp., Mucor sp.	ZR 32	Nursery 3	Prunus armeniaca	Root	+	Alternaria sp., P. cinnamomi, F. oxysporum, Aspergillus sp.,
ZR 34Nursery 3Abies sp.Soil+D. sapinea, P. gonapodyidesdes, F. oxysporum,ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,ZR 40Nursery 3Cupressus sp.Collar-ZR 41Nursery 3Cupressus sp.Collar+ZR 42Nursery 3Citrus limonSoil+ZR 42Nursery 3Citrus limonSoil+ZR 42Nursery 3Citrus limonSoil+ZR 42Nursery 3Citrus limonSoil+	ZR 33	Nursery 3	Prunus dulcis	Root	+	Alternaria sp., Mucor sp., Aspergillus sp.
ZR 35Nursery 3Eucalyptus globulusSoil+Py.polare, P. cinnamomiZR 36Nursery 3Eucalyptus globulusSoilZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,ZR 39Nursery 3Cupressus sp.Collar-ZR 40Nursery 3Cupressus sp.Collar+ZR 41Nursery 3Cupressus sp.Collar+ZR 42Nursery 3Citrus limonSoil+ZR 42Nursery 3Citrus limonSoil+	ZR 34	Nursery 3	Abies sp.	Soil	+	D. sapinea, P. gonapodvidesdes, F. oxysporum,
ZR 36Nursery 3Eucalyptus globulusSoil-ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,ZR 39Nursery 3Cupressus sp.Collar-ZR 40Nursery 3Cupressus sp.Collar+Alternaria sp., P. gonapodyides, Trichoderma sp.ZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Citrus limonSoil+P. vultimum F. oxysnorum Aspergillus sp., Mucor sp.	ZR 35	Nursery 3	Eucalyptus globulus	Soil	+	Py.polare, P. cinnamomi
ZR 37Nursery 3Abies sp.Soil+D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.ZR 38Nursery 3Citrus limonSoil+Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,ZR 39Nursery 3Cupressus sp.Collar-ZR 40Nursery 3Cupressus sp.Collar+Alternaria sp., P. gonapodyides, Trichoderma sp.ZR 41Nursery 3Cupressus sp.Collar+P. ramorum, Aspergillus sp., Mucor sp.ZR 42Nursery 3Citrus limonSoil+P. vultimum F. oxysnorum Aspergillus sp., Mucor sp.	ZR 36	Nursery 3	Eucalyptus globulus	Soil	-	· · · · · · · · · · · · · · · · · · ·
ZR 38 Nursery 3 Citrus limon Soil + Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp., ZR 39 Nursery 3 Cupressus sp. Collar - - ZR 40 Nursery 3 Cupressus sp. Collar + Alternaria sp., P. gonapodyides, Trichoderma sp. ZR 41 Nursery 3 Cupressus sp. Collar + P. ramorum, Aspergillus sp., Mucor sp. ZR 42 Nursery 3 Citrus limon Soil + Pr ultimum F. oxysporum Aspergillus sp., Mucor sp.	ZR 37	Nursery 3	Abies sp.	Soil	+	D. sapinea, Alternaria sp., Aspergillus sp., Penicellium sp.
ZR 39 Nursery 3 Cupressus sp. Collar - - ZR 40 Nursery 3 Cupressus sp. Collar + Alternaria sp., P. gonapodyides, Trichoderma sp. ZR 41 Nursery 3 Cupressus sp. Collar + P. ramorum, Aspergillus sp., Mucor sp. ZR 42 Nursery 3 Citrus limon Soil + Py ultimum F. oxysporum Aspergillus sp. Mucor sp.	ZR 38	Nursery 3	Citrus limon	Soil	+	Alternaria sp., Mucor sp., P. ramorum, Aspergillus sp.,
ZR 40 Nursery 3 Cupressus sp. Collar + Alternaria sp., P. gonapodyides, Trichoderma sp. ZR 41 Nursery 3 Cupressus sp. Collar + P. ramorum, Aspergillus sp., Mucor sp. ZR 42 Nursery 3 Citrus limon Soil + Py ultimum F. oxysporum Aspergillus sp., Mucor sp.	ZR 39	Nursery 3	Cupressus sp.	Collar	-	- · · · · · · · · · · · · · · · · · · ·
ZR 41 Nursery 3 Cupressus sp. Collar + P. ramorum, Aspergillus sp., Mucor sp. ZR 42 Nursery 3 Citrus limon Soil + Py ultimum E oxysporum Aspergillus sp., Mucor sp.	ZR 40	Nursery 3	Cupressus sp.	Collar	+	Alternaria sp., P. gonapodyides, Trichoderma sp.
ZR 42 Nurserv 3 Citrus limon Soil + Py ultimum E oxysportim Asperillus en Mucor en	ZR 41	Nursery 3	Cupressus sp.	Collar	+	P. ramorum, Aspergillus sp., Mucor sp.
i juunun, i ovysporun, isperguus sp., hueor sp.	ZR 42	Nursery 3	Citrus limon	Soil	+	Py.ultimum, F. oxysporum, Aspergillus sp., Mucor sp.

Table 1. Isolation of fungal species from young seedlings from the three nurseries

In the first nursery: Analysis of variance (one-way ANOVA), using Fisher's test, showed many significant differences in the frequency of isolation of fungal species with a 95% confidence level. The average difference (ANOVA) showed that the species belonging to the genera *Aspergillus* and *Mucor* present with any significant difference between them. In contrast, they were highly significant compared to the other species. In addition, the two species of *Pythium (Py. ultimum* and *Py. polare)* showed a slight significant difference compared to the other species. On the other hand, the species with an important economic value as *Lasio. exigua* and *P. cinnamomi* were significantly different than those caused by saprophytic species, using Fisher's test (p < 0.05).

In the second nursery, analysis of variance (one-way ANOVA) using Fisher's test showed some significant differences in the frequency of species isolated with a confidence level of 95% (Fig. 4). Indeed, the three oomycetes identified as *P. cinnamomi*, *P. gonapodyides* and *P. ramorum* and the species *Lasiodiplodia exigua* have the lowest rate and they are significant with the saprophytes of the genera *Penicellium* and *Trichoderma*.

The two species identified as *Py. ultimum* and *D. sapinea* recorded an occurrence rate of around 17%. Those species show a slightly significant difference from other isolated species.

In the third nursery, species of the genus Aspergillus and Alternaria are the most present. Analysis of variance (one-way ANOVA) using Fisher's test (p < 0.05), showed highly significant differences between these species and others such as *Py. polare* and *Lasiodiplodia exigua*. The two species identified as *Py. ultimum* and *D. sapinea* recorded an occurrence rate of around 17%. Those species show a slightly significant difference from other isolated species.

The inhibitory activity of the two isolates of Trichoderma (*Tri. Viride* and *Tri. Harzianum*) showed that it affects against all the fungal species tested (*Diplodia sp.* and *Pythium sp.*).

After 5 days of incubation, the two strains of *Tri. Viride* and *Tri. Harzianum* showed good inhibitory activity against pathogenic tested strains, with the appearance of a zone of inhibition by dispersing certain metabolites which will stop their growth.

Trichoderma strain shows an antagonistic effect on some phytopathogenic fungi by the ability to suppress the disease (Sundaramoorthy and Balabaskar, 2013). In fact, it produces lytic enzymes wich increase its antagonist action by acting synergistically (Benitez *et al.*, 2004). The antagonistic action of Trichoderma species against phytopathogenic fungi either by the secretion of cell wall hydrolytic enzymes or by the production of antibiotics (Elad, 2000).



Figure 3. Colony morphology and microscopic features of the fungi isolated on PDA: (A) Phytophthora gonapodyides, (B) P. cinnamomi, (C) P. ramorum, (D) Fusarium oxysporum (E) Pythium ultimum, (F) Py. polare, (G) Aspergillus fumigatus, (H) Asp. niger, (I) Dilplodia sapinea, (J) Lasiodiplodia exigua, (K) Mucor racemosus, (L) Rhizopus stolonifer, (M) Trichoderma harzianum (N) Tri. viride, (O) Alternaria solani, (P) Alt. alternate, (Q) Penicellium solitum.



Figure 4. The average frequency of isolation from young seedlings from the three nurseries surveyed; Mean \pm standard error. Different letters indicate significantly different means (Fisher's test, P <0.05). Antagonist test

Conclusion

According to this study, the rhizosphere of the three prospected nurseries showed the presence of a great qualitative and quantitative diversity of fungal and oomycetes species,

Macroscopic and microscopic identification showed the presence of seventeen different species, belonging to the genera *Phytophthora*, *Pythium*, *Fusarium*, *Diplodia*, *Lasiodiplodia*, *Alternaria*, *Mucor*, *Trichoderma*, *Aspergillus* and *Penicillium*. Some of them are widely studied because of their economic importance. Indeed, they can cause very significant damage to plants, and they can be dreaded parasites of nursery crops, such as *Phytophthora* species, *Pythium sp. Diplodia sp.* and *Fusarium sp.* These species are known for their variable host range on both cultivated and forest plants.

Among them, the most common in nurseries, those belonging to the genus Fusarium are the most frequent and the most damaging to crops (Nelson *et al.*, 1983). Further, listed as one of the 100 worst invasive alien species, *P. cinnamomi* is considered one of the most devastating plant pathogens worldwide (Lowe *et al.*, 2000). It causes the most severe outbreaks in topographically depressed areas poorly drained or periodically waterlogged (Brasier et al., 2004; Serrano *et al.*, 2012).

Plant trade represents the major threat for the introduction and spread of alien diseases and pests in natural ecosystems through the movement of infected plants, or infested substrate and water (Brasier, 2008). The cultivation techniques in the nursery and the continuous movement of species and varieties of different plants have facilitated new associations between pathogens and hosts within nurseries (Brasier *et al.*, 2004; Burgess, 2015).

Acknowledgments

This research work was financially supported by University of TLEMCEN and Laboratory N°31: Conservatory management of water, soil and forests.

References

- Barnett, H.L. and B.B. Hunter. 1975. Illustrated Genera of imperfect Fungi. 3 ed, Burgess Publishing copany, Minnesota, U. S. A., 233p.
- **Ben-David, A. and C.E. Davidson. 2014**. Estimation method for serial dilution experiments. Journal of Microbiological Methods. 107 : 214-221.
- **Benhanou, N. and I. Chet. 1996**. Parasitism of sclerotia of Sclerotium rolfsii by *Trichoderma harzianum* : ultrastructural and cytochemical aspects of the interaction. Phytopathology .86: 405-416.
- Benitez, T., A.M. Rincn, M.C. Limn and A.C. Codn. 2004. Biocontrol mechanisms of Trichoderma strains. International Microbiology. 7: 249-260.
- Botton, B., M. Bretton, M. Fevre, S. Gautier, J.P. Guy Larpent, P. Reymond, J.-J. Sanglier, Y. Vayssier and P. Veau. 1990. Moisisures utiles et nuisibles importance industrielle. 2 éme édition, Collection Biotechnologies, Masson, 512p.
- **Brasier C.M. 1996**. *Phytophthora cinnamomi* and oak decline in southern Europe. Environmental constraints including climate change. Ann. Sci. For. 53: 347-358p.
- Brasier C.M., S.A. Kirk, J. Delcan, D.E.L. Cooke, T. Jung and W.A. Man in't Veld. 2004. *Phytophthora alni* sp. nov. and its variants: designation of emerging heteroploid hybrid pathogens spreading on Alnus trees. Mycological Research. 108: 1172-1184.
- **Brasier C.M. 2008.** The biosecurity threat to the UK and global environment from international trade in plants. Plant Pathol. 57: 792-808.
- **Burgess T.I. 2015.** Molecular characterization of natural hybrids formed between five related indigenous clade 6 Phytophthora species. PLoS ONE: 10.1371/Journal.pone.0134225.
- **Cardon Z.G. and D.J. Gage. 2006**. Resource exchange in the rhizosphere: molecular tools and the microbial perspective. Annu. Rev. Ecol. Evol. Syst. 37, 459–488 10.1146/ annure. ecolsys.37.091305.110207.

Champion R. 1997. Identifier les champignons transmis par les semences. INRA, Paris, 385p.

- Curtis T.P., W.T. Sloan and J.W. Scannell. 2002. Estimating prokaryotic diversity and its limits. Proc Natl Acad Sci USA 99: 10494–10499.
- **Elad Y. 2000.** Biological control of foliar pathogens by means of *Trichoderma harzianum* and potential modes of action. Crop Protection. 19: 709-714.
- Erwin D.C. and O.K. Ribeiro. 1996. Phytophthora Diseases Worldwide. St. Paul, MN. 562p.
- Jung T. H. Blaschke and P. Neumann. 1996. Isolation, identification and pathogenicity of *Phytophthora* species from declining oak stands. Eur. J. For. Path. 26: 253-272p.

- Jung T., M. Horta Jung, S.O. Cacciola, T. Cech, J. Bakonyi, D. Seress, S. Mosca, L. Schena, S. Seddaiu, A. Pane, G. Magnano di San Lio, C. Maia, A. Cravador, A. Franceschini and B. Scanu. 2017. Multiple new cryptic pathogenic *Phytophthora* species from Fagaceae forests in Austria, Italy and Portugal. IMA Fungus. 8(2): 219-244p.
- Kent A.D. and E.W. Triplett. 2002. Microbial Communities and their interactions in soil and rhizosphere ecosystems. Annu. Rev. Microbiol. 56: 211-36.
- Koch R. 1883. Über die neuen Untersuchungsmethoden zum Nachweis derMikrokosmen in Boden, Luft und Wasser. Vortrag auf dem XI. Deutschen Ärztetagin Berlin. Vereinsblatt für Deutschland, Komnüssions-Verlag von F. C. W. Vogel,Leipzig, pp. 137,274–137,284
- Leake J., D. Johnson, D. Donnelly, G. Muckle, L. Boddy and D. Read. 2004. Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agroecosystem functioning. Can. J. Bot. 82: 1016-1045.
- **Lepinay C. 2013**. Study of plant-microbe interactions, within the rhizosphere, under a cost-benefit aspect, in a context of environmental variation. Doctoral thesis. Microbial ecology. University of Burgundy. 263p.
- Lowe S., M. Browne, S. Boudjelas and M. De Poorter. 2000. 100 of the world's worst invasive alien species. A selection from the Global Invasive Species Database. Invasive Species Spec. Gr. a Spec. Gr. Species Surviv. Comm. World Conserv. Union 12.
- **Nelson P.E. and T.A. Toussoun. 1983**. *Fusarium* species: An illustrated manual for identification. Pennsylvania State University Press, University Park, 206.
- Phillips A.J.L., J. Lopes, J. Abdollahzadeh, S. Bobev and A. Alves. 2012. Resolving the *Diplodia* complex on apple and other Rosaceae hosts Persoonia. 29: 29-38p.
- Phillips A.J.L., A. Alves, J. Abdollahzadeh, B. Slippers, M.J. Wingfield, J.Z. Groenewald and P.W. Crous. 2013. The Botryosphaeriaceae: genera and species known from culture. Stud Mycol. 76: 51–167p.
- Scanu B., B.T. Linaldeddu, A. Franceschini, N. Anselmi and A. Vannini. 2013. Occurrence of *Phytophthora cinnamomi* in cork oak forests in Italy. Forest Pathology. 43: 340–343p.
- Scanu B., G.C. Hunter, B.T. Linaldeddu, A. Franceschini, L. Maddu, T. Jung and S. Denman. 2014. A taxonomic re-evaluation reveals that *Phytophthora cinnamomi* and *P. cinnamomi* var. *parvispora* are separate species. For. Path. 44:1-20.
- Serrano M.D., P. De Vita, P. Fernández-Rebollo, A.C. Coelho, L. Belbahri and M.E. Sánchez. 2012. *Phytophthora cinnamomi* and *Pythium spiculum* as main agents of *Quercus* decline in southern Spain and Portugal. IOBC-WPRS Bulletin 76: 97-100.
- Smahi H., L.Belhoucine-Guezouli, A. Franceschini and B. Scanu. 2017a. *Phytophthora* species associated with cork oak decline in a Mediterranean forest in western Algeria. IOBC-WPRS Bulletin Vol. 127: 123-129p.
- Smahi H., L. Belhoucine-Guezouli, A. Berraf-Tebbal, S. Chouih, M. Arkam, A. Franceschini, B.T. Linaldeddu and A.J.L. Phillips. 2017b. Molecular characterization and pathogenicity of *Diplodia corticola* and other Botryosphaeriaceae species associated with canker and dieback of Quercus suber in Algeria. Mycosphere. 8 (2): 1261-1272p.
- **Sundaramoorthy S. and P. Balabaskar. 2013**. Biocontrol efficacy of Trichoderma spp. against wilt of tomato caused by *Fusarium oxysporum* f. sp. lycopersici. Journal of Applied Biology and Biotechnology. 1 (03): 36-40.

- **Tschen J.S.M. and W.L. Kuo. 1985**. Antibiotic inhibition and control of Rhizoctonia solani by Bacillus subtilis. Chih wu pao hu hsueh hui hui kan= Plant protection bulletin
- Viennot-Bourgin G., N. Ale-Agha and D. Ershad. 1970. Prasitic fungi of Iran (new contribution). Annales de phytopathologie. 2 (4): 689-734.
- Yan L., X. Zho, J. Shi, C. Jiang and D. Shao, 2019. Beneficals effects of endophytics fungi colonization on plants. Applied Microbiology and Biotechnologie. 103. 3327-3340