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Applied Microbiology 2016- Microorganisms to protect plants: Beneficial effects of the oomycete Pythium oligandrum on grapevines - Jonathan Gerbore - University of Pau et des Pays de l'Adour

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Abstract
Development of alternative methods to chemical pesticides to control plant diseases increased considerably in recent years. Among those, the useful and beneficial microorganisms for plant growth stimulation and plant protection is promising, especially under recent advances in trancriptomics and genome sequencing that provides new insights in the potential of microorganisms and new product development opportunities. Our report of development of a biocontrol product base on the oomycete, Pythium oligandrum, to protect grape. Oligandrum ine against Escape, a serious grapevine trunk disease that causes substantial losses in vineyards worldwide. There are No efficient chemical products are registered against this disease. In order to control Esca, P. oligandrum strains are isolated from the rhizosphere of grapevines cultivated within the winegrowing region of Bordeaux (France). A multiyear greenhouse assay showed that P. oligandrum colonized grapevine rhizosphere over months, stimulated plant defense and may protect grapevine against Esca (disease reduction ranged from 40 to 60%). Trancriptomic analysis (Microarrays and RNAseq) showed that Induced Systemic Resistance (ISR) was activated in plants treated with P. oligandrum when challenged with pathogen. A priming effect was also pointed out. Currently, a method to manage Esca disease with this plant beneficial microorganism is developed.

Introduction

Oligandrum strains collected from the root samples at the peak stage of yielding season of the crop showed that among the three strains used for inoculation, the one producing the tiniest amount of oospores was detected at 90%. Single-strand conformational polymorphism analysis revealed increases within the amount of members and thus the complexity of the fungal community over time. there are no significant differences between the microbial ecosystems inoculated with P. oligandrum and other people that weren't treated, aside from a reduction of Pythium dissotocum (ubiquitous tomato root minor pathogen) populations in inoculated systems during the last 3 months of culture. These findings raise interesting issues concerning the use of P. oligandrum strains producing elicitor and auxin molecules for plant protection and thus the event of bio-control.

In soilless cultures, the recycling of drainage water within a system is that the consequence of latest laws concerning water saving and limitation of pollution. Such closed systems minimize costs by conserving water and reducing fertilizer input; however, they'll favor the dissemination of pathogens. When pathogens manage to enter recirculation systems, they're rapidly disseminated and will cause disease epidemics, particularly during times of stress, e.g., stress because of high temperatures and/or to low levels of dissolved oxygen within the nutrient solution. Thus, numerous facultative pathogens commonly found in conventional cultures may become economically significant (53). Several of them, e.g., Pythium spp. and Phytophthora spp., are well adapted to the aquatic environment of hydroponic systems: they produce flagellate zoospores which enable them to swim within the nutrient solution, facilitating the spread of infection.

Various methods are used to reduce the risks to plant health.in the recent years, disinfection of nutrient solutions by chemical treatments or physical, e.g., ozonization, UV irradiation, chlorination, and thermo-disinfection, has been developed. These methods effectively destroy pathogenic microorganisms but are harmful to species vulnerable to benefit the plant, to be used as bio-control agents, or both. Indeed, recirculation of nutrient solutions in closed hydroponic systems favors the establishment of a potentially suppressive micro flora besides the pathogenic micro flora. the event of a beneficial microflora may thus be impeded by treatments used to destroy pathogenic microorganisms. Consequently, interest has been focused on the management of microorganisms in soilless cultures. Postma and coworkers found that the extent of root disease is increased by the use of autoclaved rock wool. Tu and coworkers observed that disease disease was less severe in closed hydroponic systems than in open cultures and suggested that the difference was because of a far better density of bacteria within the closed systems. according to Paulitz, the range of microorganisms in soilless cultures is more limited than that in conventional soil cultures, such conditions are more suitable for beneficial microorganisms, and consequently to be as the effective biological control, in no soil than in conventional soil cultures.
Biocontrol strategies are promising. However, both biotic and abiotic factors may affect the performance of biocontrol methods. Relevant biotic factors include interactions with

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nontarget microorganisms, poor implantation of the biocontrol agent due to nonadaptation to the hydroponic system or resistance from the native microflora, period of time and formulation, and host plant species and cultivar effects. Abiotic factors include climatic, chemical, and physical conditions of the soil or rhizosphere.

Despite the restrictions, various studies report evidence of the suppression of disease following the inoculation of hydroponic systems with antagonistic microorganisms. Especially, Pythium oligandrum is an efficient biocontrol agent . This oomycete colonizes roots without damaging the host plant cells and survives within the rhizosphere, where it exerts its biocontrol . P. oligandrum acts through both direct effects (mycoparasitism, antibiosis, and competition for nutrients and space) and indirect effects (stimulation of plant defense reactions and plant growth promotion) . The operating effects seem to depend upon the sort of pathogenic fungi being controlled. Le Floch and coworkers suggested that mycoparasitism is not the most mode of action. Root colonization by P. oligandrum may induce systemic resistance related to the synthesis of elicitors protecting the plant from its aggressors. Several studies have investigated formulations of P. oligandrum oospores applied to soil or seeds, and their production and use, to optimize the efficacy of biocontrol.

Effective biocontrol by P. oligandrum could even be limited by its heterogeneous implantation within the rhizosphere. Therefore, enhanced implantation and persistence of P. oligandrum within the rhizosphere should improve plant protection. We report an investigation of the persistence of P. oligandrum and its impact on the native fungal micro flora of the roots. Three strains with characteristic traits were selected to constitute an inoculums applied to tomato roots. The characteristics of the strains were the assembly of oospores to allow root colonization and favor persistence, the synthesis of tryptamine, a plant growth enhancer, and thus the assembly of oligandrin, a plant-protective elicitor. The inoculated rhizospheres were monitored to gauge the persistence of the strains and their effects on the micro flora. The population of the general tomato root pathogen. dissotocum (endemic within the studied systems) and of P. oligandrum were both assessed by plate counting and real-time PCR.