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Natural pest management with photodynamic inactivation of *Botrytis cinerea*

J Catherine*

Department of Environmental Science, Technische Universität Dresden, Dresden, Germany

*Corresponding author. E-mail: josephcatherine@edu.de

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DESCRIPTION

The primary difficulty facing in agriculture is providing enough food for the world's expanding population. Since the 1960s, agribusiness practices that include excessive use of pesticides and fertilizers are increasingly being blamed for soil, water, and air pollution, as well as the loss of biodiversity in both fauna and flora. Additionally, this industrial agriculture contributes to serious public health issues like infertility, cancer, and congenital defects in children. The European Union introduced the directive 2009/128/EC to minimize the use of pesticides after becoming aware of the necessity to lessen all these severe environmental impacts. New strategies for safe agricultural practices, such as genetically modified plants, genetic advances, as well as organic and integrated agriculture, are required to combat plant rivals and infections. With a wide range of applications for animal and plant cells, plant and animal diseases, as well as microbes, the photodynamic treatment is a general and novel approach. Therefore, photodynamic therapy may be a novel and effective tactic in future agricultural operations to combat diseases and rival plants. An important component of APDT is a chemical known as a Photosensitizer (PS). This molecule emits reactive oxygen species, which are harmful to cells, when exposed to light. In contrast, most PSs exhibit minimal cytotoxicity or genotoxicity when exposed to darkness.

Additionally, water-soluble PSs that are ideally susceptible to rapid photo degradation are the greatest choice for biological applications since they prevent the development of toxicity (Brieger, 1969). PSs are divided into a variety of families, including phthalocyanines, coumarins, furocoumarins, coumarins, porphyrins, and chlorins. On kiwi leaves studied *in vitro*, porphyrins and chlorins like chlorophyllin have been proven to be particularly effective against bacteria. It has been demonstrated that the plant-infecting fungus *Colletrichum acuratum* and *Aspergillus nidulans* are susceptible to the coumarins, furocoumarin, and phenothiazinium. *In vitro* phenotypical and molecular responses of Arabidopsis and tomato plantlets to the photodynamic stress generated by an exogenous source of PS were previously investigated. At a concentration of 3.5 M, the cationic tetra (N-methylpyridyl) porphyrin caused injury to tomato and Arabidopsis plantlets that were 14 days old. However, following a 14-day treatment, tomato plantlets might be saved but Arabidopsis plantlets were destroyed. Surprisingly, even at concentrations as high as 50 M, the anionic porphyrin Tetra-4-Sulfonatophenylporphyrin Tetra-Ammonium (TPPS) did not cause any negative effects on either plantlet (Fowler, 1983). Due to its low toxicity to plants, TPPS might provide a promising option for the development of APDT for agricultural applications.

Additionally, TPPS does not aggregate in solution and maintains its negatively charged state in a variety of chemical conditions, enabling it to pass through cell membranes and walls with ease. In order to eliminate the plant pathogen *Botrytis cinerea* and be a safe alternative for grapevine *(Vitis vinifera L.)* explants, we postulated that TPPS might be a promising PS candidate (Fox et al., 1977). *Botrytis cinerea* frequently causes severe drops in harvest crop yields as well as a decline in wine quality. Due to its genetic plasticity, which contributes to its variability in morphology, mycelial development, sporulation, and virulence, this fungus exhibits very strong resistance to various fungicides? The grapevine's vulnerability to *Botrytis cinerea* might be regarded as an important management indication for integrated pest management. In a wide range of plants, *Botrytis cinerea* is a very serious issue. This fungus has the power to infect leaves, stems, blossoms, and fruit, resulting in serious harm and economic losses in the agricultural industry (Jonkman, 1978). The fungus has a number of negative consequences on vineyards' ability to produce quality and quantity of vines. Despite all the harm it may do, its growth on grapes results in noble rot, which produces sweet wine, under certain climatic circumstances. But the battle against this virus continues every day, especially when fruit is produced in the summer or fall. The use of particular fungicides has been widely anticipated for more than 50 years, during which time Botrytis has had to develop coping mechanisms. As a result, fungicide treatments gradually lost their efficacy; even the well-known $CuSO_4$ solution, sometimes referred to as the "Bordeaux combination," no longer effectively combatted fungal diseases. Additionally, the poisonous copper divalent ion for plants also led to soil contamination. *Botrytis cinerea* mycelium growth was severely inhibited by TPPS at a very low concentration (MFC=1.5 M) under white light, which resulted in mortality. After this procedure, we were unable to save the mycelium. The impact of light-activated photosensitizers on *Botrytis cinerea* is fungi static or fungicidal, although there is little to no literature on this subject, to our knowledge. Investigating whether the anionic porphyrin could alter the mycelium structure was the initial step (Kozlovsky, 1968). In the prior investigation, it was demonstrated that treatment with antibiotics, eugenol, $FeSO_4$, and tea tree oil altered the structure of the *B. cinerea* hyphae. *In vitro*, *B. cinerea* could be eliminated by TPPS without endangering grapevine leaves. Additionally, the plantlets developed *in vitro* are not altered biochemically or phenotypically by this compound (Smith, 2000). The results of these first tests are encouraging, and further research might be conducted in a greenhouse and on a field to ascertain the true potential and effectiveness of TPPS against plant diseases.

CONCLUSION

The photodynamic treatment was created utilizing a low PS concentration, which further contributes to the results and discoveries being reported here. Because PS is effective against plant pathogens and has no negative effects on plants, we demonstrate that APDT can be employed for the fight against phyto pathogens in agronomic operations.

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