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Grapevine Plants Management Using Natural Extracts and Phytosynthesized Silver Nanoparticles

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Abstract: Starting from the well-known antimicrobial properties of silver nanoparticles, the goal of this study is to evaluate the influence of two "green" recipes, namely an alcoholic extract of *Dryopteris filix-mas* (L.) Schott and a dispersion of silver nanoparticles phytosynthesized using the extract on grapevine pathogens. The influence of some grapevine parameters (pith/wood rapport, soluble sugars, starch, total sugars, total water content, length of young shoots, number of grapes) in field experiments was also studied. The study was conducted on four clones (Feteasca alba 97 St., Feteasca neagra 6 St., Feteasca regala 72 St., and Cabernet Sauvignon 131 St.) located in vegetation pots inside a greenhouse. For the phytosynthesis of the silver nanoparticles (AgNPs) we used a scaled-up technology, allowing us to obtain large quantities of nanoparticles-containing solution. The AgNPs analysis by X-ray diffraction and transmission electron microscopy confirmed the synthesis of spherical and quasi-spherical nanoparticles of 17 nm average diameter and 6.72 nm crystallite size. The field experiments registered different responses of the four clones to the treatment, using both the natural extracts and phytosynthesized nanoparticles solution. Both recipes exhibited a protective effect against the *Uncinula necator* pathogen. For the treatment using phytosynthesized nanoparticles, significant increases in the pith/wood ratio for white wine clones (Feteasca alba 97 St. and Feteasca regala 72 St.) were observed. The biochemical analyses revealed other significant increases of soluble sugars (red wine clones—Feteasca neagra and Cabernet Sauvignon/second year), starch (Feteasca alba and Cabernet Sauvignon in 2021 for both clones), total sugars (Feteasca alba and Feteasca neagra in 2021 for both clones), and of total water content (Feteasca alba and Feteasca neagra in 2021 for both clones), respectively. The applied treatments also led to an increase of young shoots length and grape numbers for all clones as compared to the control (chemical pesticide), which would suggest a potential biostimulant effect of the recipes.

Keywords: *Vitis* spp.; *Dryopteris filix-mas*; *Uncinula necator*; pith/wood; natural treatments

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1. Introduction

Viticulture plays an important global role, both from an economic and social point of view. Unfortunately, the vineyards are frequently attacked by numerous pathogens (fungus, viruses, viroids, phytoplasmas, bacteria) that, in a worst-case scenario, can cause serious

4. Conclusions and Future Perspectives

The present study aimed to evaluate the protective effect on grapevine of a fern extract and of silver phytosynthesized using the same extract. Both types of materials revealed a significant decrease (by comparison with the chemical pesticide used in the experiments) of the frequency, intensity, and attack degree of the pathogen *Uncinula necator* (responsible for the apparition of powdery mildew). This observation was suggested by the laboratory results against *Plasmopara viticola* (pathogen responsible for the apparition of downy mildew).

The determinations regarding the pith/wood ratio of the canes showed that all the plants studied have developed very well-matured canes in all treatment options. Statistically significant differences were recorded for the Feteasca alba 97 St. clone treated with the nanoparticle solution in 2020 (lower for base and middle, higher for top level of cane, as compared to the control), while marginal differences were also recorded for 2021 (higher for all determination areas). Similar observations were made for the Feteasca neagra 6 St. clone (except for the year 2021, top zone, where significant lower values were recorded). For Feteasca regala 72 St., significantly higher values for middle and top 2021 were recorded, while for Cabernet Sauvignon 131 St., significantly lower values for middle 2020 were recorded. For all the clones, the rest of the determinations had marginal variations.

Regarding the biochemical determinations, significant variations were observed for soluble sugars (increase for Feteasca neagra and Cabernet Sauvignon/second year), for starch (increase for Feteasca alba and Cabernet Sauvignon in 2021 for both clones), for total sugars (increase for Feteasca alba and Feteasca neagra in 2021 for both clones), and for total water content (increase for Feteasca alba and Feteasca neagra in 2021 for both clones), respectively. More than that, the biostimulant effect of the fern extract and of the silver nanoparticles solution was further confirmed by the determinations on the number of grapes produced by each clone and on the length of the young shoots.

Based on the findings of this study, in which positive results were obtained using hydroalcoholic extract of *D. filix-mas* and phytosynthesized nanoparticles mixture as preventive and curative treatments grapevine against downy mildew and powdery mildew in protected area, it is recommended to extend the research in vineyards. Further studies are also necessary in order to clarify the exact mechanisms involved in the clone-dependent protective potential of the proposed solutions.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ma15228188/s1, Figure S1: Obtaining the natural extracts in large scale reactors; Figure S2: The two types of recipes prepared for field application; Figure S3: Aspects of the greenhouse experiments.

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