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Exploit Biodiversity in Viticultural Systems to Reduce Pest Damage and Pesticide Use, and Increase Ecosystem Services Provision–BIOVINE †

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Abstract: The BIOVINE project has developed natural solutions based on plant diversity to control pests and reduce pesticide dependence. Application of polyculture cover crops in organic vineyards may possibly increase resistance to pests and invasive species. In this study aim was to develop innovative viticultural systems based on increased plant diversity within (e.g., cover crops) and/or around (e.g., hedges, vegetation spots, edgings) vineyards by planting selected plant species (e.g., *Lolium prenne*, *Onobrychis vicifolia*, *Vicia sativa*, *Sinapis*, *Trifolium repens)* for the control of foliar pathogens by reducing the inoculum spread from soil in Italian vineyards. During two experimental seasons, different soil managements was applied and some of them resulted suppressive against spread of soil-born fungal diseases in both treated (fungicide) and untreated plots. The effect of the different cover crops was quite visible in the end of the first observation. For instance, downy mildew diseases severity on leaves was lower in some cover crop mixtures compared to traditional and untreated plots while the quality parameters assessed at harvest (pH, treatable acidity, sugar content and yield) where not statistically different between different soil managements. Indicated results here will give a sight to consider cover crops as integrated practice for enhancing sustainable viticulture

Keywords: viticulture; cover crops; innovative; fungi; pests; downy mildew; powdery mildew

1. Introduction

Grapevine is the fourth most cultivated fruit in the world [1]. The main purpose of grape growing is wine production, followed by fresh consumption (table grape), dried grape production, and several other minor productions (e.g., juice, vinegar, grappa). Grape is a priority crop in few countries, in fact, five nations cover more than 50% of the world's production (Spain, China, France, Italy, and Turkey) [2], but considering winegrape, Italy, France, Spain, and the USA are the main producers.

Grapevine is susceptible to many different pathogens, the majority are fungal disease, but there are also important viruses spread by vectors (normally insects) or present in the soil and insects that directly damage vines [3]. The most prominent diseases that mainly affect leaves and bunches are powdery mildew, downy mildew, grey mold, and black rot. In viticulture disease control is mainly based on the use of preventative fungicides, that prevent disease onset (by contact) in the early stages of pathogen development when it is still on the plant surface. In terms of protection, conventional viticulture is heavily dependent on the use of chemical pesticides that are harmful to human health, although it secures higher yields. In recent years, the use of cover crops has increased due to their effect on the reduction of chemical inputs, the desired improvement of soil fertility, and more sustainable production [4]. Highly diverse plant communities are less susceptible to soil-borne pathogens than poorly diversified systems, however, it is important to select the right cover crop species.

Therefore, the BIOVINE project was designed and funded to develop new viticultural systems based on increasing plant and functional diversity within (e.g., cover crops) and around (e.g., hedges, vegetation spots, edgings) the vineyards by planting plant species. Our 2-year study investigated the effect of different cover crop mixtures as a possible tool for disease control by reducing spore dispersals in the vineyards.

2. Material and Methods

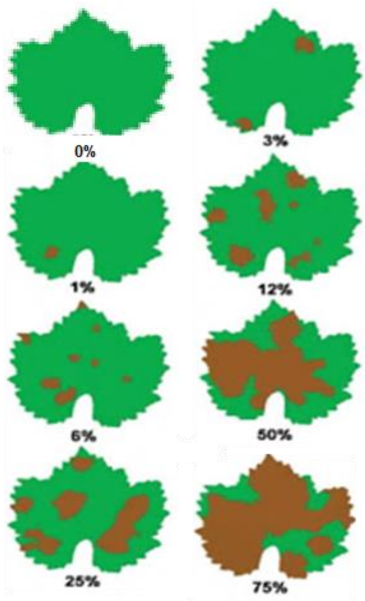
Two experimental sites (Res Uvae farm, the demonstration platform for sustainable viticulture, and Gasparini vineyard, the experimental vineyard, of the University of Piacenza) were established to test selected cover crops. Innovative systems were applied on large plots (homogeneous for variety, plant age, training system, and terroir) and compared with the current practice for organic farms. In the *on-farm* experiments, both autumn and spring sowing, as well as the traditional approach (soil tillage and spontaneous grassing every second row), were compared under organic fungicides scheduling regime and untreated (control) plot.

Cover Crop Mixtures

Selected cover crop mixtures were sown in inter-rows of each vineyard at different seasons. Therefore, cover crop mixtures can be listed as below:

- Autumn sowing-*Lolium perenne* 50%, *Onobrychis viciifolia* 25%, *Trifolium repens* 25%;
- Spring sowing-*Vicia sativa* 50%, *Sinapis* sp. 50%;

The effectiveness of the different systems was evaluated during the grape-growing season. Disease progress was assessed as incidence and severity of symptoms on leaves and/or bunches, depending on the disease using specific diagrammatic scales (Figure 1), for downy and powdery mildew, black rot and botrytis bunch rot. For assessing the growth stage of cover crops, BBCH scale was used. During the season, vineyards were monitored periodically, and scouting was performed in each plot at least once per week. During each visit phenological stages and incidence/severity of occurring diseases (on leaves and bunches) were recorded.



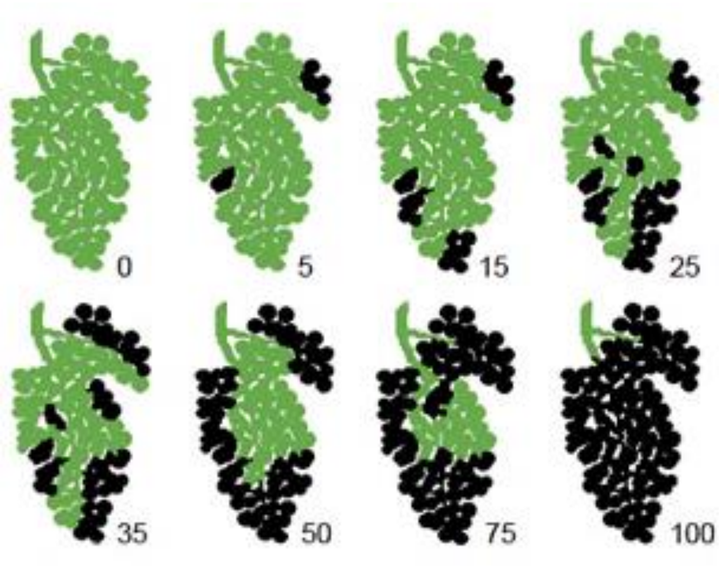
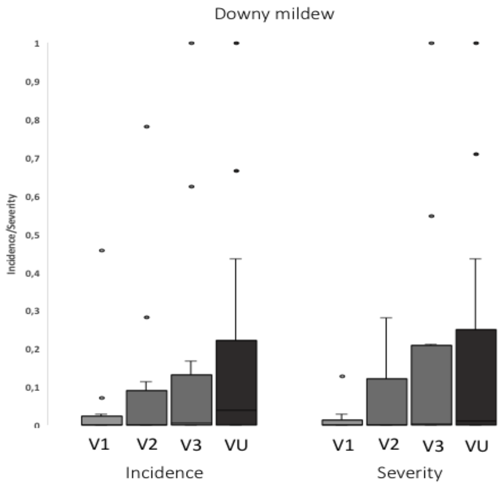


Figure 1. On the left, diagrammatic scale of disease severity on grape leaves from healthy (0%) to heavily affected (75% or more) [5]. On the right, diagrammatic scale of disease severity on grape bunches from healthy (0%) to heavily affected (100%) [6].

3. Results and Discussion

Results from the growing seasons 2019 and 2020 showed interesting differences between the tested cropping systems. For instance, the effect of the different cover crops was quite visible in the case of a soil-transient pathogens, like Plasmopara viticola, and for another key pathogen of grape, like Erysiphe necator (Figure 2).



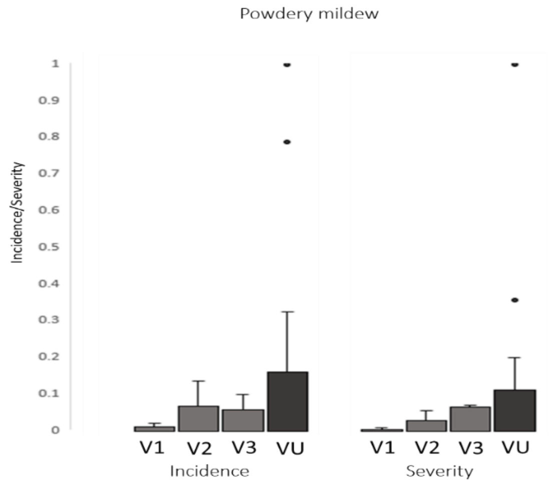


Figure 2. Box plot of the diseases incidence and severity assessments of downy and powdery mildew throughout grape growing season in autumn sowing (V1), spring sowing (V2), traditional (V3) and untreated control (VU) plots in two vineyards over two seasons. Boxes contains 50% of the observed cases, whiskers show maximum and minimum while dots represent outliers.

All viticultural systems tested showed a significant difference compared to the untreated control. Cover crop mixture sowed in autumn showed a significantly reduced downy and powdery mildews pressures also compared to the farm practice. Botrytis bunch rot did not appear over the two seasons in both experimental vineyards while black-rot assessments did not show any significant difference in the treated plots (data not shown).

The results obtained during this project, highlighted the role of cover crop selection and sowing time as relevant factors that should be considered in an integrated disease control strategy. Moreover, sowed cover crops present a lower competition with vines and allow a better water conservation in soil compared to natural grassing [7].

BIOVINE project showed that there is a genuine potential to develop new viticultural systems based on increased plant diversity within (e.g., cover crops) and/or around (e.g., hedges, vegetation spots, edgings) vineyards by planting selected plant species. These species have potential to contribute to the control of arthropods, soil-borne pests (oomycetes, fungi, nematodes) as well as foliar pathogens and thereby increase economic, social and environmental sustainability of organic vineyards. It will subsequently lead to higher income and satisfaction of organic winegrowers.

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