University of Fribourg / Faculty of Science and Medicine / Department of Biology

Evaluation of Viticultural Management and Consequences for Soil Biodiversity, Functions and Ecosystem Services in Vineyards

Magdalena Steiner

Agricultural intensification is one of the main drivers of biodiversity loss. Eutrophication of rivers and ponds, degradation of soils and the simplification of landscapes have negatively impacted native biodiversity. Soil microbial communities are involved in most soil processes and may be affected by agricultural practices. To date there is not much known about how they are affected or which factors influence the assembly of microbial communities in agro-ecosystems. Perennial cropping systems are suitable agro-ecosystems to investigate links between biodiversity, functions and services, as there is a relatively large space between the crops that is not directly agriculturally used. In the PromESSinG project we evaluated viticultural management methods and their effects on biodiversity, soil functions and ecosystem services, in vineyards in the Canton of Valais in southern Switzerland. Across three years, we assessed microbial diversity of soil bacteria, fungi and protists, decomposition rates of organic substrates and microbial respiration, as well as grape quality, and compared them in regard to three common vegetation management practices, which differed in their intensity, at a national and continental scale. Furthermore, we measured levels of soil copper contamination, a known problem in perennial crop systems, to investigate how fungicide residues alter biodiversity.

We found that pesticide application and their residues in soils had non-target effects on microbial communities reducing them in richness but more severely changing their community compositions. Soil functions were selectively affected with microbial activity and biomass being consistently negatively correlated with management intensity at both the national and continental scale. The influence of management intensity on the assembly of microbial communities was small in comparison to local factors at a national, and even more so, at a continental scale. Moreover, bacteria and fungi had distinct biogeographic variations, finding fungi were more strongly associated with geographic patterns than bacteria at a continental scale. In regard to effects on ecosystem services, low intensity management could enhance grape quality, based on the ecological principle of complementarity, where the presence of nitrogen fixing plants promoted grape quality to a similar extent as pesticide application.

We conclude that agricultural systems seem to be able to buffer stressors, such as , herbicide or copper-containing fungicide application, to the current extent. However, it is unknown how changes in microbial community composition affect the stability of systems in the face of other stressors or to what extent management practices impede potential beneficial interactions. The selective promotion of beneficial interactions between non-crop vegetation and crops, which are often mediated by soil microorganisms, could reduce the input of agrochemicals, while maintaining high quality crops and thus could directly reduce the trade-off between agricultural production and biodiversity.

Jury:

Prof. Dr. Jörn Dengjel (President of the Jury, University of Fribourg)

Prof. tit. Dr. Sven Bacher (Thesis Supervisor, University of Fribourg)

Prof. Dr. Pilar Junier (External Expert, University of Neuchâtel)

Prof. Dr. Louis-Félix Bersier (Internal Expert, University of Fribourg)