

Effects of grapevine root density and reinforcement on slopes prone to shallow slope instability

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Slope erosion and shallow slope instabilities are the major factors of soil losses in cultivated steep terrains. These phenomena also cause loss of organic matter and plants nutrients, together with the partial or total destruction of the structures, such as the row tillage pattern of the vineyards, which allow for the plants cultivation.

Vegetation has long been used as an effective tool to decrease the susceptibility of a slope to erosion and to shallow landslides. In particular, the scientific research focused on the role played by the plant roots, because the belowground biomass has the major control on the potential development of soil erosion and of shallow failures. Instead, a comprehensive study that analyzes the effects of the roots of agricultural plants on both soil erosion and slope instability has not been carried out yet. This aspect should be fundamental where sloped terrains are cultivated with plants of great economical relevance, as grapevine.

To contribute to fill this gap, in this study the features of root density in the soil profile have been analyzed in slopes cultivated with vineyards, located on a sample hilly area of Oltrepò Pavese (northern Italy). In this area, the viticulture is the most important branch of the local economy. Moreover, several events of rainfall-induced slope erosion and shallow landslides have occurred in this area in the last 6 years, causing several economical damages linked to the destruction of the vineyards and the loss of high productivity soils.

Grapevine root distribution have been measured in different test-site slopes, representative of the main geological, geomorphological, pedological, landslides distribution, agricultural features, in order to identify particular patterns on root density that can influence the development of slope instabilities. Roots have been sampled in each test-site for characterizing their strength, in terms of the relation between root diameter and root force at rupture. Root density and root strength have been combined in a physical model (Fiber Bundle Model), for the assessment of the trends of the root reinforcement in soil.

The results of this study have contributed to identify root distribution behaviours, in different agricultural and environmental conditions, that have not been enough to guarantee slope stability or that can promote an increase of it. This can furnish important indications for a better identification of slopes more susceptible to slope instabilities and for improving land planning.