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Spatial variability of soil water content and soil chemistry affect grapevine growth in degraded slopes

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Three slopes with grapevines were investigated to see changes in the soil-plant-water system over vegetation growth. The slopes have the following parameters: 1) young grapevine plants with tilled soil (YR), 2) older grapevines with grassland between rows next to the young grapevine (OR), and 3) older grapevines with grass between rows at a different location and slope position (OF). All experimental slopes had identical plant canopy management such as pruning or shoot and bunch thinning. All slopes are prone to erosion. For continuous hydrological monitoring soil water content and temperature sensors were placed at 15 cm and 40 cm below ground both at the top and bottom of the slopes. For indications of plant growth photosynthetically active radiation (PAR) sensors were placed below the canopy, and Normalized Difference Vegetation Index (NDVI) and Photochemical Reflectance Index (PRI) sensors were used to monitor leaf reflectance. All sites included a set of hemispherical sensor sets to measure incoming radiation. Leaf Area Index (LAI) was measured on a biweekly basis using a handheld ceptometer. We found that in the OR and OF sites the soil water content (VWC) was higher at the lower portion of the slope, while for the YR the VWC was the highest at the top. Soil temperature was higher at the top of the slopes over 6% for YR and 9% for OR sites compared to the bottom measuring points. The most notable difference in the NDVI values was observed for OR, where the plants at the top of the slope showed much lower NDVI values compared to the ones at the bottom of the slope. For the younger grapevines, this tendency was showing the opposite results, the plants at the top of the slope had much higher NDVI values than the lower ones, indicating higher leaf densities. The collected PAR values further support these findings, as the OR plants at the top of the slope had the highest PAR values signifying lower leaf areas and densities. The differences in the PRI values suggest that plants at the bottom of the slope have either better nutrient usage or less stress for drought conditions. The LAI values correlated well with the spectral reflectance sensor data. The OR and OF showed higher LAI at the bottom of the slope, while the younger grapevines showed the opposite. The highest LAI values were observed for the YR (max values were around 7) and the lowest for the OF plants (max LAI value was 3.2).