Pesticide residues in vineyard soils and water-eroded sediments – predictions versus observations

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Viticulture, which plays a major role in the economy of several EU countries, is highly dependent of pesticides. In the São Lourenço experimental catchment, located in an important wine-growing region in Portugal, vineyards are the dominant land cover. Previous studies in this catchment showed the presence of different pesticide residues in surface water and erosion rates in vineyards of up to 30 Mg ha⁻¹ y⁻¹. However, information on the presence of pesticide residues in topsoils and water-eroded sediments are lacking, not just in this catchment but in general. To address these knowledge gaps, we conducted two soil sampling campaigns (fall 2015, fall 2016) and a field runoff-erosion experiment (winter 2015). We sampled 3 vineyards in the first campaign and 9 in the second, both covering different soil types (humic cambisols, calcic cambisols and chromic luvisols). Soil samples were collected within and between the vine rows, at the top, middle and bottom of the slope, and at two soil depths (0-2 and 15 cm). The runoff-erosion experiment involved 9 plots of ~12 m²; pesticide residues were monitored in topsoil and eroded sediments at six occasions after important rainfall events (>50 mm). 47 prioritized pesticide residues were analysed in 162 soil and 108 sediment samples. The levels of residues in soil were compared with their predicted environmental concentrations (PECs), calculated according to European Food Safety Authority (EFSA) pesticide application recommendations and to local farmers records. All soil samples contained pesticide residues, dimethomorph, glyphosate and its metabolite AMPA being the most frequent detected compounds. Measured levels of the different residues in soil occasionally exceeded predictions. Pesticide levels seemed related to slope position, generally being higher at the bottom than at the top or middle of the slopes, but not to the position within or between vine rows. Soil depth played a noticeable role in pesticide levels, with 80% lower concentrations of glyphosate and tebuconazole at 15 cm than 0-2 cm depth. For dieldrin (the only long-banned pesticide detected), the concentration was higher at 15 than 0-2 cm depth. Sediments had fewer compounds than soils, but the frequencies with which they were detected were similarly high. Pesticide levels were significantly higher in sediments than soils, especially in the case of the finest sediments (<0.04 mm). Dimethomorph and pyrimethanil were the most common compounds in the eroded sediments, but glyphosate and AMPA had the highest concentrations. Pesticide export varied between compounds but never exceeded 3% of the content at 0-2 cm
depth. Pesticide export strongly depended on erosion rates, which, in turn, differed between soil
types. Overall, our results reinforced the notions that: (i) intensive pesticide use turns soils into
pesticide sinks and (ii) soil erosion leads to lateral transport of pesticides and their further
accumulation in deposition zones at slope bottoms, with subsequent risks for nearby aquatic
systems. It therefore seems increasingly urgent to establish and implement monitoring programs
for pesticide residues in soil, in order to enable pesticide post-registration control and
comprehensive risk assessments.