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QUALITY ASSESSMENT OF FRESHWATER RESOURCES IN A VINEYARD AREA (SOUTH PORTUGAL)

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Introduction

This study was developed in the scope of the WATERWEB project "Water Resource Strategies and Drought Alleviation in Western Balkan Agriculture" and was supported by the EU Sixth Framework Programme (Inco).

Objectives

- To improve food quality and safety of the wine sector;
- To fulfil the legislation on water protection and management in relation with drinking water, quality of surface water and protection of groundwater against pollution;
- To support the decision-making for technicians and farmers, namely through a sustainable use of pesticides, considering their intrinsic properties and environmental conditions;
- To predict the distribution in the environment and the leaching potential of pesticides using modelling;
- To assess the impact of pesticides on the quality of ground- and surface water in a vineyard area of the 'Alentejo' region (South Portugal);
- To compare the exposure levels of pesticides with their parametric values for human consumption, environmental quality standards (EQS) and ecotoxicological treshold values;
- To evaluate the effects of ground- and surface water on aquatic organisms using toxkit microbiotests;
- To identify measures necessary to minimize contamination of the environment and impact on non-target species.

Materials & Methods

Study area

Vineyard farm located in 'Estremoz' council ('Alentejo' region, Portugal), producing high quality wines
Irrigation method: ´drop by drop' system
High groundwater contamination potential (based on hydrogeological information from the DRASTIC method developed for Portugal)

Water and sediment sampling

Study period: March-October, two to four times per year, 2004-2006
Groundwater sampling: 43 samples from six wells (three drilled wells, two dugged wells and one spring)
Surface water sampling: nine samples from five points of drainage channels (after rain events)
Sediment sampling: seven samples from four points of drainage channels

Environmental fate and ecotoxicological characterisation

Pesticides selected for study:
Herbicides: alachlor*, atrazine*, simazine*, terbuthylazine, terbutryn, trifluralin*
Atrazine metabolite: desethylatrazine (DEA)
Insecticides: chlorfenvinphos*, chlorpyrifos*, endosulfan**, lindane**
*Priority substances in the field of water policy; **Priority hazardous substance (Directive 2008/105/EC, 2008)

Physico-chemical properties/partition coefficients
Fugacity-based environmental equilibrium partitioning model – level I (Mackay Model) (Mackay, 2001) → Predicted environmental distribution (PED)
Bacci & Gaggi and GUS leaching indexes (Bacci and Gaggi, 1993; Gustafson, 1989) → Leaching potential
Ecotoxicological characteristics → Toxicity to algae, *Daphnia* and fish

Bioassays for toxicity testing

Toxkit microbiotests (MicroBioTests, Gent, Belgium)

Toxicity testing of water:
The Algaltoxkit F™ is a 72h growth inhibition test (at 25°C with 24h of light), based on the green algae *Pseudokirchneriella subcapitata* (SOP, 2004a). Algal growth was determined by optical density measurements in a Hitachi U-2000 spectrophotometer UV-Vis.

The Daphtoxkit F™ magna is a 24-48h acute toxicity test (exposure in darkness at 20°C), based on immobility or mortality of the cladoceran crustacean *Daphnia magna* (SOP, 2003).

These microbiotests adhere to 'International Organization for Standardization' guidelines (ISO, 1996, 2004).

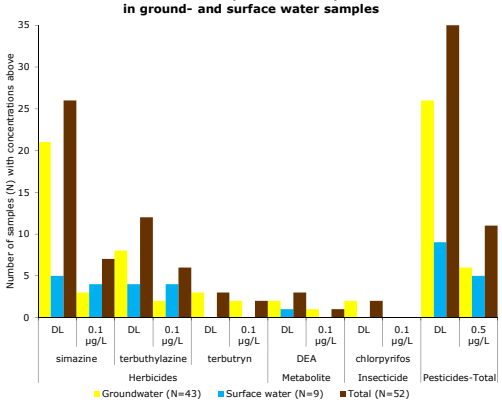
Toxicity testing of sediments:
The Ostracodtoxkit F™ is a 6 days chronic toxicity test (at 25ºC in darkness) with the ostracod *Heterocypris incongruens* based on two distinct effect criteria: mortality of the test organism or growth inhibition, resulting from the direct contact with (non-diluted) sediment (SOP, 2004b).

Analysis of pesticides in water

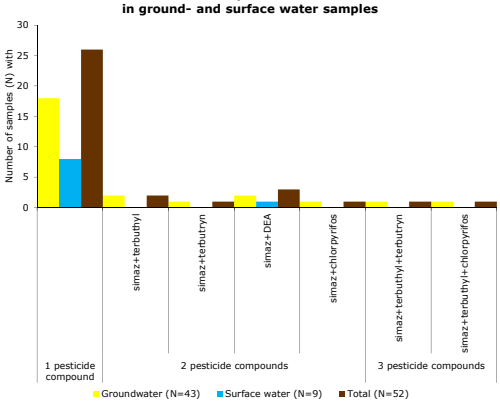
Extraction: Solid-phase microextraction (SPME)
Identification/quantification: Gas-liquid chromatography coupled to mass spectrometry (GC-MS)

Results & Discussions

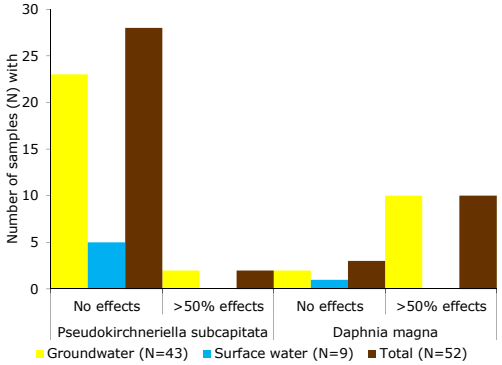
Occurrence of individual pesticides and pesticides-total in ground- and surface water samples



Occurrence of pesticide mixtures in ground- and surface water samples



Occurrence of effects on *Pseudokirchneriella subcapitata* and *Daphnia magna* in ground- and surface water samples



Conclusions

This study demonstrated ground- and surface water contamination by pesticides in a vineyard area between 2004 and 2006, namely to the herbicides simazine, terbuthylazine, terbutryn, metabolite desethylatrazine and the insecticide chlorpyrifos. All these pesticides presented concentrations higher than the parametric value for human consumption and groundwater quality standard for individual pesticides (0.1 µg/L) and/or individual short-term hazard to algae, *Daphnia* and fish. The parametric value for pesticides-total (0.5 µg/L) was also exceeded in a number of samples.

Toxic effects greater than 50% on *Pseudokirchneriella subcapitata* and *Daphnia magna* were determined only in groundwater samples.

Concerning effects on *Heterocypris incongruens* in sediment samples, mortality and growth inhibition values were below 38%.

Future investigations in the scope of the management of river basins are needed to identify the trends of the concentrations of detected pesticides in groundwater. Other compounds than those considered in the present study with potential impact on human health and the environment should also be evaluated. It is also important to assess how relevant are combination effects due to pesticides mixtures that are typically found in the aquatic environment.

The sustainable use of pesticides through the substitution by compounds with more favourable physico-chemical and ecotoxicological properties taking into account ecosystem specificities could be considered an important mitigation measure to reduce pesticide inputs into ground- and surface water at the farm and catchment scales.

References

- Bacci, E., Gaggi, C., 1993. Simple models for ranking pesticide mobility from soils, paper presented at the IX Symposium on Pesticide Chemistry. Mobility and degradation of xenobiotics, Piacenza, Italy, 12–13 October.
- Directive 2008/105/EC of European Parliament and Council on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/419/EEC, 86/280/EEC and amending Directive 2000/60/EC. Official Journal L 348 of 24.12.2008, pp.84-97 (2008).
- Gustafson, D.I., 1989. Groundwater ubiquity score: a simple method for assessing pesticide leachability. Environ. Toxicol. Chem. **8** (4), 339-357.
- ISO, 1996. Water Quality-Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea)-Acute toxicity test. ISO 6341, International Organisation for Standardisation.
- ISO, 2004. Water quality-Freshwater algal growth inhibition test with unicellular green algae. ISO 8692, International Organisation for Standardisation.
- Mackay, D., 2001. Multimedia Environmental: the Fugacity Approach-Second edition. Lewis Publishers Boca Raton.
- SOP (Standard Operational Procedure), 2003. Daphtoxkit FTM magna, Crustacean Toxicity Screening Test for Freshwater. MicroBioTests Inc., Mariakerke (Gent), Belgium.
- SOP (Standard Operational Procedure), 2004a. Algaltoxkit FTM, Freshwater Toxicity Test with Microalgae. MicroBioTests Inc., Mariakerke (Gent), Belgium.
- SOP (Standard Operational Procedure), 2004b. Ostracodtoxkit F, Chronic 'direct contact' Toxicity Test for Freshwater Sediments. MicroBioTests Inc., Mariakerke (Gent), Belgium.