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

Emília Silva, Sofia Batista, Lia Caetano and Maria José Cerejeira
Instituto Superior de Agronomia, Univ. Téc. de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

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 (Intm).

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 modeling;
- 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 threshold values;
- To evaluate the effects of ground- and surface water on aquatic organisms using toxicity 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)

Environmental fate and ecotoxicological characterization

Pesticides selected for study:

Herbicides: alachlor*, atrazine*, simazine*, terbuthylazine, terbutryn, trifluralin*

Agrazine metabolite: desethylatrazine (DEA)

Insecticides: chlorfluanidophos*, chlorpyriphos*, endosulfan**, lindane**

*Priority substances in the field of water policy; **Priority hazardous substance (Directive 2008/105/EC, 2008)

Physico-chemical properties/partition coefficients

Predicted environmental distribution (PED)

Bacci & Gaggi and GUS leaching indexes (Bacci and Gaggi, 1993; Gustafson, 1989) → Leaching potential

Ecotoxicological characterization: → Toxicity to algae, Daphnia and fish

Analysis of pesticides in water

Extraction: Solid phase microextraction (SPME)

Identification/quantification: Gas-liquid chromatography coupled to mass spectrometry (GC-MS)

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 dug 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

Bioassays for toxicity testing

Toxkit microbiotests (MicroBioTests, Gent, Belgium)

Toxicity testing of water:

The Algaltoxkit Fm is a 72h growth inhibition test (at 25°C with 24h of light), based on the green algae Pseudokirchneriella subcapitata (SOP, 2004a).

The Daphnitoxkit Fm 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).


Toxicity testing of sediments:

The Ostracodtoxkit Fm is a 6 days chronic toxicity test (at 25°C 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).

Environmental quality standards

To compare the exposure levels of pesticides with their parametric values for human consumption, environmental quality standards (EQS) and ecotoxicological threshold values.

Results & Discussions

Conclusions

- This study demonstrated ground- and surface water contamination by pesticides in a vineyard area between 2004 and 2006, namely to the herbicides simazine, terbutryn, atrazine, terbuthylazine, and the insecticide chlorpyriphos. 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


-CEER Irrigation Engineering (SOE, 2004a). Algalgrowth was determined by optical density measurements in a Hitachi U-2000 spectrophotometer UV-Vis.


-CEER Irrigation Engineering (SOE, 2004c). Daphnitoxkit Fm 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).


-SoD (Standard Operational Procedure), 2004a. Algaltoxkit Fm, Freshwater Toxicity test with Microalgae, MicroBioTests Inc., Mariakerke (Gent), Belgium.


-SoD (Standard Operational Procedure), 2004c.