In-situ control of agrochemical pollution in combined tree-crop systems

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INTRODUCTION

Agricultural pollution consists a serious concern for environmental protection managers, governmental agencies, local communities and the European Commission, mainly due to the extent of agricultural activity throughout every region and the non-point source nature of this pollution. Among the pollutants, nitrates, phosphoric components and organic pesticides from application in agriculture are the most common and hazardous to the environment and the human health.

Several mitigation techniques have been proposed for the reduction of the pollutants entering the aquatic systems. Agroforestry, which is the common cultivation of crops and trees, is one such mitigation technique (Jose, 2009). The pollutant controlling function of agroforestry is based on the hypothesis that trees, with their deeper and wider roots, create a protective net underneath crops, thus minimizing pollutant leaching to groundwater (Andrianarisoa et al., 2016). A previous study in Greece has produced encouraging results for the potential of pollutant reduction by agroforestry systems (AFS), under the geoclimatic conditions and cultivating techniques applied in Northern Greece (Gikas et al., 2016); leaching of N and P was reduced by up to 54% and 50%, respectively. Additionally, Borin et al. (2010) conducted a relevant study in Italy examining nutrient and herbicide reduction in runoff; very high levels of agrochemical attenuation was observed (60-90% for herbicides and up to 100% for nutrients).

In the present study, the efficiency of agroforestry systems in pollutant reduction is reviewed. Additionally, experimental results from an established tree-crop system in Attica region, Greece, consisting of common olive tree-maize cultivation, are presented. The novel parameter examined in this study is the evaluation of the effectiveness of AFS on mitigation of herbicide environmental pollution from leaching to groundwater in the Mediterranean environment.

MATERIALS AND METHODS

An extended literature review in Scopus and Science direct databases, demonstrating the efficiency of agroforestry systems throughout the world was conducted. More than 200 peer-reviewed, relevant manuscripts were evaluated, with the majority of the systems to be set up outside the EU Region. Thus, a lack of information for EU region crop-tree system combination, and particularly for the Mediterranean basin, was identified. Additionally, no information on the performance of such systems in the attenuation of the commonly used herbicides was available, hence, the present study also orientates on herbicides commonly used in the EU.

Within the scope of the experimental part of the study, a regularly cultivated and irrigated field was

selected, which is located in Koropi Area, at the Eastern part of Attica prefecture, Greece. A pilot cultivating system of approximately 100 m^2 with maize as crop and 15 year-old olive trees was established for the field study.

The monitored pollutants were nitrogen, phosphorus and the dinitroaniline herbicide pendimethalin. Soil samples were collected at various depths and distances from the olive trees row. Pollutant concentrations were measured in the laboratory using Gas Chromatography with Electron Capture Detector (GC-ECD) and Ion Chromatography (IC) techniques.

RESULTS AND DISCUSSION

Previous knowledge demonstrates that tree roots are able to reduce nitrogen and phosphorus from 20% and up to 100% for nitrogen, and simultaneously provide benefits to the ecosystem including carbon sequestration, erosion reduction, positive effects on biodiversity and the improvement of soil quality. Moreover, from the present study results, it is seen that the examined olive tree-maize agroforestry system has the potential to reduce pollutant migration to groundwater.

The study is still on-going with new crop types in order to investigate the fate and behaviour of these pollutants in different AFS.

From the current results, it could be observed that the higher pollutant concentrations were measured in samples at greater distances from the trees (control points), and reduction of their concentrations with descending distance from the tree row, with nitrogen compounds reduced at higher levels.

From the results already obtained, it can be concluded that the tested systems have the potential for pollution abatement and thus further investigation of the observations is deemed necessary, adding also more parameters for consideration, such as the fate and behaviour of other herbicidal products in the same system, examination of different tree-crop systems, examination of the levels of pollutants in the vadose zone water through lysimeter studies, as well as the metabolic pathway of the organic pollutants in the field.

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