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Low-cost approaches for the removal of terbuthylazine from agricultural wastewater: Constructed wetlands and biopurification system

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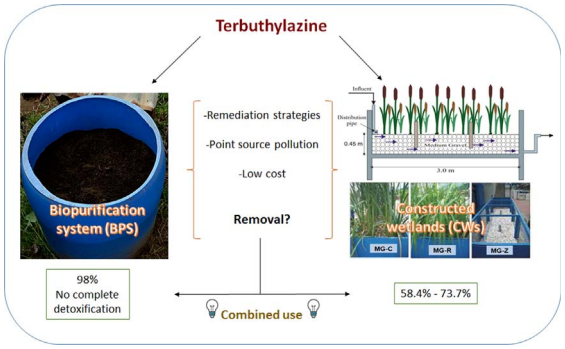
GRAPHICAL ABSTRACT



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ABSTRACT

Constructed wetlands (CWs) and biopurification systems (BPS) present two low-cost approaches for the removal of pesticides from waters of agricultural origin. Both strategies were tested in the treatment of the herbicide terbuthylazine, a triazine of worldwide use. Three horizontal subsurface flow (HSF) CW systems were operated continuously for one year; the planted CWs (containing either *Phragmites australis* or *Typha latifolia*) were able to remove up to 73.7% and 58.4% of the pesticide, respectively, and exhibited a markedly superior performance compared to the unplanted CW. However, by the end of the treatment period, some symptoms of phytotoxicity were observed in the plants of the CWs, which are related to high terbuthylazine concentrations in plant material. A coconut fiber-containing biomixture was used in BPS which was able to rapidly remove terbuthylazine, with an estimated half-life of 8.1 d, the fastest so far reported in these systems. However, the biomixture failed to detoxify the matrix, according to ecotoxicological tests of seed germination. The current data suggests that

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coupled/hybrid configurations comprising CWs and BPS in series could provide increased effectiveness and a low-cost technology to remove terbuthylazine from highly contaminated water.

1. Introduction

Pesticides are widely used all over the world as they are necessary to sustain the agricultural sector; in particular, the use of herbicides is a major component in all integrated pest management systems. Triazines comprise one of the most widely used families of pesticides for the control of grass and broad-leaved weeds in a variety of crops, like wheat, grape, peaches, sorghum, asparagus, corn, barley, apple, banana, citrus, pineapple, sugarcane, coffee and maize, as well as for non-agricultural purposes including forestry and maintenance of roads [1,2]. Due to the prohibition of atrazine in the European Union, terbuthylazine was gradually employed as the replacing herbicide [3], which is considered as the most persistent triazine herbicide in surface environments [4]. Its presence has been reported worldwide in water bodies [5,6] and is among the most frequently detected pesticides in surface and groundwater in Greece [7–10].

Due to the use of pesticides, ecosystems suffer from negative impacts, such as soil and air, and surface and groundwater contamination when these chemicals enter the environment by diffuse or point-source pollution [11,12]. Mixing and loading of pesticides, filling and washing

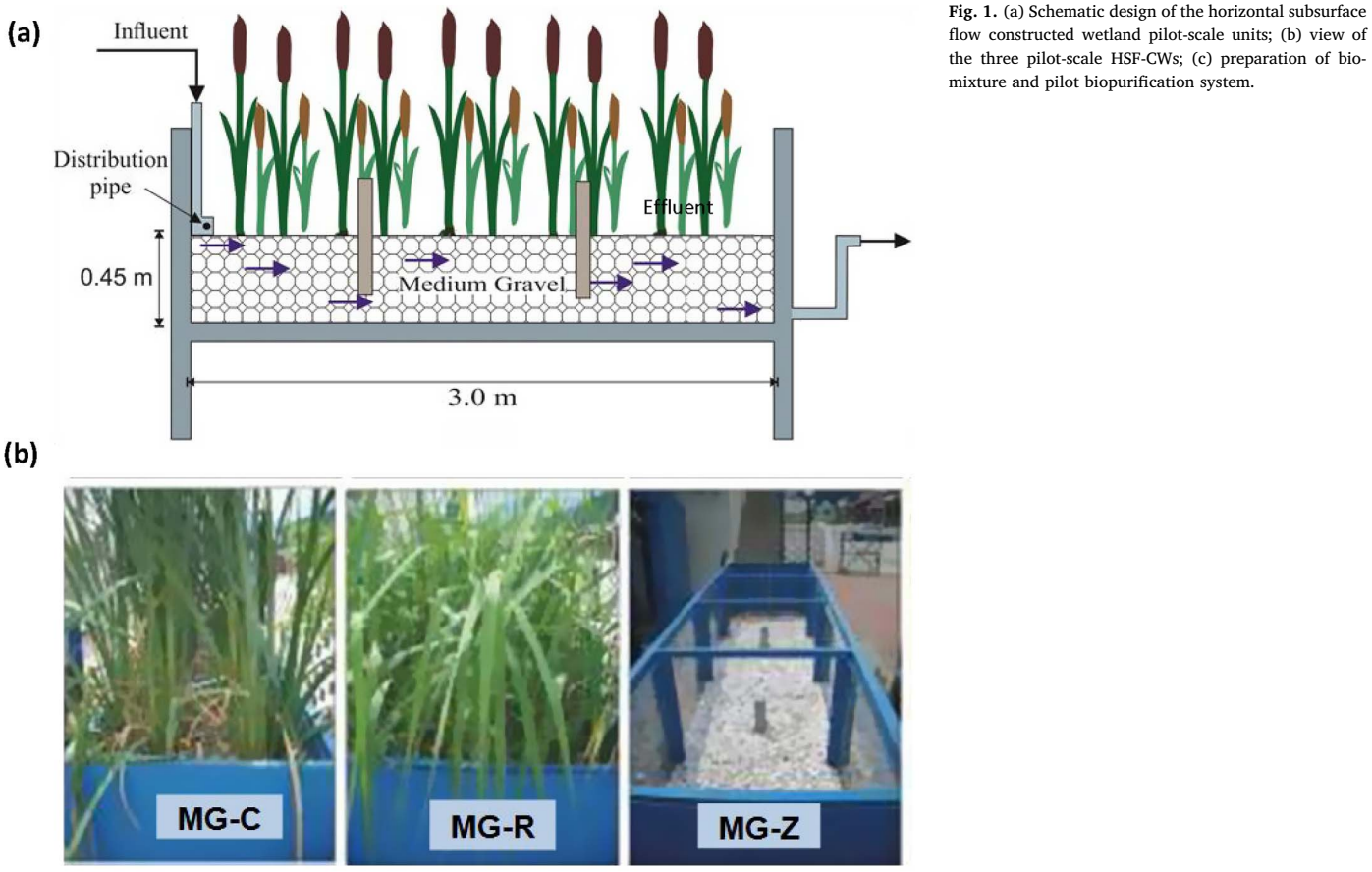

Fig. 1. (a) Schematic design of the horizontal subsurface flow constructed wetland pilot-scale units; (b) view of the three pilot-scale HSF-CWs; (c) preparation of biomixture and pilot biopurification system.