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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRO-ALIMENTARI

RegioneEmilia-Romagna

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Giornate Fitopatologiche

10th European Conference on Pesticides and Related Organic Micropollutants in the Environment
&
16th Symposium on Chemistry and Fate of Modern Pesticides
joined to
10th MGPR International Symposium of Pesticides in Food and the Environment in Mediterranean Countries

CONCERNS, CHALLENGES & POSSIBLE SOLUTIONS

BOOK OF ABSTRACTS

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SYMPOSIUM EVENTI

Symposium S.r.l.

Via delle Tovaglie 12 - 40124 Bologna
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ISBN 978-88-95221-00-7

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September 12 - 14 2018 · Bologna (Italy)

Conference Hall "20 Maggio 2012"

Regione Emilia-Romagna

Viale della Fiera, 8

INVITED LECTURE

PESTICIDE BIOPURIFICATION SYSTEMS: MOVING FROM ON-FARM TO OFF-FARM ACTIVITIES

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ABSTRACT: Point sources are major contributors to the contamination of natural water resources with pesticides stemming from inappropriate practices during sprayer preparation, washing or handling of spraying remnants. Biopurification systems called biobeds (or biofilters, phytobac etc) have been used to mitigate pesticide point source contamination at on-farm level. Recent monitoring studies have shown that off-farm activities can also contribute to the contamination of surface water resources with pesticides. Fruit-packaging plants, seed-producing companies and bulb-coating agro-industries produce effluents contaminated with persistent and toxic pesticides which according to the EU legislation should be treated on-site. In the absence of physicochemical treatment strategies modified biobeds appear as a cost-effective treatment method for these effluents. A step-wise experimental approach was followed to explore the potential of biobeds to decontaminate these agro-industrial effluents. Laboratory dissipation and adsoprtion studies identified optimum materials for the packing of biobeds and column studies optimized their water management. Finally pilot biobeds showed high depuration capacity against pesticides contained in effluents from fruit-packaging plants. Bioaugmentation with tailored-made microbial inocula improved the depuration capacity of biobeds for persistent chemicals like thiabendazole. Risk assessment analysis revealed that biobed-treated effluents did not entail an unacceptable environmental risk. Composting was the most effective methods for the decontamination of the spent-biobed packing material. Dissipation and adsorption studies have provided an initial assessment of the biobeds for the removal of pesticide used in seed-coating and bulp-dipping activities.

KEYWORDS: *biobeds; agro-industrial effluents; biodegradation; fungicides*

INTRODUCTION

Point sources contribute to the contamination of water resources with pesticides stemming from inappropriate practices during sprayer preparation, washing or handling of spraying remnants. Biopurification systems called biobeds (or biofilters, phytobac etc) have been used to mitigate pesticide point source contamination at on-farm level (1). Recent monitoring studies have shown that off-farm activities can also contribute to the contamination of surface water resources (2). Fruit-packaging plants, seed-producing companies and bulb-coating agro-industries produce effluents contaminated with persistent and toxic pesticides (thiabendazole, imazalil, fludioxonil, *ortho*-phenylphenol and chlorothalonil) which according to the EU legislation should be treated on-site (3). We aimed to explore the potential of biobeds for the treatment of these pesticide-contaminated agro-industrial effluents.

METHODOLOGY

- A step-wise experimental approach was followed to explore the potential of biobeds for the treatment of effluents obtained from fruit-packaging plants. Initial lab studies on a range of organic biomixtures, relevant to the Mediterranean agriculture, measured the degradation and adsorption of the fungicides contained in effluents from fruit packaging plants (thiabendazole, imazalil, *ortho*-phenylphenol) (4)
- Leaching column studies aimed to identify the most optimum water management of the biobed packing material to achieve maximum depuration performance (5)
- Pilot biobed systems fed with wastewaters containing combinations of pesticides produced either from citrus or pome fruit-packaging plants were tested. Bioaugmentation with thiabenazole and ortho-

phenylphenol degrading bacteria were employed at pilot scale biobeds as an optimization approach. The levels of pesticides in the treated effluents were used to assess the risk associated with their environmental release. Finally composting, storage at ambient temperature or bioaugmentation were tested for the decontamination of spent-biobed packing material upon its replacement (6)

- The adsorption and degradation of pesticides used in seed-coating (fludioxonil, chlorothalonil, metalaxyl, fluxapyroxad) and bulp-dipping activities (chlorothalonil, thiabendazole) on the optimized biobed packing material vs soil was determined as a first measure of the potential of biobeds to treat effluents from these agro-industries

FINDINGS

- Laboratory degradation and adsorption studies showed that a bioorganic material composed of soil (25%), straw (25%) and spent mushroom material (50% by volume) was the most effective in the dissipation of thiabendazole, imazalil, ortho-phenylphenol, diphenylamine used in fruit-packaging plants, with the first two being the most peristent of the compounds tested.
- Leaching column studies verified the superior depuration performance of spent mushroom substrate-rich packing materials which was not associated with the presence of Pleurotus ostreatus in this material.
- Pilot-biobeds exhibited depuration efficiency exceeding 99.5% for all pesticides. Bioaugmentation with thiabendazole-degrading bacteria increased the depuration efficiency of pilot biobeds to 100%. Environmental risk assessment suggested that biobed-treated effluents were of high quality and their environmental release did not entail a risk. Bioaugmentation was the most effective decontamination method of the spent biobed packing material, although composting was also effective and is proposed as the most easy to implement method
- Degradation studies with pesticides used in seed-coating and bulp-dipping activities showed a superiority of biobed packing material over soil in the degradation of the studied pesticides with fluxapyroxad being the most persistent chemical (DT_{50} = 143 d). When tested in mixtures relevant to their practical use, the degradation of all pesticides was retarded with the most prominent example being thiabendazole whose DT_{50} was extended from 37.6 to 116 days in the biobed packing material.

CONCLUSIONS

Overall our findings suggest that biobeds could be a valuable method for the treatment of pesticide-contaminated effluents from fruit-packaging plants. Our recent laboratory studies have demonstrated the superiority of biobed packing material for the dissipation of pesticides contained in effluents from bulp-dipping and seed-coating activities. Up-scaling studies will evaluate the dissipation removal of biobeds under realistic conditions and will address particular requirements of these effluents like the dyes contained in seed-coating effluents.

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Acknowledgements: This research has been co-financed by the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code:T1EDK-02566, project acronym: MINOTAUR)