An Evaluation of Bacterial Pesticide Reduction Capabilities Facilitated by Wood Chip Bioreactors

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Introduction

The application of pesticide is often an essential aspect of crop production. As a result of this process pesticides are introduced to neighboring waterbodies, eventually accumulating downstream, contributing to regional environmental degradation while posing a serious health risk to local residents. The goal of this study is to evaluate the remediation potential of wood chip bioreactors by monitoring pesticide reduction rates in a controlled environment where variables that influence the bacterial digestive process can be identified and maintained.

Background

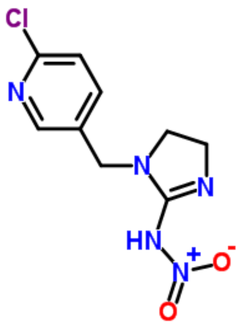

Figure 1: Imidacloprid ($C_9H_{10}ClN_5O_2$)
http://www.chemspider.com

Imidacloprid ($C_9H_{10}ClN_5O_2$) is an insecticide commonly used for agricultural pest management. This compound belongs to a class of chemicals known as neonicotinoids, which bind to the neuron receptors of insects, disrupting their nervous system. The application of imidacloprid can also effect nontarget species, such as honey bees, and is widely believed to be associated with colony collapse disorder.

One on site management strategy that has shown promise in reducing contaminate levels in agricultural effluent is the use of wood chip bioreactors to treat runoff before it is released into receiving waters. These systems facilitate the bacterial digestive process by providing a sufficient source of carbon, as well as a viable substrate for reproduction

Figure 2: Both containing bacterial communities that have been screen for imidacloprid reduction capabilities.

System Design

Substrate

Figure 3: (A) Pumice blocks, (B) plastic bioballs, and (C) pine wood chips used during preliminary research to evaluate viable substrate type for the cultivation of bacteria. (D) Wood chip bioreactor channels separated by substrate grade. The left channel contains small grade wood chips and the two channels on the right contain large grade wood chips.

Hydraulic Efficiency

Table 1: Observed hydraulic efficiency of various substrate grade in relation to theoretical hydraulic residence times (HRT).

Channel	Hydraulic Efficiency
Control	14%
Small Wood chip	84%
Large Wood Chip	100%

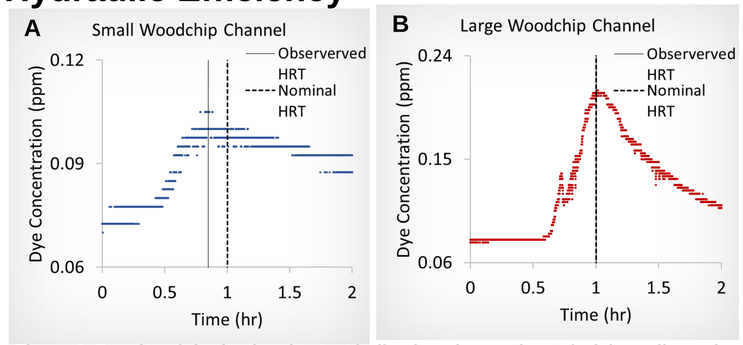

Figure 4: Results of rhodamine dye test indicating observed HRT in (A) small wood chip and (B) large wood chip channels in comparison to theoretical values.

Temperature

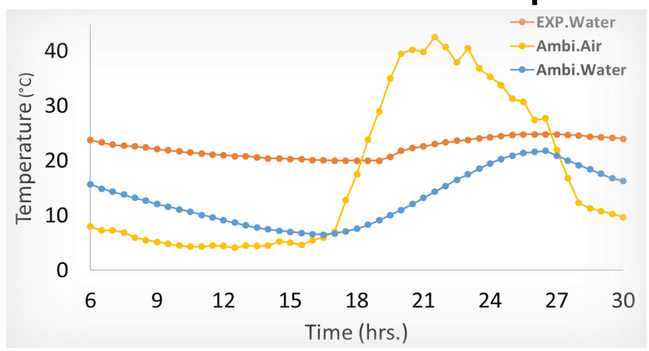

Figure 5: Variations in temperature observed under ambient air, ambient water and experimental conditions.

Table 2: Average temperate observed at various sampling locations on Oct 3, 2017.

Location	Average Temp. (C°)	Standard Deviation
Ambient Air	17	14
Ambient Water	13	5
Exp.	22	2

Sampling Protocol

1. System flow rate is set to achieve a 1 hour hydraulic residence time (HRT).
   - Exp Channels: 38 mL/sec
   - Cont Channel: 63 mL/sec
2. 1 L of DI water is dosed to a predetermined pesticide concentration.
3. Solution is separated into four equal parts and added to each individual channel.

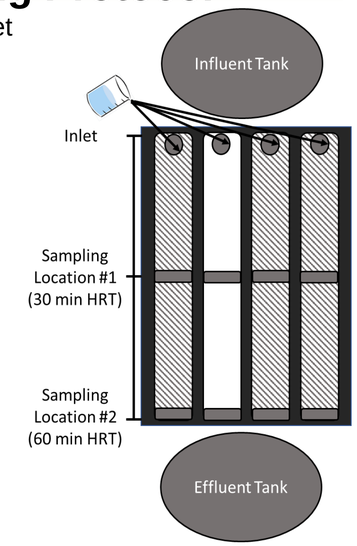

Table 3: Sampling interval for each channel from location 1 or 2 during indicated period of time.

Time	Beaker	Location 1	Location 2
0 min	X	X	
30 min		X	X
60 min		X	X

Sample Analysis

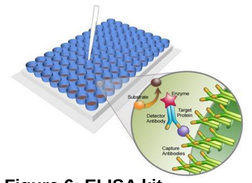

Figure 6: ELISA kit
http://www.gmotesting.com

Pesticide concentration for each sampling interval will be determined through the use of an enzyme-linked immunosorbent assay (ELISA) based on the established factory protocol.

Acknowledgements

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