Pesticide Rinsate Biobed for Conserving Water Quality

Sarah Johnson[1*], Phoenix Nakagawa[1], Marufa Fatema[1], Terrance Anseeuw[1], Andrej Kao[1], Fahad Khan[1], Alistair Brown[1], Inoka Amarakoon[1], Claudia Sheedy[†2] and Annemieke Farenhorst[1].

[1]Department of Soil Science, University of Manitoba, [†2]Deceased, formally at Agriculture and Agri-Food Canada Lethbridge Research and Development Centre, *Corresponding author: johns293@myumanitoba.ca

Introduction

Biobeds are above- or in-ground containers that hold biomixtures in a single- or dual- cells (Table 1). A biomixture typically consists of dry plant material (e.g., straw), humified organic matter (e.g., peat) and soil in a 2:1:1 ratio (Figure 1).

Biobeds in Saskatchewan and Alberta

We calculated the efficiency of two single-cell and two dual-cell biobeds that had been previously established in Saskatchewan and Alberta (Table 1). A total of 67 unique pesticide active ingredients were detected with almost all of the samples containing pesticide mixtures. More than two-third of the unique active ingredients detected in influent samples had concentrations > 1µg/l. Maximum detected concentrations in the influent included > 65,000 µg/l concentrations for herbicides 2,4-D and MCPA. The mean concentrations of 2,4-D (2.6 µg/l) and MCPA (124 µg/l) in effluent were significantly smaller than the mean concentrations of these active ingredients in influent (2,4-D=7,441 µg/l, MCPA=7,946 µg/l), showing that the biobeds were functioning well. In fact, both single-cell and two dual-cell biobeds were highly effective for a wide range of pesticides, some examples are shown in Figure 2. However, the biobed effectiveness was relatively poor for bentazone and clopyralid because more than two-third of the effluent samples contained these herbicides and at maximum concentrations >3,000 ug/l. This suggests that further improvements in biosystem design need to be made for optimizing the recycling of these pesticides.

Table 1: Summary information of the four biobeds included in this study.

Location	Biomatrix	Surface area (m^2)	Sampling year and number
Single-cell biobeds in the Province of Alberta			
Grand Prairie[1]	Wheat straw, compost, soil	44 m^2	2015 (8), 2016 (8)
Vegreville[2]	Wheat straw, peat, soil	8 m^2	2015 (12), 2016 (16), 2017 (8)
Dual-cell biobeds in the Province of Saskatchewan			
Outlook[2]	Wood chips, peat, soil	6 m^2	2014 (8), 2015 (14), 2016 (14)
Simpson[2]	Wood chips, peat, soil	4.5 m^2	2015 (8), 2016 (12)
Dual-cell biobeds in the Province of Manitoba			
Carman[2]	Wheat straw, peat, soil	8 m^2	2020 (7), 2021 (9)

[1]Below ground biobed, [2]Above ground-biobeds.

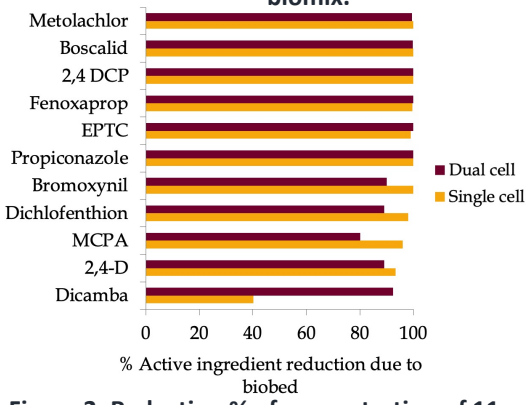

Figure 2: Reduction % of concentration of 11 pesticides in single and dual biobeds.

Biobed in Manitoba

The Canadian Agricultural Partnership program allowed for the development of a dual cell biobed in Manitoba for recycling tank rinsate on a research farm. The biobed that is established at the Univ. Manitoba Ian Morrison Research Farm in Carman is open to collect rinsate from all sprayers on the farm (Figure 3). Close to 10,000 L of rinsate were processed through the biobed from June to October in 2021. In addition to being functional for farm operations on site, the biobed is also being used for demonstrations to the agricultural industry, and for scientific research to improve on biobed efficiency. This includes temperature and moisture probes connected to the Internet-of-Things (Figure 4). Future samples from the Univ. Manitoba Ian Morrison Research Farm in Carman will be analyzed in the MAKE Analytical Solutions (MASS) lab in Winnipeg, MB (Figure 5).

Figure 1: Photo of biomix.

Figure 3: Biobed setup at research farm in Carman, MB.

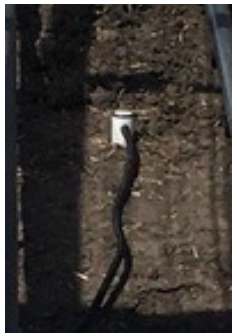

Figure 4: Probe inside biomix.

Figure 5: MASS Laboratory in Winnipeg, MB.