ATMOSPHERIC CONCENTRATIONS OF PESTICIDES IN CANADA IN RELATION TO WETLAND WATER QUALITY

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Along with many collaborators, The Department of Soil Science, University of Manitoba, Canada is conducting research in the prairie pothole region of south central Canada and north central United States to determine how wetland hydrology and water quality is influenced by upland and regional land use. The prairie pothole region of has an area of over 777,000 km^2 and contains millions of wetlands that are closely associated with agricultural land.

Passive air samplers (uptake rate of about 3.5 m^3 air per day) were established at seven sites across the provinces of Manitoba and Ontario for 90 days. Locations were chosen in regions with varying herbicide use so that the relative air concentrations of 12 currently-used herbicides could be determined. In addition, we analyzed for two pesticides that are no longer registered for use in Canada. The herbicide alachlor was de-registered in 1986. The insecticide Lindane, also known as Gamma-hexachlorocyclohexane (HCH), was de-registered in 2001. Alpha-HCH, the main isomer in technical HCH, was also analyzed for.

The impact of wet and dry atmospheric deposition of pesticides on wetland water quality was then assessed at one research location, the Manitoba Zero Till Research Association (MZTRA) Farm, Brandon, Manitoba. This included taking weekly air samples (uptake rate of about 2000 m^3 air per week) and taking bulk atmospheric deposition (rainfall + particulate deposition) samples from May 26 to September 15, 2008. Water samples were taken from four on-site wetlands every second week. In addition to the compounds listed above, the bulk deposition and wetland water samples were also analyzed for the herbicides glyphosate and glufosinate.

At the MZTRA Farm, 12 pesticides were detected in the air, with MCPA, triallate, and gamma-HCH being detected every week. Clopyralid and alpha-HCH were detected in 94% of the air samples analyzed followed by trifluralin (88%), dicamba and bromoxynil (82%), mecoprop and ethalfluralin (65%), 2,4-D (53%), and metolachlor (47%). Nine pesticides were detected in bulk deposition samples with MCPA again being the most frequently detected compound (76%) followed by 2,4-D (65%), bromoxynil and glyphosate (53%), clopyralid and dicamba (41%), atrazine and metolachlor (12%), and mecoprop (6%). Nine pesticides were found in the wetland samples but the detection frequencies were very low with the exception of clopyralid (100%) and MCPA (57%). Maximum concentrations in wetland water was 0.34 µg L^{-1} for clopyralid and 0.17 µg L^{-1} for MCPA with maximum air concentrations of 3.71 ng m^{-3} and 1.84 ng m^{-3}, respectively, and maximum bulk depositions of 16.99 µg m^{-2} $week^{-1}$ and 70.87 µg m^{-2} $week^{-1}$, respectively. A predictive model was developed that estimated the wetland water contamination of clopyralid and MCPA due to the atmospheric deposition of these chemicals. The estimated concentrations were close to actual concentrations for MCPA, but not for clopyralid suggesting a source other than atmospheric deposition.

The results of the passive air samplers revealed that the concentrations of currently-used herbicides in air decreased with increasing distance from areas in which their agricultural use was concentrated. Currently-used herbicides were not detected in Thompson and Churchill which locations are about 650 and 950 kilometres north of Manitoba's major agricultural region, respectively. However, alpha-HCH and alachlor were detected in Thompson and Churchill suggesting that these compounds are relatively persistent and tend to move northward. In contrast, currently-used herbicides are more readily degraded in the atmosphere.