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NH_3 Losses Following Soil-Surface Application of Poultry Manures in Eastern Canada

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INTRODUCTION

- ✓ In Canada, land application of poultry manure results in the volatilization of 10.8 Gg NH_3-N annually (Sheppard and Bittman, 2013);
- ✓ NH_3 emissions from surface-applied poultry manure may be influenced by previous manure handling and storage;
- ✓ There are few reports of relationships between field NH_3 emissions and poultry manure characteristics: total ammoniacal N (TAN), dry matter and pH (Misselbrook et al., 2005a); pH (Lau et al., 2010).

OBJECTIVES

- ✓ Quantify NH_3 losses from several poultry manure types commonly found in Eastern Canada, and relate NH_3 emissions to manure TAN applied.

MATERIAL AND METHODS

- ✓ **Site:** Québec City, Canada (lat. 46º05'N, long. 71º02'W, elevation 110 m);
- ✓ **Period:** 6 to 28 August 2012;
- ✓ **Soil:** Loamy Typic Humaquept (30% sand, 19% clay);
- ✓ **Experimental design:** Randomized complete block with three replicates;
- ✓ **NH_3 emission measurement:** Wind tunnels (Lockyer, 1984);
- ✓ **Treatments:** Seven different poultry manures;
- ✓ **Application rate:** 20 g total N m^{-2}

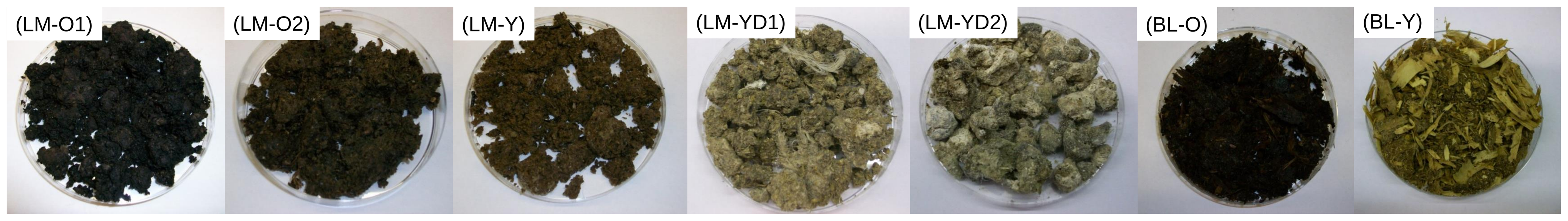

Table 1. Selected characteristics of the poultry manures (wet basis).

Treatments†	pH	Dry Matter	NH_4^+-N	NO_3^--N	Organic N	Total N	Total C	C/N
		(%)	----------	----------	g kg^{-1}	----------	----------	
LM-O1	7.9	61.4	5.6	0.0	35.3	40.9	189.1	4.6
LM-O2	8.4	43.5	13.9	0.0	12.9	26.8	129.2	4.8
LM-Y	8.0	37.0	6.0	0.0	18.5	24.5	120.6	4.9
LM-YD1	7.9	94.9	0.7	0.0	36.3	37.0	315.1	8.5
LM-YD2	7.1	69.9	2.3	0.0	33.7	36.0	235.2	6.5
BL-O	8.5	51.9	3.2	0.0	14.6	17.8	178.8	10.1
BL-Y	8.4	64.8	4.0	0.1	19.6	23.7	266.6	11.2

† LM: Layer Manure, BL: Broiler Litter, O: Old, Y: Young, D: Dry.

Table 2. Details of the poultry manure handling and storage.

Treatments†	Description
LM-O1	Layer manure, old, compact, stockpiled for more than 7 months in a closed shed.
LM-O2	Layer manure, old, stockpiled wet: 4 months on a concrete platform followed by 40 d in the field.
LM-Y	Layer manure, young, stored beneath the cages and removed twice a week.
LM-YD1	Layer manure, young, droppings were dried with an efficient system within 24 h, and then stockpiled for 20 d in a closed shed.
LM-YD2	Layer manure, young, droppings were partially dried within 1-7 d, and then stockpiled for 10 d in a closed shed.
BL-O	Broiler litter with wood shavings, old, stockpiled for more than 7 months in a closed shed.
BL-Y	Broiler litter with wood shavings, young, stockpiled for 5 d in the field.

† LM: Layer Manure, BL: Broiler Litter, O: Old, Y: Young, D: Dry.

RESULTS

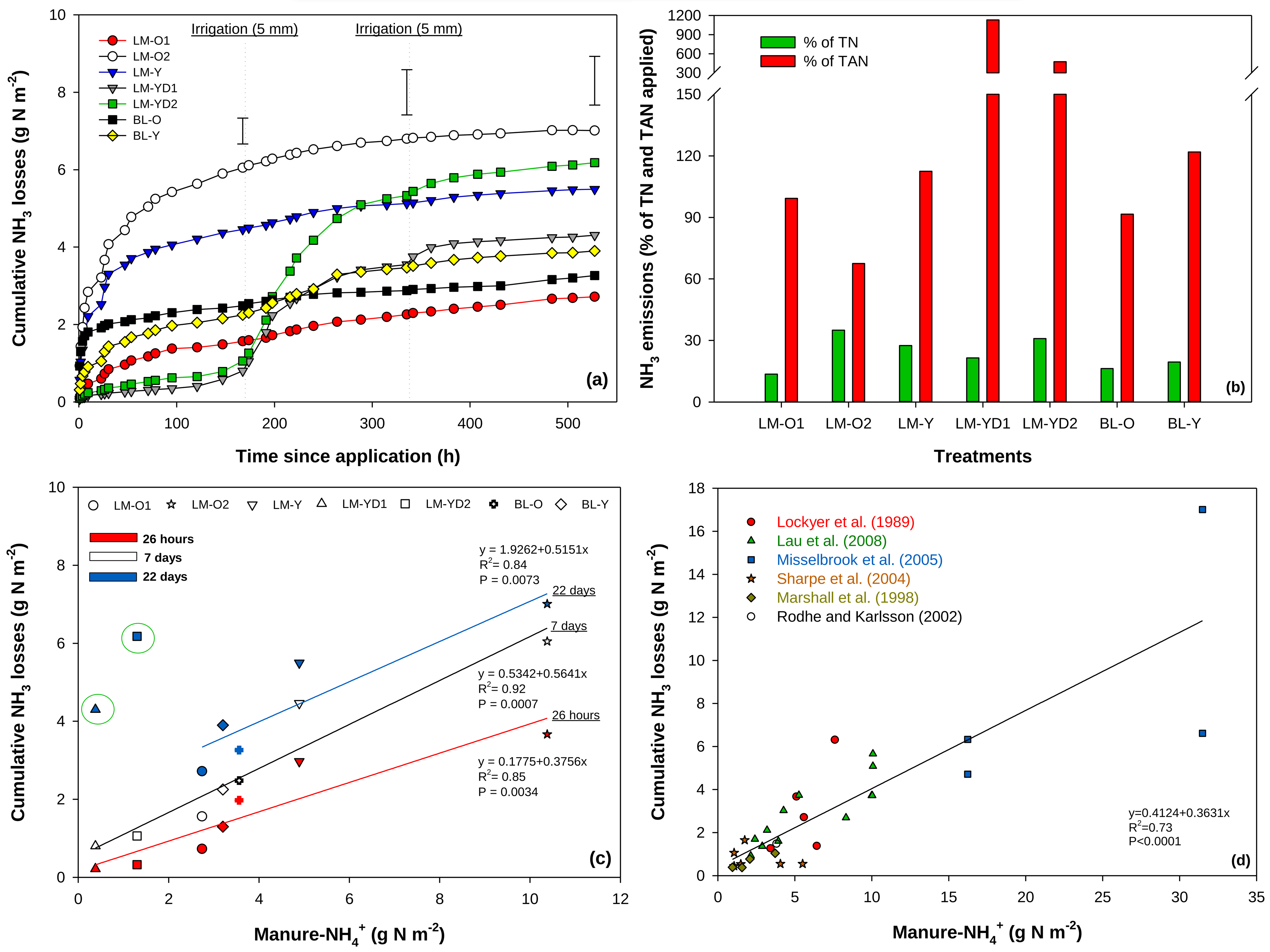

Figure 1. Cumulative NH_3 losses (a), NH_3 emissions as a fraction of manure total N (TN) and total ammoniacal N (TAN) applied (b), cumulative NH_3 losses vs TAN applied in this study (c) and for the summary of literature data on poultry manures (d).

(LM: Layer Manure, BL: Broiler Litter, O: Old, Y: Young, D: Dry)

Table 3. Time after manure application when NH_3 losses reached 5 to 75% of total emissions

Treatments†	5%	10%	20%	30%	40%	50%	75%
	----------	----------	----------	Time after manure application (h)	----------	----------	----------
LM-O1	1.4	3.5	12.3	30.3	61.2	108.3	270.0
LM-O2	0.6	0.9	1.9	4.2	9.0	18.3	97.0
LM-Y	0.7	1.0	2.3	4.8	9.8	19.8	104.8
LM-YD1	25.8	124.7	168.3	177.2	187.3	199.5	254.5
LM-YD2	22.8	109.7	173.8	183.8	195.0	208.0	257.7
BL-O	0.0	0.0	0.1	0.4	2.2	9.0	115.8
BL-Y	0.4	1.3	6.2	19.3	47.5	99.7	231.2

† LM: Layer Manure, BL: Broiler Litter, O: Old, Y: Young, D: Dry.

CONCLUSIONS

- ✓ NH_3 losses accounted for 13.6 to 35% of TN;
- ✓ Linear regressions between cumulative NH_3 losses and applied TAN explained 85, 92 and 84% for the first 26 h, 7 d and 22 d, respectively;
- ✓ Literature data indicates that, on average, 36% of poultry manure TAN is lost as NH_3 with a contribution of other NH_4 sources estimated at 0.41 g NH_3 m^{-2};
- ✓ Incorporation of dried manures (LM-YD1 and LM-YD2) can wait until first rainfall. Omitting the dried manures, the mean incorporation delay to limit losses to 20% was 4.5 h;
- ✓ NH_3 losses using semi-open chambers = 30% of wind tunnels estimates.

Lau et al. (2008) Can. Biosyst. Engin. 50:647-655; **Lockyer** (1984) J. Sci. Food Agric. 35:837-848; **Lockyer** (1989) Environ. Pollut. 56:19-30; Sharpe et al. (2004) J. Environ. Qual. 33:1183-1188; **Marshall** et al. (1998) J. Environ. Qual. 27: 1125-1129; **Misselbrook**, et al. (2005a) Bioresour. Technol. 96:159-168; **Misselbrook**, et al. (2005b) Environ. Pollut. 135:389-397; **Rodhe and Karlsson** (2002) Biosyst. Engin. 82:455-462; **Sheppard and Bittman** (2013) Agric. Ecosyst. Environ. 171:90-10.