Nutrient dynamics during composting of straw-bedded and wood chip-bedded feedlot manure

Francis J. Larney and Andrew F. Olson

Agriculture and Agri-Food Canada, Research Centre, Lethbridge, Alberta

Introduction

The County of Lethbridge in southern Alberta has a licenced capacity of 668,000 head of feedlot cattle. The volume of raw manure produced is putting pressure on the land base in terms of high nutrient loadings. Feedlot operators are looking at composting as a means of moving nutrients further away from source so that they are applied to soils with lower soil test levels for nitrogen and phosphorus (Larney *et al.*, 2000).

Traditionally, cereal straw has been used as bedding for feedlot cattle. However, in recent years wood residuals from the forest and lumber industry are being promoted as bedding alternatives (McAllister *et al.*, 1998)

The objective of this study was to compare nutrient dynamics during the composting of straw-bedded and wood-chip bedded manure during three summer composting experiments.

Materials and methods

The compost trials were conducted at the Agriculture and Agri-Food Canada Research Centre in the summers of 1998, 1999 and 2000 (Table 1). Feedlot pens were bedded with straw and wood-chips. The straw bedding had 452 kg Mg^{-1} total C; 4.4 kg Mg^{-1} total N; C/N ratio of 109; 0.47 kg Mg^{-1} total P and a pH of 6.7. The wood-chip bedding had 507 kg Mg^{-1} total C; 1.8 kg Mg^{-1} total N; C/N ratio of 313; 0.34 kg Mg^{-1} total P and a pH of 5.6. Experimental windrows (2 replicates) of straw-bedded and wood-chip bedded manure were established on a roofed concrete pad. Each windrow was about 8 m in length, 2.5 m wide at the base and 2 m high.

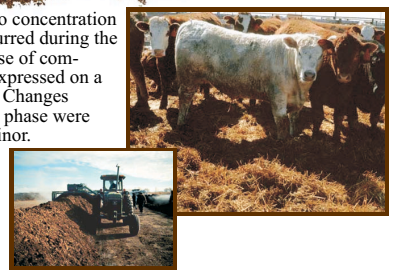
Initial samples of raw manure and final samples of compost were analyzed for water content, ash content, available N (NO_3-N + NH_4-N, KCl extracts), total C and total N (automated elemental analyzer), total P (colormetrically after digestion with H_2SO_4 and H_2O_2), and available P (Kelowna extract).

Table 1. Details of thermophilic phase compost trials, 1998-2000.

	1998	1999	2000
Windrow setup	Jun 22-23	Jul 20-23	Jul 12
First turning	Jun 25	Jul 27	Jul 20
Last turning	Oct 29	Oct 26	Nov 9
No. turnings	16	8	8
No. Days	129	98	120

Results and discussion

All results refer to concentration changes that occurred during the thermophilic phase of composting and are expressed on a dry weight basis. Changes during the curing phase were comparatively minor.



Nitrogen

In general, total N concentration of the raw manure was higher with straw-bedded manure than wood-chip bedded (average of 17.5 kg Mg^{-1} *vs.* 14 kg Mg^{-1}) [Table 2]. With final compost, there was less of a difference in concentration (average of 17 kg Mg^{-1} *vs.* 15.8 kg Mg^{-1}) due to a general increase in N concentration during composting of the wood chip-bedded material. Because of the loss of ~30% dry matter (DM) during composting, increased N concentrations in compost compared to fresh manure denote that N mass losses are less than DM losses. If N concentrations remain the same in fresh manure and compost, then N mass losses are equal to DM losses. However, if N concentrations drop during composting, then N losses are higher than DM losses.

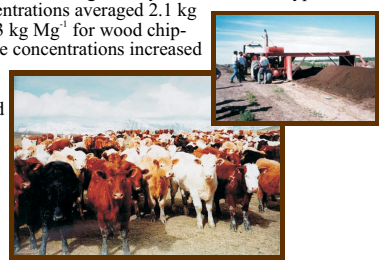
Table 2. Nitrogen concentrations of manure and compost 1998-2000 (kg Mg^{-1} dry wt.).

	Straw bedded initial manure	Straw bedded final compost	Wood chip-bedded initial manure	Wood chip-bedded final compost
1998				
Total	16.4	16.4	14.6	15.6
Available	2.0	1.0	2.1	1.7
% Available	12	6	14	11
1999				
Total	18.9	16.6	16.2	16.3
Available	1.3	1.3	1.5	2.3
% Available	7	8	9	14
2000				
Total	17.2	17.9	11.3	15.4
Available	2.3	1.2	2.9	1.0
% Available	13	7	26	6

Phosphorus

P concentrations increased during composting (Table 3) for all 6 comparisons (3 years x 2 bedding types). This denotes that P losses were less than DM losses. Unlike N, P is not very mobile in the environment and losses may only be expected if the compost windrows were subjected to severe runoff. Generally, initial P concentrations were lower in the wood chip-bedded material than in the straw-bedded material (average of 4 kg Mg^{-1} *vs.* 3.5 kg Mg^{-1}). This trend continued through composting with average P concentrations of 5.3 kg Mg^{-1} for straw-bedded *vs.* 4.5 kg Mg^{-1} for wood chip bedded material.

Available P concentrations were generally similar for both types of material. Initial concentrations averaged 2.1 kg Mg^{-1} for straw and 2.3 kg Mg^{-1} for wood chip-bedded manure. These concentrations increased to 4.1 kg Mg^{-1} for straw and 4 kg Mg^{-1} for wood chip-bedded compost.



However, the percent of total P in the available form was higher for wood-chip material than straw material for both raw manure (66% *vs.* 51%) and compost (89% *vs.* 78%). Composting increased the level of available P (as a percent of total P) from 66% to 89% for wood chips and from 51% to 78% for straw-bedded material.

Table 3. Phosphorus concentrations of manure and compost, 1998-2000 (kg Mg^{-1} dry wt.).

	Straw bedded initial manure	Straw bedded final compost	Wood chip-bedded initial manure	Wood chip-bedded final compost
1998				
Total	4.1	5.9	3.6	5.0
Available	1.7	3.9	2.1	4.2
% Available	41	66	58	84
1999				
Total	3.8	4.6	3.8	4.8
Available	1.9	4.0	2.6	4.4
% Available	50	87	68	92
2000				
Total	4.2	5.5	3.0	3.6
Available	2.6	4.4	2.2	3.3
% Available	62	80	73	92

Ash content

Ash content of the straw-bedded manure (average of 42%) was higher than the wood chip-bedded manure (average of 26.2%) [Fig. 1]. Similarly, average ash content of the straw-bedded compost was 61% *vs.* only 37.3% for wood chip-bedded compost. This means that more organic matter (62.7%) would be applied to land in the form of wood chip bedded-compost than straw-bedded compost (39%).

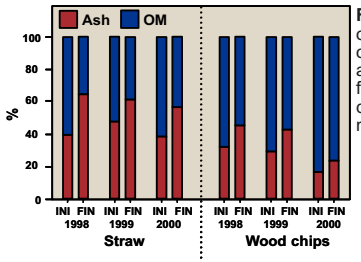


Figure 1. Ash and organic matter content of initial manure (INI) and final compost (FIN) for straw and wood chip-bedded treatments, 1999-2000.

Acknowledgements

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References

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* Important note regarding results presented in scientific posters: "The research reported here is in progress, and therefore the study results have not been subjected to scientific peer review."
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