HORSE MANURE MANAGEMENT

Randall E. James[1]

INTRODUCTION

It is common in the United States to find large concentrations of horses being stabled in suburban counties, immediately adjacent to large cities. Wood sawdust is one of the most common bedding materials used for horses. The high C/N ratio present in horse manure and hardwood sawdust mixtures makes this material problematic for use in agronomic or horticultural production. The high C/N ratio can induce a nitrogen deficiency in growing crops, due to the immobilization of soil nitrogen by micro-organisms as they attempt to break down this material. Often when these mixtures are put on soils for agronomic production the result is crops that are noticeably stunted and yellow. Thus farmers and landscapers are often unwilling to accept manure from stables. This study was designed to identify a nitrogen source that could be applied to stable manure as collected, to prevent nitrogen immobilization when the material was applied to the soil, regardless of the time in storage or the degree of decomposition.

METHODS

Experiments were conducted at a laboratory on The Ohio State University campus in Columbus, Ohio, and at a stable, and a greenhouse in Geauga County, Ohio. Geauga County is immediately adjacent to and East of Cleveland, Ohio.

Mixtures of 40 g hardwood sawdust plus 62.4 g of a standard manure mix was added to small (500 ml) plastic cartons. The standard manure mix consisted of a 4:1 ratio of horse feces to horse urine. Various rates of urea and ammonium nitrate were added to the horse manure plus hardwood sawdust mixtures to produce a range of C/N ratios in the cartons from 80:1 to 30:1. Perforated lids were placed on top of each carton and the treatments were incubated for a period of 10-12 weeks in a laboratory. Each carton was open and stirred 2 times per week. Distilled water was added periodically as needed to keep the samples visibly moist, but not completely saturated. Samples of the mixtures were removed from the cartons every two weeks, stored, and later analyzed to determine the resulting C/N ratios.

A greenhouse study was also conducted using various horse manure plus hardwood sawdust plus ammonium nitrate mixtures. The mixtures were used fresh and after composting. These mixtures were incorporated into soil in one gallon plastic pots at a rate of 50 tons/ac. The soil in the pots was the top six inches of a Chili loam. This soil was a fine-loamy, mixed, mesic Typic Hapludalf. It was collected from a long fallow garden and had ph 5.6. Annual ryegrass seed was planted on the top of each pot. The pots were maintained in a greenhouse at approximately 80°F for six weeks.

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[1] Associate Professor, Ohio State University Extension, P.O. Box 387, Burton, OH 44021.
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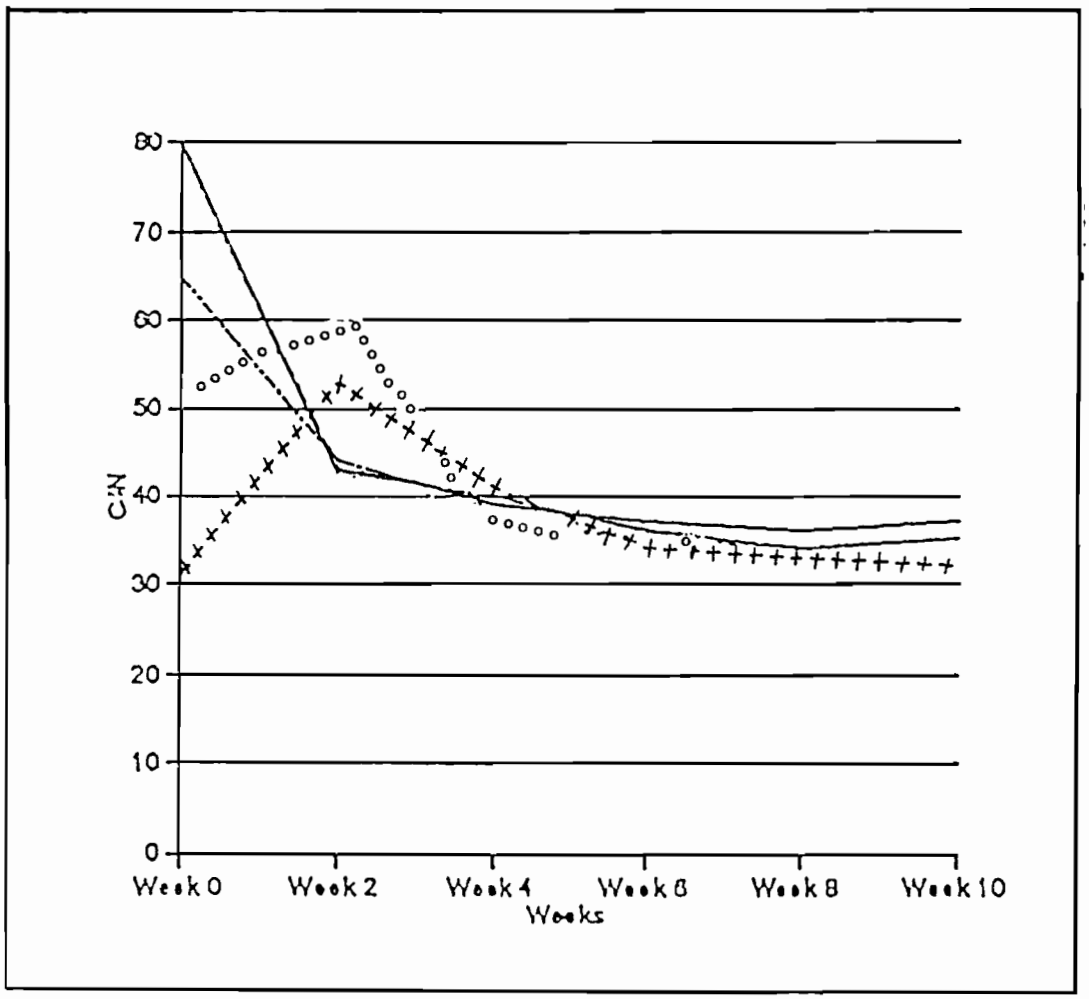
RESULTS AND DISCUSSION

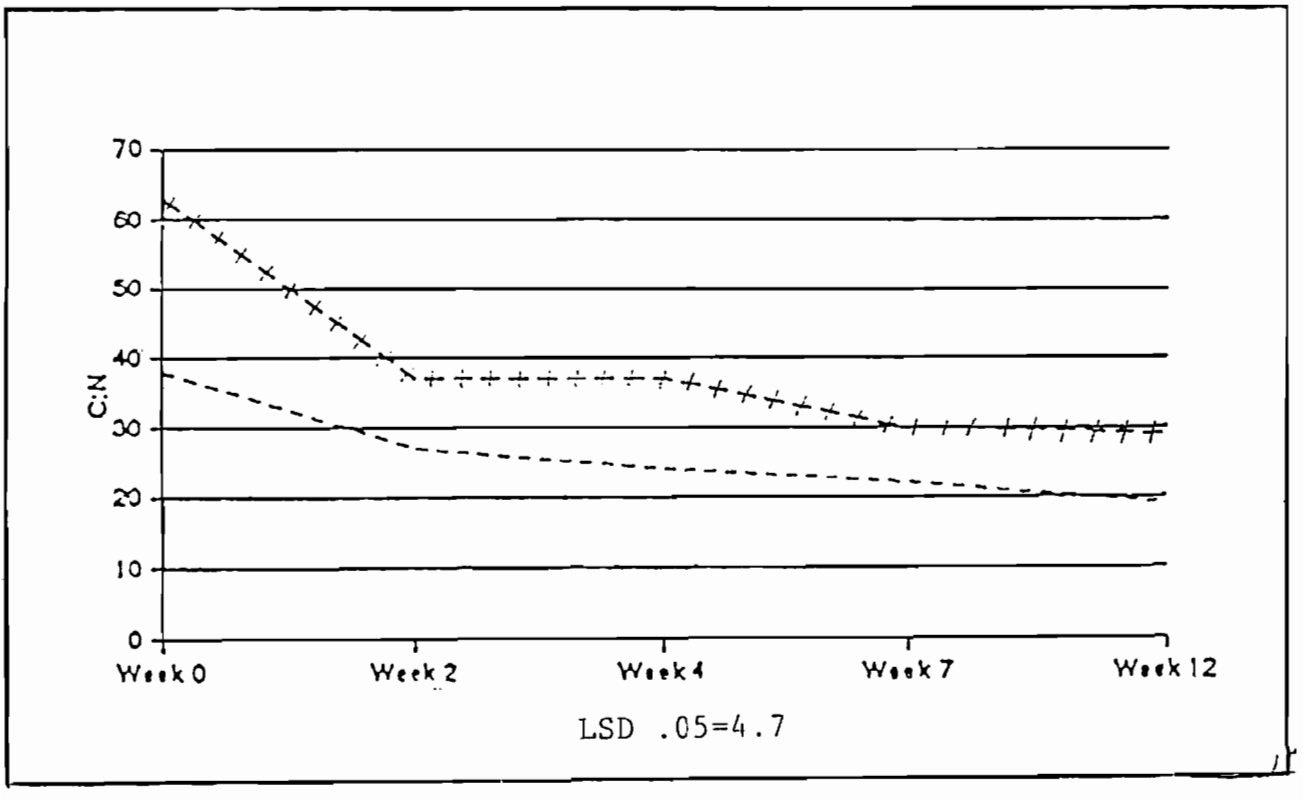
Incubation Study. The following graph (fig. 1) provides a summary of the C/N ratio changes over time for 4 treatments containing mixtures of horse manure + hardwood sawdust + varying urea additions. The treatments with the most narrow C/N ratio at the beginning (largest urea application) have the widest C/N ratio at week 2 and they were significantly wider at week 2 than the treatments where little to no urea was applied. At week 10 there were no significant differences between any of the treatments.



_____ Treatment 1 - 0 g-N ..... Treatment 2 - 0.1 g-N
oooooo Treatment 3 - 0.3 g-N +++ Treatment 4 - 0.8 g-N

Figure 1. C/N ratio of hardwood sawdust plus horse manure mixtures incubated at 80°F as affected by time and the addition of 0.1 g-N, 0.3 g-N and 0.8 g-N as urea/kg mixture.

The changes in the mean C/N ratio of the laboratory incubated mixtures of hardwood sawdust + horse manure + ammonium nitrate are presented in Figure 2.



++++ Horse Manure + Hardwood Sawdust
---------- Horse Manure + Hardwood Sawdust + 2.6g N as NH_4NO_3/kg Mix

Figure 2. Effect of NH_4NO_3 on C:N ratio of horse manure plus hardwood sawdust mixtures incubated at 100°F for 12 weeks.

The horse manure plus hardwood sawdust mixture with no ammonium nitrate added began the incubation period with a C/N ratio of 63:1. After two weeks the C/N ratio had fallen significantly to 37:1, during the remainder of the 12 week incubation period, the C/N ratio fell very slowly. The final C/N ratio of this treatment was 29:1.

The treatment with horse manure plus hardwood sawdust plus added ammonium nitrate began the incubation period with a C/N ratio of 38:1, after two weeks incubation it had also fallen significantly to 27:1. It continued to fall slowly throughout the remainder of the incubation period and its final C/N ratio was 19:1.

Throughout the twelve week incubation, the horse manure plus hardwood sawdust plus ammonium nitrate treatment maintained a significantly lower C/N ratio than the horse manure plus hardwood sawdust treatment where no ammonium nitrate was added.

Greenhouse Study. All of the above ground portion of the greenhouse grown annual ryegrass pots were harvested after six weeks of growth. 300 plants were randomly selected from each pot, and the mean value of the amount of nitrogen taken up by the plants was determined. The values for the various horse manure, hardwood sawdust and ammonium nitrate mixtures are presented in Table 1.

Table 1. Nitrogen uptake of annual ryegrass leaf tissue as affected by several horse manure, hardwood sawdust and NH_4NO_3.

	TREATMENTS	APPLICATION RATE	Mg - N
1.	Control Soil Only	--	25.9
2.	NH_4NO_3	100 lb/ac	43.2
3.	Fresh Manure + Sawdust	50 ton/ac	17.0
4.	Fresh Manure + Sawdust + 10 lb/ton NH_4NO_3	50 ton/ac	42.4
5.	Horse Manure + Sawdust Compost + 10 lb/ton NH_4NO_3-(Compost)	50 ton/ac	47.6
6.	Horse Manure + Sawdust Compost	50 ton/ac	14.9

L.S.D. .05 = 10.92
L.S.D. .10 = 8.88

All of the treatments where ammonium nitrate had been added (Treatments 2, 4 and 5) had taken up significantly higher amounts of nitrogen than the control (Treatment 1). Treatment 6 had taken up significantly less nitrogen than the control, indicating an induced nitrogen limitation, and net nitrogen immobilization in the soil. Treatment 3, the fresh horse manure plus sawdust was not significantly different from the control at the .05 level, however it was significantly different at the .1 level, indicating that this treatment was behaving similarly to Treatment 6.

CONCLUSION

Evidence collected in these studies strongly suggest that horse manure plus hardwood sawdust bedding, as it is removed from a stable, does not contain enough readily available protons to convert NH_3 to NH_4 as urea is degraded. NH_3 is therefore volatilized passing through and eventually out of the collected horse manure plus hardwood sawdust mixture. This is the only plausible explanation for the increased C/N ratio observed when these materials were incubated in the presence of urea, (fig. 1). The results of this study have indicated urea is an ineffective additive, to mixtures of hardwood sawdust and horse manure, for the purpose of narrowing the C/N ratio of the mixture, if the mixture is to be stored for even a few days prior to incorporation into the soil. In fact, after two weeks incubation the mixtures with urea added were often less suitable for land application and agronomic production than the control mixture where no urea was added.

Observations on the behavior of NH_4NO_3 in horse manure plus hardwood sawdust mixtures (fig. 2.) suggest that it would be well suited for use with these materials. NH_4NO_3 was effective in reducing the initial C/N ratio of materials collected from the stable. Also, unlike urea, ammonium nitrate was retained in the system and maintained a C/N ratio low enough to prevent immobilization of soil nitrogen regardless of the length of storage. Therefore, horse manure plus sawdust mixtures plus ammonium nitrate could be applied to soils for crop production immediately, or after some period of storage and partial decomposition. Phytotoxicity did not appear to be a major problem with these materials. If any minor phytotoxic effects were present, they were completely masked by the addition of ammonium nitrate.

The addition of ammonium nitrate to horse manure plus hardwood sawdust mixtures provided a "low-tech" solution to a problematic agricultural waste disposal situation. Stable owners could simply add approximately 1/3 lb. ammonium nitrate/horse/day to the manure and bedding as it is being cleaned out of the stall. Additional handling of the manure would simply serve to further mix the ammonium nitrate. Once the ammonium nitrate was added, the manure and bedding mixture would be immediately fit for use on crop producing soil. It could also be stored for later use. With this simple solution available, it would be difficult to justify the additional cost and management required to establish a composting system for most stables.

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Program Chairman and Editor:

Dr. Maurice Vitosh
Michigan State University
Dept. of Crop and Soil Sciences
Plant and Soil Sciences Building
East Lansing, MI 48824-1325