Cultivation with Manure Application Affects Ammonia Volatilization and Corn Silage Yield

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Rationale:

Nitrogen management of agricultural fields is of increasing importance as the price of nitrogen fertilizer rises and as the negative effects of agricultural volatiles such as ammonia become better recognized. Manure is an important contributor to both nitrogen for crop growth and to ammonia volatilization. The time of manure application and the method of manure incorporation into the soil (or lack of manure incorporation into the soil) will influence both ammonia volatilization and the amount of nitrogen available to crops.

Research Goals:

The objective of this experiment was to compare three tillage systems a) manure application, then disking, then planting, b) disking, then manure application, then planting, and c) disking, then Aerway, then planting, ability to reduce ammonia volatilization, which affects soil nitrogen availability throughout the growing season.

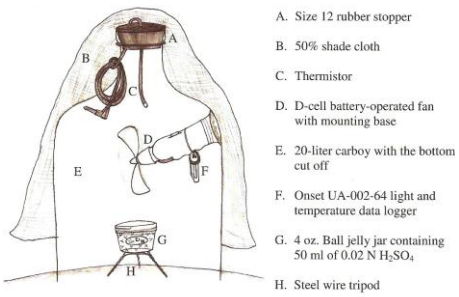

Figure 1. A depiction of the apparatus used to collect ammonia

Experiment Overview:

The experiment was initiated in the Spring of 2010 at the University of Massachusetts Amherst Crops and Animal Research and Education Farm in South Deerfield, MA. A field with no history of manure application was chosen so as to begin with a baseline of very low nitrogen. Stubble had been left from corn grown the previous season. The field was subdivided into three 200 ft long strips, each approximately 30 ft wide. One strip was conventionally disked, one strip was cultivated with an Aerway® vertically to a depth of about 8 inches, and the third strip was left bare as the control. At approximately 8:00 AM on May 27th, 2010, liquid manure was spread uniformly at a rate of about 6,000 gallons per acre. Immediately upon the manure truck's departure, the third strip of the plot was disked. At the same time, 12 ammonia collection units, four for each treatment, were set up on the field to measure ammonia volatilization. A depiction of the apparatus is shown in Figure 1. Each unit remained at one location for one hour, at which time the jar collecting the ammonia was removed for N analysis. For the first 8 hours, the apparatus was moved hourly to another location within the plot. After 8 hours, units were placed on the plots for one hour periods four times over the following three days. Corn was planted on the entire plot on June 1st. No additional fertilizer was used on the plots.

Ten foot sections of each plot were harvested on September 3, 2010 for yield analysis. Ears and stover were separated in order to assess silage quality as well as total yield. In addition, Corn Stalk Nitrate Tests (CSNT) samples were taken to determine nitrate status of the plants. (Corn plants store excess nitrate at the base of the stalk.)

Results:

Manure analysis showed 19.1 lb N per 1000 gallons, of which 10.4 lb was in the form of ammonia. This translates into 62.4 lb ammonia N per acre. Figure 2 shows ammonia loss over the first 8 hours following manure application. It was very clear that the immediate disking of the manure reduced loss of nitrogen through volatilization of ammonia. Volatility is increased by many factors including high temperature and wind. The day of application was hot with temperatures in the ammonia collection chamber ranging from 67°F at the time of manure application to the mid-90's by the 7th and 8th hours of ammonia collection. Afternoon temperatures also reached the low 90's on days 2 and 3 following the manure application. For all three treatments, the greatest single hour loss of ammonia was during the first hour following manure application. Ammonia loss continued after 3 days, but the rate was always calculated as less than 0.5 lb N per acre per day by the third day following manure application. Measured ammonia nitrogen loss was up to about 5 lb N per acre in the three days following manure application when no post-manure cultivation was used. This was reduced to 1 lb per acre if the field was disked immediately. Pre-application cultivating with the Aerway was better than conventional disking, but was not nearly as effective in preventing N loss as was post-application disking.

Table 1 shows yields of corn grown on the three plot sections and availability of N to the plants, as expressed by CSNT. All treatments produced acceptable silage yields. The middle (Aerway section) of the field had substantial weed problems which likely led to reduction of silage yield, as well as quality defined by earcorn percentage. CSNT result of less than 500 indicates that more nitrogen would have been helpful to the crop. The very low CSNT value of the Aerway plot may be related to the weed problem, as well.

Table 1. Yield characteristics of silage corn as influenced by manure incorporation method.

Method	Silage[z] Ton/ acre	Earcorn[y] Ton/ acre	Percent Ear by dry weight	CSNT[x]
Manure→Disk→Plant	28.1	5.9	52.7	1655
Disk→Manure→Plant	27.5	5.6	51.2	321
Disk→Aerway→Plant	22.0	4.1	45.9	79

[z] Silage yield adjusted to 70 percent moisture

[y] Earcorn yield adjusted to 25 percent moisture

[x] CSNT corn stalk nitrate-N concentration at harvest (µg nitrate-N per gram stalk tissue)

Overall, silage yield and quality (ear/stover) were best from the manure incorporated treatment. Loss of up to 5 lbs ammonia-N loss out of 62 lbs ammonia-N applied per acre was documented over the first 3 days following application when manure was not incorporated.

2011 Research:

This experiment has been repeated in 2011 on a more uniform piece of land. The Aerway and disk-directly-after-manuring treatments were as in 2010. The third treatment in 2011 was no-till, whereas in 2010 the plot had been disked before manuring. As in 2010, manure application took place on a very hot day, and there was significantly more ammonia volatilization on the plots that were not disked right after manure application. Aerway treated plots showed less ammonia volatilization than no-till plots.

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