Cultivation with Manure Application Affects Ammonia Volatilization and Corn Silage Yield

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Rationale: Nitrogen management of farm fields is becoming increasingly important 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 of nitrogen for crop growth as well as to ammonia volatilization. The time of manure application and the time and 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 for uptake by crops. Preliminary research assesses a method of determining ammonia volatilization. This volatilization measure can be useful in assessing differences among tillage methods as they relate to losses of crop-available nitrogen. Further research has focused on different methods of manure incorporation. The ultimate goal of the research is to develop manure application recommendations which will reduce need for purchased nitrogen fertilizer, as well as reduce air pollution.

Description of the Project: In the spring of 2010, a field at the University of Massachusetts Amherst Crops and Animal Research and Education Center (CAREC)in South Deerfield, MA, approximately 100 ft x 200 ft was selected for the experiment. The field did not have a history of manure application. In 2010, stubble had been left from corn grown during 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 vertically with an Aerway®to a depth of about 8 inches, and the third strip was left bare. At approximately 8:00 AM on May 27, 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 in the field to measure ammonia volatilization. Each unit remained at its location for one hour, at which time the jar collecting the ammonia was removed for N analysis. Each apparatus was moved to a new location within the plot hourly. This continued for the first 8 hours. After 8 hours, units were placed on the plots in one-hour increments four times over the next three days. The experiment was repeated in 2011 with changes as follows: A more uniform, slightly higher location approximately 1000 ft northwest of the 2010 plot was used in 2011. The disk→manure treatment of 2010 was replaced by a No-till→manure treatment for assessment of ammonia volatilization in 2011. (The disk→manure treatment was repeated, however(without volatilization measurement), and corn yields from this method are included in harvest assessments.). In 2011 and 2012 the plots had been under sod the previous year. Grasses were killed using glyphosate prior to the initiation of the experiment. In 2012 the experiment was moved north another 100 ft to a previously sodded location which could support a no-till treatment. Treatments were as in 2011 with the addition of a manure→Aerway® treatment. In all three years corn was planted on the entire plot several days after manure application. In order to more fully assess the effects of the specified treatments, no additional fertilizer was used on the plots.

Ten foot linear sections of each plot were harvested in September for yield analysis. To assess silage quality and total yield, ears and stover were separated. Because corn plants store excess nitrate at the base of the stalk, 8 inch stalk samples were taken from the base to determine the nitrate status of the plants (corn stalk nitrate test (CSNT)).

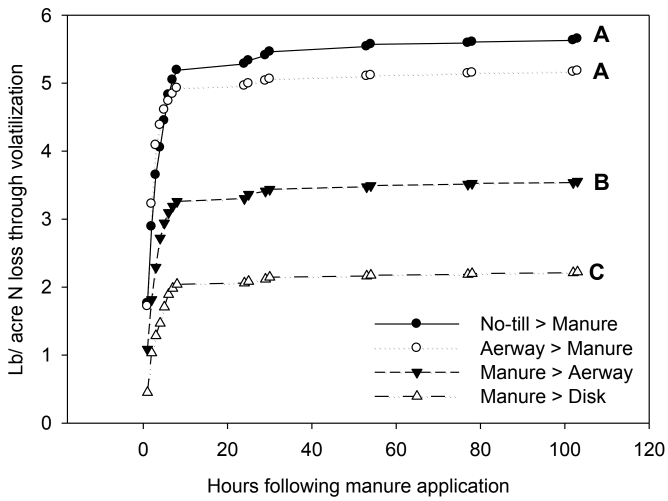

Figure 1. Influence of soil treatments before and after manure application on ammonia volatilization following manure application

Results: Analysis of manure used in 2010 showed 19.1 lb N per 1000 gallons, of which 10.4 lbs was in the form of ammonia. This translates into 62.4 lbs ammonia N per acre. Figure2 shows ammonia loss over the first 8 hours following manure application. It was very clear that the immediate disking-in 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 in all three years was hot, with temperatures in the ammonia collection chamber ranging from 67°F at the time of manure application in 2010 to over 100°F 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. Overall, the greatest single hour loss of ammonia was during the first hour following manure application, even though the temperature was always cooler in the later mid-day hours. Ammonia loss continued beyond 3 days, but the rate always dropped to less than 0.5 lb N per acre per day, as estimated by periodic one-hour ammonia collections in 2010 and 2011. Measured ammonia nitrogen loss was up to about 5 lbs N per acre in the three days following manure application when no post-manure cultivation was used. This was significantly reduced if the field was disked immediately. Pre-application cultivation with the Aerway was better than conventional disking or no-till, but was not nearly as effective in preventing N loss as was immediate post-application disking. The post-manure-application Aerway treatment reduced N loss in 2012 more than did pre-manure-application Aerway treatment.

In 2012, following the initial eight hourly ammonia volatilization measurements, the carboys/ bell jars were left in place for longer periods of time (shown in Figure 1) in order to assess total ammonia volatilization loss over the first four days following manure application. Post manure application treatments significantly reduced N loss, with disking being more effective than Aerway use.

Table 1 shows yields of corn grown on the three plot sections for the three years. All plots produced acceptable silage yields in 2010 and low yields in 2011. The central area(Aerway section) of the 2010 field had substantial weed pressure which likely led to a reduction in silage yield. Because corn stalks accumulate excess nitrate taken up by the plant, a harvest time corn stalk nitrate test (CSNT) can be a useful tool in assessing whether appropriate nitrogen fertilizer had been applied for the growing season.

A result of less than700 indicates that more nitrogen might have increased yield, while a result of over 2000 indicates an excess of nitrogen. The very low CSNT value the 2010 Aerway plot produced may be related to the weed problem.

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

Treatment	PSNT[z]	Silage[y] Ton/ acre	Earcorn[x] Ton/ acre	Percent Ear by dry weight	CSNT[w]
Manure→Disk→Plant2010	-	28.1 A[v]	5.9 A	52.7 A	1655 A
Aerway→Manure→Plant2010	-	22.0 B	4.1 B	45.9 B	79 B
Disk→Manure→Plant2010	-	27.5 A	5.6 A	51.2 A	321 AB
Manure→Disk→Plant2011	13 A	21.7 A	5.2 A	59.5	2318
Aerway→Manure→Plant2011	6 B	20.8 A	4.9 A	59.1	799
Disk→Manure→Plant2011	6 B	13.6 B	3.2 B	56.8	193
No-till→Manure→Plant2011	4 B	16.6 AB	4.0 AB	58.9	1446
Manure→Disk→Plant2012	16	17.8	3.0	47.5	0
Manure→Aerway→Plant2012	15	24.6	3.9	45.2	0
Aerway→Manure→Plant2012	11	15.2	2.4	44.6	0
Disk→Manure→Plant2012	15	18.1	3.1	48.7	0
No-till→Manure→Plant2012	17	24.8	3.7	43.0	0

[z]PSNT: Preside-dress Soil Nitrate Test taken early July (µg nitrate-N per gram soil).

[y]Silage yield adjusted to 70 percent moisture

[x]Earcorn yield adjusted to 25 percent moisture

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

[v] Values followed by a different letter within a column x year are significantly different from one another at odds of 1:20.

In 2010 and 2011, silage yield and quality were best on the post-manure disking treatment. Silage and earcorn yields, as well as silage quality (defined as percent ear) under this treatment were unexcelled. Immediate disking after manure application significantly reduced ammonia loss to the atmosphere and saved nitrogen for uptake by the corn crop. In 2012, total rainfall in July was under 0.6 inch, and the corn crop suffered as a consequence. Yield was variable, and no significant treatment related differences were observed in 2012. However, the post-manure disk and Aerway treatments did significantly reduce ammonia volatilization.