8-21-2000

# Soil pH and losses of fall-applied ammonia

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# Soil pH and losses of fall-applied ammonia

**Abstract**
Soil temperature has been the primary criterion for evaluating risks associated with losses of fall-applied nitrogen (N). The basic idea is that ammonium is not converted to nitrate in cold soils, so withholding applications until soils are cold reduces the risk of N losses by leaching and denitrification when soils have excess water in the spring. Recent studies indicate that soil pH also deserves attention.

**Keywords**
Agronomy

**Disciplines**
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Soil Science

INTEGRATED CROP MANAGEMENT

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## Survey of fields in 1998

The first indication that soil pH is important came in a survey of 21 sites in 11 fields in Boone, Greene, and Hamilton counties in 1998. Weather conditions had been warm and wet, and many farmers were asking about possible losses of fall N. Opportunity to address this problem was provided by more than 50 students from Iowa and Ukraine participating in an exchange program that focused on science, agriculture, and the environment.

The survey was designed with the assumption that time of N application was important and that landscape position within fields also may be important. In late April and early May, soil samples were collected to a depth of 12 inches by using intensive sampling techniques that would normally be considered impractical due to labor costs. Separate samples were collected within and between bands left by the ammonia applicators to enable calculation of fertilizer N recovery as nitrate and exchangeable ammonium.

Results showed great variability in percentage of N recovered, but neither time of application nor landscape position explained much of the variability. The results appeared in this newsletter [1] on May 18, 1998. Subsequent analyses, however, revealed that about half of this variability could be explained by soil pH (Figure 1). This finding was totally unexpected, and the evidence for an important relationship needed further support.

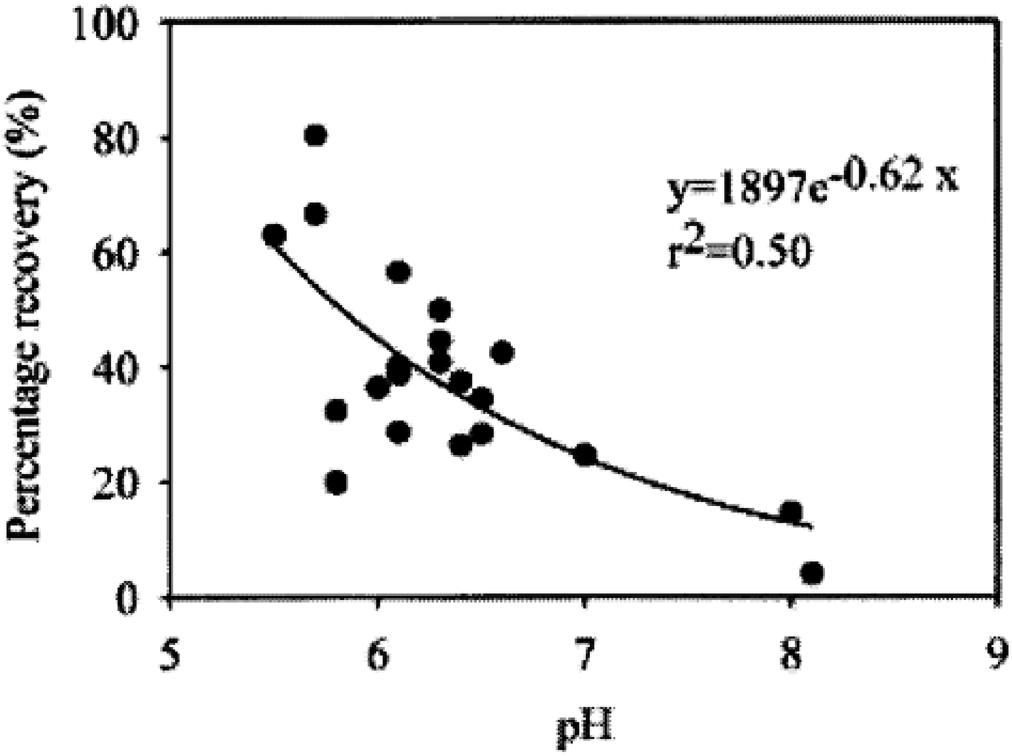


**Figure 1. Relationship between soil pH and percentage of fall-N recovered in April 1998.**

## Precision farming trials in 1999

More rigorous evaluation of a possible relationship between soil pH and losses of fall ammonia was conducted in three field-scale trials. Anhydrous ammonia was applied with and without N-Serve in November 1998, and recovery of this N in the surface 18 inches of soil was measured in early May 1999. Weather conditions were unusually favorable for losses of fall N, and crop responses indicated that significant losses of fall N had occurred. The crop responses are summarized in the August 7, 2000, ICM newsletter article titled, "Is fall N profitable?" Recovery of N was measured in 15 pairs of plots within each trial. Effects of N-Serve were studied on paired plots that seemed similar with respect to soil type. The 15 pairs of plots, however, were positioned to study the effects of variability in soil characteristics within each field. Variability in soil pH was one of many soil characteristics studied. The results showed soil pH to be a major factor influencing recovery of fall-applied N (Table 1).

## Precision farming trials in 2000

Anhydrous ammonia was applied in three field-scale trials with and without N-Serve in late November 1999, and recovery of this N was measured in early May 2000. Recovery of N was measured on numerous pairs plots to learn how the effects of N-Serve varied with soil characteristics.

Weather at the sites was warmer than usual during the winter and unusually dry through May where the trials were conducted. Conditions were dry enough to essentially prohibit losses of N by leaching and denitrification. Recovery of fertilizer N in the surface 18 inches averaged approximately 50 percent, and any effects of soil pH and N-Serve were relatively small.

## Conclusions

Current results suggest that soil pH has important effects on recovery of fall-applied N in the spring when conditions are favorable for leaching and denitrification, but soil pH does not have important effects when conditions are unfavorable for N loss by these mechanisms. Soil pH, therefore, deserves attention as an important factor determining the amount of risk associated with applying N in the fall.

The most likely explanation of the results is that conversion of ammonium to nitrate occurs more rapidly in soils having high pH than in soils having low pH. Rapid conversion makes the N vulnerable to loss by these mechanisms.

Factors other than soil temperature and pH also influence losses of fall-applied N. Identification of these factors would show when and where fall-applied N has acceptable levels of risk associated with N loss. If these factors are not identified, then all applications of fall N may seem to carry unacceptable risks of N losses.

**Table 1. Effect of soil pH on recovery of fall-applied anhydrous ammonia-N in early May 1999.**

| | Percentage recovery of applied N[a] | |
|---|---|---|
| **Soil pH** | **Without N-Serve** | **With N-Serve** |
| Less than 6.0 | 28 | 58 |
| 6.0 to 7.0 | 17 | 37 |
| Greater than 7.0 | 3 | 16 |

[a]Percentage recovered as nitrate and exchangeable ammonium in the surface 18-inch layer of soil.

This article originally appeared on pages 158-159 of the IC-484(21) -- August 21, 2000 issue.