Predicting the Reliability of the Late Spring Soil Nitrate Test

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What Should You Know when Using the Late-Spring Soil Nitrate Test in 2008!

- ***Should I use the late-spring soil nitrate test?***
  Yes, if all or the majority of N fertilizer was applied before planting corn and there is concern about N fertilizer losses and needs for additional N fertilizer applications.

- ***What critical soil nitrate concentration to use?***
  A range of 20-25 ppm nitrate-N is considered optimal but:
  1. Lower the critical concentration by 3-5 ppm if the soil samples were collected within 2-3 days after rain.
  2. Lower the critical concentration by additional 5 ppm (a total of 8-10 ppm) if the May rainfall exceeded 5-6 inches and cooler than normal average soil temperature occurred before soil sampling.
  3. For fields that received liquid swine manure, fall applied anhydrous ammonia (AA) with an inhibitor, or spring applied AA, a 10 ppm nitrate-N is often sufficient.
  4. Adjust the critical soil nitrate concentrations for favorable or unfavorable grain and fertilizer prices.

- **More Detailed Information**
  The large amount of rain received during the last four weeks in Iowa made many growers considering using the late-spring soil nitrate test. The test was developed to help estimate the need for additional nitrogen (N) fertilizer to be sidedressed to corn on fields where all of the N or a majority of N in a form of manure or commercial fertilizers was applied before planting. The test is done when corn plants are 6-12 inches tall, which usually happens in late spring or early June. The test could be useful this season because much of fertilizer and soil derived N has probably been lost by leaching or denitrification due to the unusually high rainfall.

  Soil nitrate-N concentrations measured by the test should reflect the net effects of two dynamic processes in the soil: losses of N before plants start rapid uptake and mineralization of N from the soil organic matter. The basic idea of the test is to estimate the likelihood of yield response to additional fertilizer when soil nitrate concentrations found in the surface 12 inches of the soil are below or above the critical soil nitrate range.

  The test is often called pre-sidedress nitrogen test (PSNT) outside of Iowa, and many states recommend similar critical concentrations ranging from 20 to 25 ppm of nitrate-N.

In this article, we provide specific information for using the late-spring nitrate test when making decisions about additional N fertilizer applications, and we present some results from On-Farm Network trials in 2007 that will help you decide which fields to sidedress.

A good start would be to review some Iowa State University Extension publications and Integrated Crop Management newsletters. Specific information about how to adjust the critical soil nitrate concentration for the effects of weather and prices of fertilizer and grain can be found at: http://www.extension.iastate.edu/Publications/PM1714.pdf
Another useful publication that discusses inconsistencies in results of soil nitrate testing is at: http://www.ipm.iastate.edu/ipm/icm/1997/5-26-1997/nitrateic.html

Next, we would recommend reviewing two posters prepared for ISA On-Farm Network® Nitrogen Conferences in 2005 and 2006. The posters will give you the latest information about the test.

1) The late-spring test for nitrate: what it can and cannot do. (page A3) http://www.isafarmnet.com/06Nconf/A1-A5.pdf
2) N-sufficiency levels in cornfields with injected liquid swine manure
   Testing soils for nitrate in late spring
   http://www.isafarmnet.com/06Nconf/B10.pdf

One of the difficulties when using the test is in selecting the critical soil nitrate concentration or a critical range. In other words, making a decision whether to apply or not apply N fertilizer below or above a certain soil test value. Here, we present an example of using N strip trials done in 2007 that had fields sampled for soil nitrate in early June. We will show how the choice of the critical soil nitrate range can affect the accuracy of the tests.

As you recall, like this year, many cornfields in Iowa had standing water from heavy rainfalls in late May and early June in 2007. Many growers were concerns about N fertilizer losses from heavy rainfall. Responding to growers' and crop consultants' concerns, the On-Farm Network® staff conducted a survey of 23 fields planted to corn after soybean or corn after corn in Greene and Boone counties. Growers fertilized the fields with their normal N rates applied as commercial fertilizer or manure in fall or spring. The fields were tested for the late-spring nitrate test in early June and then each field received an additional 50 lb N/acre of N sidedressed as urea ammonium nitrate solution (UAN) in four or more replicated strips.

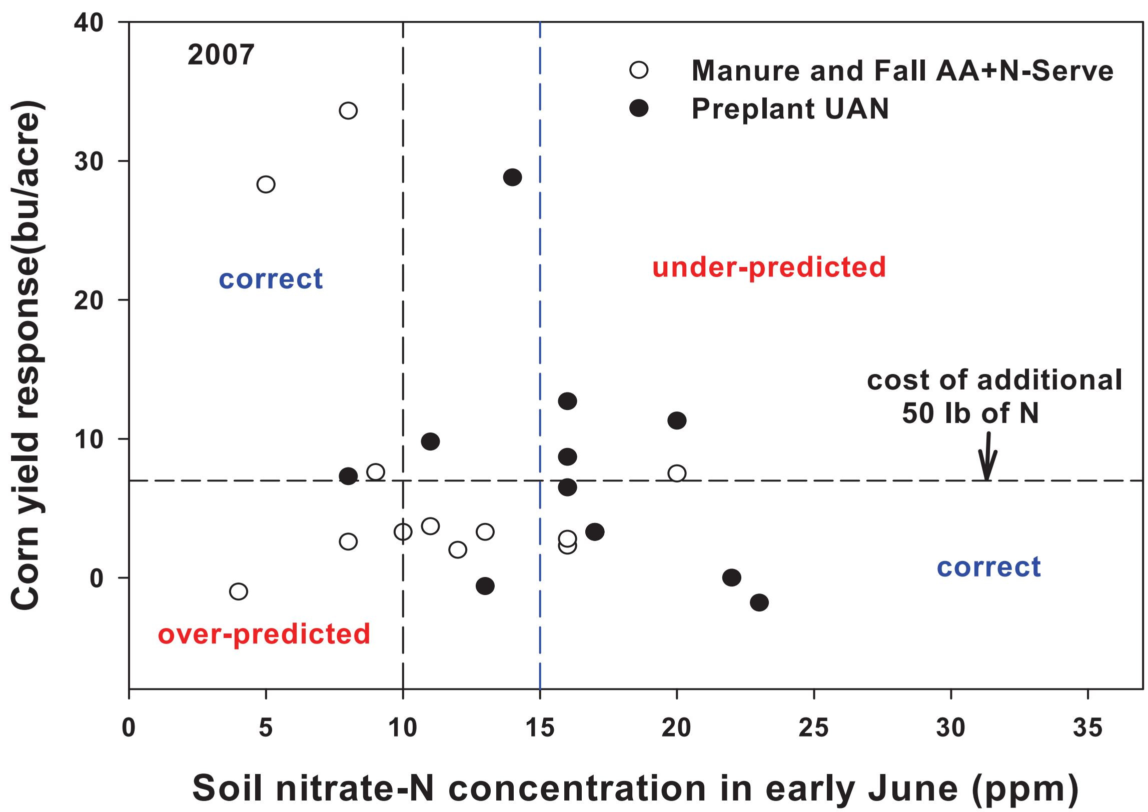

Figure 1. Classifying yield responses by soil nitrate-N concentrations at 23 corn fields with Normal plus 50 N trials in 2007. *(10 ppm nitrate-N was the best critical concentration for fields that received liquid swine manure and fall AA with N-Serve, and 15 ppm was the best critical concentration for fields that received preplant UAN in these 23 fields.)*

Figure 1 describes the relationship between yield response to additional fertilizer and soil nitrate concentrations found in early June in 2007. At first glance, all soil test values were below the commonly recommended critical range 20-25 ppm nitrate-N. Because the fields received about 6 inches of rain in May, it was necessary to lower the critical range to 15 ppm (the vertical black line) or to 10 ppm (the vertical blue line).

We assigned all points in the graph to 4 quadrants that were created by the vertical lines that show the critical soil nitrate concentrations and the line showing the amount of grain (about 7 bu) needed to pay for the cost of N fertilizer and fertilizer application. In the upper left quadrant are the fields where the test correctly predicted profitable yield responses and in the lower right quadrant are the fields where the test correctly predicted non-profitable yield responses. In the lower left quadrant are the fields where the test over-predicted yield responses: soil test values were lower than the critical concentration but yield responses less than 7 bu/acre. The upper right quadrant shows the fields where the test under-predicted profitable yield responses: soil nitrate concentrations were above the critical range but additional N produced a yield increase higher than the cost of additional N.

Table 1 shows how many fields were correctly identified as needing or not needing fertilizer by using different soil nitrate critical ranges. When using the critical concentration of 15 ppm nitrate-N, the test correctly identified 12 fields out of 23 fields. We separated fields that received fall-applied anhydrous ammonia (AA) with N-Serve and liquid swine manure from fields that received preplant UAN because of possible high ammonium-N concentrations and potential mineralization of manure derived N later during the season from the fields that receiving manure and AA. When using 10 ppm as a critical concentration for fall-applied AA and manured fields and 15 ppm for preplant UAN, the accuracy of the test increased to 16 correctly identified fields that either needed or did not need additional fertilizer applications.

Table 1. Accuracy of the late-spring soil nitrate test for predicting yield responses to the additional 50 lb N/acre in 23 trials in 2007 by using different critical soil nitrate ranges.

Category	Critical range	Correct	Over-predicted	Under-predicted
	NO_3-N ppm		number of fields	
All trials	16--25	**12**	**7**	**4**
All trials	11--25	**15**	**2**	**6**
Manured and Fall AA+N-Serve	11--25	9	2	1
Spring -applied UAN	16--25	7	1	3
Total		**16**	**3**	**4**

#Additional 50 lb N/acre cost about 7 bu of grain in the fertilzer and application costs in May of 2007.

*The fields received on average 5.8 inches of rain in May 2007 with a range 5.4-6.4 inches.

Another way to assess the performance of the test is to calculate mean yield responses at different soil test values and the percentage of fields that had yield responses above the economic threshold (Table 2). Both the mean yield response and the probability of profitable yield response decreased as the soil nitrate concentration increased.

Table 2. Mean yield response and the probability of profitable yield response to additional fertilzier application

Soil test value	Mean yield response	Percentage of trials with profitable yield response
ppm nitrate-N	bu/acre	%
<10	12	57
10--15	7	33
>15	5	30

More insight can be gained by calculating the economic benefits or losses when growers decide to apply an additional 50 lb N/acre to all the fields (Table 3). The benefit was calculated by subtracting the fertilizer and application costs from the mean yield response in each quadrant. The highest benefit was in the upper left quadrant, where the test correctly predicted yield responses when soil nitrate concentrations were below the critical range. The unique observation from Table 3 and Figure 1 is that if the test identified the highly responsive fields (those with >10 bu/acre), it would be profitable to apply additional N fertilizer to all the fields. *We caution that the data presented here were collected during one year under specific soil and weather conditions and were not intended to calibrate the test, and therefore, should not be used as a general recommendation.* However, using different criteria for evaluating the test accuracy as shown above should help users understand and assesses possible risk when using the test. Growers who have a few years of cornstalk nitrate results from fields know the most about N their fields typically require for profitable fertilization and can make the best of results from the late-spring soil nitrate test.

Table 3. Economic benefit from the test when all fields received additional N

Quadrant	Test accuracy	Mean yield response	Benefit#
		bu/acre	
1	over-predicted	1	-6
2	corect	19	12
3	corect	10	3
4	under-predicted	3	-4
		Total benefit	5

#Calculated by substracting the cost of N fertilizer and application cost experesed in bushels of grain from mean yield response in each quadrant.

Because the test was not developed to provide the accurate estimates for losses of N from the soil, calculating the exact amount of N fertilizer in lbs/acre to be sidedressed from test values can be tricky. The amount of N fertilizer (8 lbs N/acre) required to increase soil nitrate concentration by 1 ppm is an average value that varies across the range of soil and management practices used in Iowa. Our experience shows that using flat rates such 50, 75 or 100 lb N/acre can be more practical than trying to estimate precise N fertilizer rates based on the test. During soil sampling, try to collect soil samples that represent the fields as well as increase the accuracy of the test. The largest errors often occur because the nitrate concentration of the soil sample does not represent the nitrate concentration of the field, so it is important to use an appropriate soil sampling protocol. The most difficult fields to sample are the ones where N was applied in a band as anhydrous ammonia or injected swine manure. The best way to sample fields that have received banded N is to collect three sets of 8 cores that are positioned at various distances between two corn rows. By this method, the person doing the sampling moves in a random pattern within the test area to select approximate positions for collecting cores. Each time a core is collected, however, its exact position is selected relative to the two nearest corn rows. The first core is collected in a row. The second is collected one-eighth of the distance between any two rows after moving to another part of the test area. The third is collected one-quarter of the distance between any two corn rows after moving to another part of the test area. The process is continued until the eighth core is collected seven-eighths of the distance between any two corn rows. The soil from all cores should be crushed and thoroughly mixed before a subsample is removed for analysis (adapted from ISU pamphlet 1714). Finally, the late-spring soil nitrate test is only a diagnostic tool that can reduce some uncertainty in N management but it cannot predict the magnitude of yield response in individual fields. The test was not developed to predict the future weather events after the samples are collected and the fertilizer is applied. Drought or excessive rainfall later in the season can reduce yields and yield responses to N and the results cannot be expected to provide accurate recommendations when unusual weather events occur after sampling. Understanding what the late-spring soil nitrate test can do and cannot do is crucial when using the test this growing season.