

Nitrogen Management for Corn in Delaware: The Pre-Sidedress Nitrate Test

Unlike other nutrients, such as potassium or phosphorus, the nitrogen (N) requirement of corn cannot normally be met by N found in the soil. Consequently, most of the N needed by corn is supplied by applications of commercial fertilizers or manures unless crop rotations include legumes (e.g., alfalfa, clover, hairy vetch, soybeans), where N available from legume residues can often provide a significant percentage of corn's N requirement.

Historically, soil tests for N could not reliably identify the amount of N available to corn from soil organic matter, past applications of animal manures, crop residues, or previous applications of N fertilizers. Therefore, N recommendations for corn (and other crops) were based solely on expected crop yield. In Delaware, the general N recommendation for corn is 1.0 lb of N per bu of expected yield. However, beginning in the 1980's, research in Delaware and other states led to the development of soil tests that can reliably estimate the contribution of soil N to the overall N requirement of corn. The purpose of this fact sheet is to provide information about using the pre-sidedress soil nitrate test (PSNT) to refine N recommendations for corn. Proper use of this test can result in economic savings and reduce the likelihood of groundwater contamination by nitrate-nitrogen.

Overview of the Pre-sidedress Nitrate Test and Application to Delaware

The PSNT, which was first developed in Vermont, is used commercially in many eastern and midwestern states. The PSNT is based on the concept that early season soil nitrate-N levels are proportional to the amount of N that will be available over the growing season from the soil and any recently added organic N sources (e.g. manures, forage legume residues) in fields with a history of manure application or legume production. As such, the PSNT is most accurate during "typical" growing seasons. The accuracy of the PSNT will be reduced in years that are very wet or dry.

To conduct the PSNT, a soil sample is taken to a depth of 12 inches immediately before the period of maximum N uptake by corn (Fig. 1), when plants are about 10-12 inches high (approximately V5 to V6). An N recommendation is made based on the soil nitrate-N concentration in this sample and the expected corn yield goal that is updated at the time of sampling to reflect current conditions in the field, such weather conditions, plant stand, pest or weed pressure, irrigation use and prior N applications. For example, poor stand or excessive weed pressure at the time of sampling might lead to a lower yield goal than initially expected. The remainder of the crop N requirement, beyond that provided by soil N, can then be supplied by N applied via sidedressing or fertigation.

The PSNT was evaluated in field studies that were conducted under both irrigated and dry-land conditions in Delaware and other Mid-Atlantic states (Fig. 2). These studies showed good results, particularly on fields with a history of manure use, where relative yields (defined as the ratio of yield with no added N to economically optimum yield on the site where N was added) were well correlated to soil nitrate levels obtained by the PSNT. Little or no yield increase

resulted from addition of N at sidedress when PSNT levels were ≥ 20 ppm. These studies showed that the PSNT successfully identified situations when the amount of soil N available during the growing season was adequate to achieve desired crop yield goals and no additional N fertilization was required. Therefore, use of the PSNT can result in a considerable economic savings to the farmer and can aid in identification of an appropriate N rate if N fertilization is needed.

The PSNT is not recommended for corn fields with no history of manure application (i.e., commercial fertilizer is the only N source for three or more years). In addition, the PSNT is not recommended for manured fields that received commercial fertilizer (pre-plant or pre-emergence) at rates exceeding 40 to 50 lbs N/ac. Under these conditions, the PSNT may overestimate the amount of soil N that will be available to the corn crop over the season; growers can better calculate N-needs based on realistic yield goal (1 lb N/bu corn) with an adjustment for the amount of N applied prior to sidedress.

We caution against applying N recommendations from other regions, such as the Midwest when interpreting PSNT results in Delaware. For example, growers in the Midwest often use the PSNT on non-manured soils. However, soils in the Midwest have a higher N mineralization potential than the sandy, low organic Coastal Plain soils found in Delaware. In addition, many growers in the Midwest apply anhydrous ammonia in the fall and they use the soil nitrate tests to estimate the availability of this N in the spring.

Sample Collection and Preparation for the Pre-sidedress Nitrate Test

The PSNT is quick and easy to perform. Soil samples can be collected by farmers, Cooperative Extension agents, crop consultants and sent to the UD Soil Testing Laboratory or other commercial laboratories for analyses and recommendations. The PSNT measures nitrate-N, which is a form of soil N that is highly susceptible to leaching and to changes from fluctuating soil temperature and moisture conditions. For example, if soil samples are stored too wet, nitrate can be lost by denitrification, leading to an artificially low PSNT value. For this reason, sample collection and preparation are very different from that used with routine soil samples. **Proper sample collection and preparation are important to ensure accurate results and an appropriate N recommendation.**

Follow these steps to ensure proper collection and handling of PSNT soil samples.

1. Collect a total of 15 to 20 soil cores from each field (no more than 20 acres per field) to a depth of **12 inches** when the corn plants are 10-12 inches tall (approximately V5 to V6). Separate samples should be taken for areas with contrasting soil types or in areas with difference in the corn stand (e.g., plant populations, stage of development, etc.) Take care not to sample too close to a leaching rainfall event. As a rule of thumb, you should wait 2 to 3 days after a significant rainfall event to collect samples.
2. Take soil cores from the middle of the row to avoid any starter fertilizer bands applied at planting.
3. Combine soil cores from each field and thoroughly mix them together.
4. Spread a 1-2 cup subsample of the soil is spread very thinly ($\frac{1}{2}$ inch or less) on newspaper in a warm, dry place and allow to dry. Take special care to dry the samples properly to minimize changes in the soil nitrate level prior to analysis. If drying cannot be initiated within 1 hour of collection, store the sample on ice in a cooler or in a refrigerator (preferably below 50°F) until the sample can be dried properly.

- Place dried samples in a plastic bag and submit to the laboratory for testing.

Calculation of Sidedress Nitrogen Recommendation Based on Results of the Pre-Sidedress Soil Nitrate Test

The need for additional N fertilization is determined based on results of the PSNT test. If the PSNT value is ≤ 25 ppm soil nitrate-N, the basic N rate recommendation is obtained based on the realistic yield goal and the PSNT value (Table 1). A credit is applied for banded starter N applications based on the starter N application rate. This is because banded starter N will not be picked up by the PSNT sample if the sample is properly collected from the row middles. A credit is not applied for broadcast N fertilizer that is applied pre-sidedress (e.g., N applied with pre-emergence herbicide) because this N will be accounted for by the PSNT.

Table 1. Basic nitrogen recommendations (lbs N/ac) based on results of the pre-sidedress soil nitrate test (PSNT)[†].

PSNT Value (ppm)	Realistic Yield Goal (bu/ac)								
	75	100	125	150	175	200	225	250	275
	Recommended Nitrogen Rate (lbs N/ac)								
0 – 10	75	100	125	150	175	200	225	250	275
11 – 15	55	75	95	115	130	150	170	190	210
16 – 20	0	55	70	85	100	115	130	145	160
21 – 25	0	0	0	60	75	85	100	110	125
> 25	0	0	0	0	0	40	50	60	70

[†]PSNT recommendations for “intensively managed corn” with realistic yield goals ≥ 200 bu/ac were extrapolated based on results of previous field trials conducted in Delaware and are not calibrated recommendations. These values are provided as guidance for growers; however, other N management strategies, such as the leaf chlorophyll meter, may provide better guidance for N needs under “intensively managed” conditions.

A manure "credit" is applied to soils with a low PSNT value that received 3 or more tons of manure per acre (Table 2) to help avoid the unnecessary use of sidedress N fertilizer. The manure credit was developed to account for scenarios where corn grown on manured fields with low PSNT soils may show no response (based on field studies conducted in Delaware) to addition of N fertilizer at sidedress. This situation is common on sandy soils due to leaching of available nitrate-N below 12 inches (below the PSNT sampling depth), but not below the crop rooting zone. Alternatively, cold and/or dry spring conditions may also slow the rate of manure decomposition and give a low PSNT reading. If soil moisture conditions improve later in the season, the release of N from manure can occur and sidedressing will not be needed.

The sidedress N rate is then calculated using the equation:

$$\text{Sidedress N Rate (lbs N/ac)} = \text{Basic N Rate (Table 1)} - \text{Starter N Application rate} - \text{Manure Credit (Table 2)}$$

Table 2. Credits (lbs N/ac per ton manure applied) for manure applications \geq 3 tons/acre when determining sidedress nitrogen rate recommendations based on the pre-sidedress nitrate test (PSNT) results.

PSNT Value (ppm)	Length of Time Since Application	
	1 month or less	More than 1 month
	————— lbs N/ac per ton of manure applied —————	
	<u>Poultry Litter</u>	
0 – 10	30	20
11 – 15	20	10
16 – 25	10	5
> 25	0	0
	<u>Dairy, Swine, or Horse Manure</u>	
0 – 10	3	2
11 – 15	2	1
16 – 25	1	0.5
> 25	0	0

Example Calculation of Sidedress Nitrogen Rate using the Pre-sidedress Nitrate Test

A corn field has a realistic yield goal of 150 bu/ac. Results of the PSNT test for this field indicated there was 14 ppm soil nitrate. The grower applied a starter N at a rate of 30 lb/ac N and a poultry litter at a rate of 3 tons/ac that occurred 2 months prior to planting. Calculate sidedress N rate using the equation:

$$\text{Sidedress N Rate (lbs N/ac)} = \text{Basic N Rate (Table 1)} - \text{Starter N Application rate} - \text{Manure Credit (Table 2)}$$

Based on Table 1, the basic N rate for this field is 115 lb N/ac. The starter N application rate was equal to 30 lb N/ac. The manure credit for this PSNT value (14 ppm) and poultry litter is 10 lbs N/ac for each ton of poultry litter applied. In this case, 3 tons of PL was applied, so the manure credit will be 30 lb N/ac.

Sidedress N Rate = 115 lb N/ac – 30 lb N/ac – 30 lb N/ac

Sidedress N Rate = 55 lb N/ac

Therefore, the grower should apply a total of 55 lb N/ac to this corn field at sidedress.

Summary

Results of the PSNT test are used to provide more accurate N fertilizer recommendations for corn in Delaware, especially when manure is used. The PSNT can identify situations where additional yield response is or is not expected following sidedress applications of N fertilizer, allowing growers to manage N fertilizers more profitably and also reduce the risk of nitrate leaching to groundwater from over-fertilization. University of Delaware PSNT recommendations are based on results of field studies (conducted under both dry-land and irrigated conditions) in Delaware and other Mid-Atlantic states. Basic N recommendations obtained using the PSNT should be adjusted to account for the N applied in starter fertilizers and, in some cases, applications of manure at rates exceeding 3 tons/ac.

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