Soil Nitrate Tests for Corn Production in Wisconsin

Preplant and Pre-Sidedress Nitrate Tests

Improving the efficiency of nitrogen (N) applications to corn is fundamental to promoting farm profitability and environmental quality in Wisconsin.

By implementing the 4Rs of nutrient stewardship — right rate, right time, right place, and right source — farms can tailor nutrient applications to maintain nutrient availability for crop growth while protecting water quality.

Soil nitrate tests are examples of available tools to help determine the “right rate” of N for corn grain, corn silage, and sweet corn.

**AVAILABLE SOIL NITRATE TESTS**

**Preplant Nitrate Test (PPNT)**

*Assesses nitrate carry-over from the previous growing season and is used to adjust preplant or sidedress N application rates.*

A PPNT is most effective when corn follows corn in rotation. A PPNT is used to assess N carry-over in the top three feet of soil if the previous season’s N applications were:

- In excess of crop need,
- Previous growing season and overwinter precipitation was below normal,
- N fertilizer was applied and the crop was not planted due to weather conditions (prevent plant), or
- When manure or legumes were not fully credited for the previous growing season.

Due to sample collection in early spring (post-frost, but before planting and any N application), a PPNT does not measure N released from previous fall, winter or spring applications of manures or N released from the mineralization of forage legume residue. If a PPNT is used to adjust a N fertilizer rate, manure should be properly credited using established book values or manure analysis results. Likewise, legume nitrogen credits should be properly credited where appropriate. (See Chapter 9, A2809, *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin*)

When corn follows corn, the PPNT is the preferred soil nitrate test to evaluate potential N carryover into the second growing season after a manure application or alfalfa crop termination. However, the PPNT does not measure N released during the second growing season after application/termination. Therefore, total N application rates should be adjusted using second-year manure or legume N credits, as well as PPNT results.

**Pre-sidessdress Nitrate Test (PSNT)**

*Assesses early season N mineralization, as well as N carry-over from the previous growing season and is used to adjust sidedress N application rate.*

PSNT samples are collected in early to mid-June when corn is at V3 to V5 (approximately 6 to 12 inches tall) or approximately two weeks before sidedress application of N. As soil microbial populations are active during this time, conversion of organic N to plant-available N is occurring. Therefore, the PSNT is used to predict the amount of N released from previous alfalfa, clover or legume crops, fall, winter, or spring manure applications, and soil organic matter.

**PSNT should not be used on fields** with pre-plant broadcast or incorporated N fertilizers during the current growing season. Banded starter applications of N should not interfere with PSNT results, as long as PSNT soil samples are collected midway between fertilizer bands.

Due to its later sampling date, PSNT is better able to estimate N released by manure or legumes during the second cropping year after application/termination. If using PSNT in these situations, MRTN recommendations should not be adjusted for second year manure or legume credits. Only PSNT credits should be used.

PSNT sampling is particularly useful in fields where manure was applied, but the rate and/or nutrient concentration is questioned or when manure was applied in summer or early fall the preceding season.

**PSNT can be used to gauge potential N tie-up from cover crops.** Research has shown high biomass producing cover crops may render some fall-applied N unavailable during the following growing season. PSNT can be used to adjust manure N crediting in this situation.

**The amount of nitrogen available for crop uptake is influenced by many factors, so it is important to choose the proper soil nitrate test for your specific situation.**

Field specific considerations include:

- Soil texture
- Timing of manure and nitrogen fertilizer application
- Previous growing season and overwinter precipitation
- Previous crop and its nitrogen status

**PPNT**

**PSNT**
# General Precautions with Soil Nitrate Tests

**PPNT and PSNT should only be used** in medium to fine textured soils. Due to the high permeability of sand and loamy sand soils, retention of nitrate in the soil profile is unlikely. Therefore, PPNT and PSNT should not be used in sand or loamy sand soils.

<table>
<thead>
<tr>
<th>Terms used in this fact sheet</th>
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<tbody>
<tr>
<td><strong>Nitrogen (N)</strong></td>
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<tr>
<td><strong>Nitrate (NO₃⁻)</strong></td>
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<tr>
<td><strong>Mineralization</strong></td>
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**PPNT should only be used** in years of corn following corn when the previous growing season and overwinter period experienced normal or below normal precipitation.

When above normal precipitation occurs in the preceding growing season and overwinter period, little residual soil nitrate is likely to carry-over. In normal or below normal precipitation years, the PPNT is the preferred soil nitrate test to assess carry-over N, as its deeper sampling depth provides a more complete assessment of residual N in the rooting zone.

**PPNT should not be used** on first year corn following alfalfa or other forage legumes.

As samples are collected in very early spring, a PPNT does not measure N released from alfalfa or legume forage crops immediately preceding the corn crop. Instead, legumes should be properly credited using established values.

**PPNT should not be used** on fields where manure was applied the previous summer or early fall.

Considerable plant available N can be released from summer and early fall applied manure prior to PPNT sampling. Therefore, using a PPNT could potentially lead to overcrediting of N, particularly if manure crediting is used along with PPNT results. In this situation, a PSNT should be used.

**PSNT may underestimate N availability** when average air temperatures in May and June are 1°F or more below the long-term average.

As N mineralization from soil organic matter, manure, and crop residues is controlled by soil microbes, the concentration of N measured by PSNT is influenced by weather and soil conditions before sample collection. Cool, wet springs can slow N release, causing the PSNT to underestimate the amount of N that will become available during the growing season. In these situations, book value N credits for manure and previous legume crops should be used in combination with the PSNT credit to determine an appropriate N sidedress application rate. Lower than expected PSNT N credits in these conditions are more likely to occur with spring manure applications or corn following spring terminated alfalfa stands.

**PSNT should not be used** to adjust N application rates in a soybean-corn rotation.

N fertilizer rate recommendations for corn following soybean in Wisconsin already reflect N availability based upon the crop rotation effect. Therefore, N application rates should not be adjusted using a PSNT.

**PSNT can be used** to confirm a first year alfalfa N credit.

If the PSNT result is <21 ppm N, apply no more than 40 lb/a N.
SAMPLE COLLECTION AND STORAGE

SAMPLE COLLECTION

Collect soil samples randomly from a 20-acre (or less) area in one-foot increments to the correct depth (see below) with a minimum of 15 soil cores from each depth. Thoroughly mix the cores for each sample and then place a one-cup subsample in a bag to be delivered to the soil testing laboratory (see A2100, Sampling Soils for Testing). Samples should not be collected near fences or roads or in headlands, low spots, near lime or manure piles, etc. All soil samples should be representative of the area sampled. Therefore, areas of different soil textures or past management practices should be sampled individually.

SAMPLE STORAGE

PPNT and PSNT samples should be delivered to the soil testing lab within 24 to 48 hours after being collected. Samples should be kept cool (<50 degrees F) between the time of collection and time of delivery to the laboratory. If timely delivery or shipping to the laboratory is not possible, the samples should be frozen or air-dried to prevent changes in nitrate content during storage.

SAMPLE ANALYSIS

PPNT and PSNT can be analyzed at several commercial labs across the state. Consult Wisconsin Department Agriculture, Trade and Consumer Protection’s website to obtain a list of certified manure and soil testing labs: https://datcp.wi.gov/Documents/NMSoilManureLabs.pdf

Additional resources


Soil samples for the PPNT are collected in the early spring after frost has dissipated and prior to planting or any preplant applications of N.

PPNT samples are collected from 0 to 1-foot and 1 to 2-foot depth increments of the soil profile.

The amount of nitrate-N in the 2 to 3-foot depth is estimated in the laboratory recommendation program using the nitrate content of the 1 to 2-foot depth sample. Alternatively, a 2 to 3-foot depth sample can be taken.

Soil samples for PSNT should be collected when corn is at V3 to V5 (approximately 6 to 12 inches tall) or approximately two weeks before a planned sidedress N application. Samples collected before this time will not provide an adequate estimation of N release and will underestimate PSNT N credits.

PSNT samples are collected from the top 1 foot of the soil profile. Samples should be collected from between the rows, avoiding areas of starter fertilizer application.
ADJUSTING PLANNED N FERTILIZER APPLICATIONS WITH LAB RESULTS

**PPNT and PSNT** results are used to adjust MRTN application rates based from UW recommendations.

### ADJUSTING MRTN APPLICATIONS TO CORN

University of Wisconsin (UW)'s recommended N application rates to corn are based upon the Maximum Return to Nitrogen (MRTN) concept. MRTN uses the cost per unit of N fertilizer and an anticipated corn price per bushel to determine the N rate that maximizes economic return on fertilizer investment. N credits for forage legumes, legume vegetables, animal manures, and green manures are subtracted from the MRTN recommended N rate to account for potential increased N availability. However, the N fertilizer adjustment for a preceding soybean crop is already reflected in the MRTN fertilizer recommendation and so, no N credit adjustment is needed. (See Chapter 6, A2809, *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin*).

#### Using PPNT lab results, adjust UW nitrogen fertilizer recommendations as follows:

- **Results between 0 to 50 lbs N/acre**
  
  PPNT N credit = 0
  
  *Use MRTN recommendations without adjustment.*

- **Results between 51 to 200 lbs N/acre**
  
  PPNT credit = PPNT test value – 50 lb N/a
  
  50 lb/acre N in the 0-3 foot soil profile in the spring is considered background in medium and fine textured soils.
  
  **Adjusted MRTN recommendation = MRTN recommendation – PPNT credit**
  
  A minimum application of 50 lb N/acre is recommended.

- **Results over 200 lbs N/acre**
  
  No supplemental N is needed.

#### Using PSNT lab results, adjust UW nitrogen fertilizer recommendations as follows:

- **Adjusted N recommendation = MRTN recommendation – PSNT credit**

#### PPNT and MRTN example

Using MRTN, the target N application rate for corn following corn with < 50% residue cover, in a high yield potential soil when the N:Corn Price Ratio is 0.1 is 165 lbs N/acre.

The PPNT result indicates 70 lbs N/acre available N.

The resulting adjusted N application rate should be 145 lbs N/acre

165 lbs N/A – (70 lbs N/A – 50 lb N/acre) = 145 lbs N/acre

To meet this recommendation, total preplant, starter, and in-season N applications should not exceed 145 lbs N/acre.

#### PSNT and MRTN example

Using MRTN, the target N application rate for corn following corn with < 50% residue cover, in a high yield potential soil when the N:Corn Price Ratio is 0.1 is 165 lbs N/acre. Starter was applied at 40 lbs N/acre.

The PSNT result of 13 ppm indicates a 35 lb N/acre credit.

The resulting adjusted sidedress application rate should be 90 lbs N/acre

165 lbs N/A – (40 lbs N/A – 35 lb N/acre) = 90 lbs N/acre

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**PSNT Nitrogen Credits** for Corn

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<thead>
<tr>
<th>Soil Yield Potential</th>
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<tbody>
<tr>
<td>High</td>
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<tr>
<td>Medium</td>
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<table>
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<tr>
<th>PSNT Result (ppm N)</th>
<th>N Credit</th>
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<tbody>
<tr>
<td>≥ 21</td>
<td>No additional N needed</td>
</tr>
<tr>
<td>20-18</td>
<td>100</td>
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<tr>
<td>17-15</td>
<td>60</td>
</tr>
<tr>
<td>14-13</td>
<td>35</td>
</tr>
<tr>
<td>12-11</td>
<td>10</td>
</tr>
<tr>
<td>≤ 10</td>
<td>0</td>
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1 Pounds of N/acre credit to subtract from base MRTN fertilizer application rate
2 Consult A2809, *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin*

*When corn follows alfalfa*, the maximum N recommendation is 40 lb N/acre for all PSNT results < 21 ppm N.

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