Nitrogen fertilizer placement

Study Overview

Nitrogen (N) fertilizer placement is an important component of N management, as positioning N closer to the root zone can improve uptake efficiency and reduce loss. The goal of this study is to assess the effect of nitrogen fertilizer placement across a standard and reduced commercial nitrogen rate, and the interaction of the two on yield, marginal net return, nitrogen use efficiency, and potentially leachable nitrogen. Investigating N fertilizer placement across a standard and reduced nitrogen rate will allow us to better understand how the practice impacts both yield and nitrogen need of the crop and what this means for nitrogen management. Since the trial only uses two nitrogen rates, it is not designed to determine the optimum nitrogen rate for this system. If that is the goal of a trial, a full nitrogen rate study with 6 or more N rates is recommended (NOPP Option 1).

As you develop specific project details including your research question, treatments, and trial layout, we recommend that you connect with the UW team to develop a project that best meets your interests and goals. If you're applying for a NOPP grant, specific project details can be discussed with UW NOPP Research Director Monica Schauer (monica.schauer@wisc.edu). If interested in implementing this research protocol independently on your own farm, reach out to UW-Extension On-Farm Research Coordinator Abby Augarten (aaugarten@wisc.edu).

Selecting placement treatments

This protocol allows you to investigate N placement most relevant to your operation. Common placements to compare are broadcast (with or without incorporation), injected, in-furrow, 2x2, and y-drop (along row, center of row). If comparing N placement methods that typically would be applied at different times of the season, work with UW staff to design a study with proper timing and placement controls to address the research question of interest.

Projects derived from this protocol are designed to answer producer driven nitrogen fertilizer placement questions. The project requirements described in this protocol align with the research requirements of the DATCP's Nitrogen Optimization Pilot Program (NOPP) grant Option 3 but can be used independently on your own farm to investigate nitrogen management. Current funding opportunities for NOPP can be found here.

This protocol was developed by the UW-Madison Department of Soil and Environmental Science and Division of Extension.

Selecting nitrogen rate treatments

Identifying a standard commercial nitrogen rate should be based on the rate you would normally apply. Based on project goals, the reduced N rate can be 20-40% less N than your standard rate. Chosen rates are going to vary based on specific project details so please reach out to the UW team to fine tune rates used to match your project goals.

Project design

Given that nitrogen dynamics are variable within a given field, a well-structured project design provides confidence in the results of the project. Replication, or repeating each treatment multiple times in the field, and randomization, or assigning treatments to plots with no particular order, make it possible to account for the natural field variation that occurs. Using a well-structured design and statistical analysis, we can determine if any differences in yield effects were due to the treatments, or random chance and variability. For this study, a minimum of four replications is required. Complete randomization of plots is recommended but not required, since it can be difficult due to limitations in field equipment, but trials can be designed to work around these limitations. See example plot layouts at the end of this protocol.

- Field selection: Select a field that is uniform, relevant to the research question, and accessible for ease of data collection (or outreach). Avoid headlands and any known areas with in-field variability when laying out plots.
- Strip width: Determined based on equipment width. It is important to consider the size and capability of planter, nitrogen application equipment, and harvester. Strip width should be at least the width of the harvester (preferably two or more combine header widths).
- Strip length: Recommended that strips are the length of the field for ease of implementation. Strips can be shorter if desired but should be >350 ft if using a yield monitor and >150 ft if using a weigh wagon.
- Field management: All other in-season field management outside of product and nitrogen fertilizer placement (i.e. herbicide, other fertilizer, tillage) should occur uniformly across the field and trial area.

Data collection

Required data and sampling

- Field history & management records (survey to collect this information will be provided).
- Manure sample (if manure applied during this crop year), one sample per application.
- Routine soil (pH, OM, P, K, etc.) sampled across trial area as one composite sample.
- Cover crop sample if field has cover (see UW sampling resources linked in the NOPP protocol library). Sample at time of termination in each replicate.
- Soil nitrate and ammonium sampled prior to nitrogen rate treatment applications at 0-1’ & 1-2’. Soil nitrate and ammonium sampled prior to nitrogen applications at 0-1’ & 1-2’. For example, if all synthetic N is going out pre-plant, sample by each replicate before planting.
- Yield data from calibrated yield monitor or weigh wagon.

Additional sampling is encouraged as your budget allows. Examples include:

- In-season soil nitrate and ammonium (0-1’ & 1-2’)
- Post-harvest soil nitrate and ammonium (0-1’ & 1-2’)
- Soil health analysis
- Plant tissue nutrient analysis
- Forage quality analysis
- Corn ear leaf
- Stalk nitrate
- Grain %N

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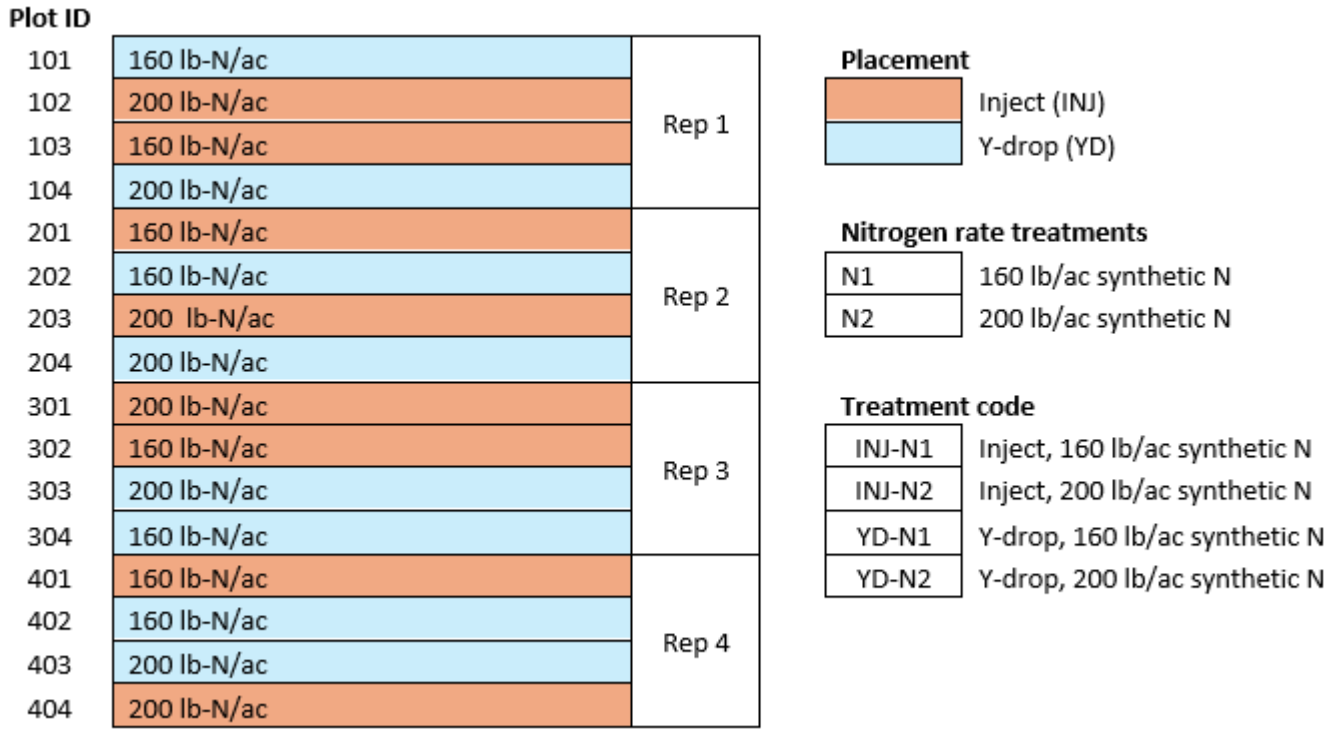
Plot plan examples

Plot plan A

Complete randomization and replication of N placement and N rates. This is the preferred plot plan if achievable by equipment and field size.



Plot plan B

Complete replication of N placement and N rates with N source plots grouped and not fully randomized. This allows for wider passes.

Plot ID		
101	160 lb-N/ac	Rep 1
102	200 lb-N/ac	
103	160 lb-N/ac	
104	200 lb-N/ac	
201	200 lb-N/ac	Rep 2
202	160 lb-N/ac	
203	160 lb-N/ac	
204	200 lb-N/ac	
301	200 lb-N/ac	Rep 3
302	160 lb-N/ac	
303	200 lb-N/ac	
304	160 lb-N/ac	
401	160 lb-N/ac	Rep 4
402	200 lb-N/ac	
403	200 lb-N/ac	
404	160 lb-N/ac	

Placement

	Inject (INJ)
	Y-drop (YD)

Nitrogen rate treatments

N1	160 lb/ac synthetic N
N2	200 lb/ac synthetic N

Treatment code

INJ-N1	Inject, 160 lb/ac synthetic N
INJ-N2	Inject, 200 lb/ac synthetic N
YD-N1	Y-drop, 160 lb/ac synthetic N
YD-N2	Y-drop, 200 lb/ac synthetic N

Plot plan C

Complete replication of N placement and N rates with N placement plots grouped and not fully randomized. This allows for a wider passes.

Plot ID		
101	160 lb-N/ac	Rep 1
102	200 lb-N/ac	
103	160 lb-N/ac	
104	200 lb-N/ac	
201	200 lb-N/ac	Rep 2
202	160 lb-N/ac	
203	160 lb-N/ac	
204	200 lb-N/ac	
301	200 lb-N/ac	Rep 3
302	160 lb-N/ac	
303	200 lb-N/ac	
304	160 lb-N/ac	
401	160 lb-N/ac	Rep 4
402	200 lb-N/ac	
403	200 lb-N/ac	
404	160 lb-N/ac	

Placement

	Inject (INJ)
	Y-drop (YD)

Nitrogen rate treatments

N1	160 lb/ac synthetic N
N2	200 lb/ac synthetic N

Treatment code

INJ-N1	Inject, 160 lb/ac synthetic N
INJ-N2	Inject, 200 lb/ac synthetic N
YD-N1	Y-drop, 160 lb/ac synthetic N
YD-N2	Y-drop, 200 lb/ac synthetic N