Nitrogen fertilizer source

Study Overview

Nitrogen (N) fertilizers vary in their form and percentage of nitrogen, which can influence both crop uptake efficiency and the potential for nitrogen losses. Choosing the right N source helps synchronize nitrogen release with crop demand while minimizing environmental losses. The goal of this study is to assess the effect of nitrogen fertilizer source 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 source 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. 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 nitrogen source treatments

This protocol allows you to choose the N sources most relevant to your operation. Common N sources to compare include UAN (28% or 32%), urea, coated urea, and anhydrous ammonia. If MAP, DAP, AMS, or ATS are used, other nutrients should be applied uniformly across all N source treatments. Some considerations are listed below.

Projects derived from this protocol are designed to answer producer driven questions on nitrogen source. 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.

- Timing of nitrogen applications should remain consistent between source treatments.
- Units of N should be equal across source treatments. For example, if urea is being compared to UAN, the application rates should have equal lb-N/ac across sources.
- If the nitrogen source contains fertilizer other than N, other fertilizers should be applied uniformly across all N treatments. For example, if urea is being compared to a UAN+AMS mix, elemental S should be applied to the urea plots to make S application uniform across all plots.

Selecting nitrogen rate treatments

Identifying a standard synthetic nitrogen rate should be based on the rate you would normally apply. For example, if you would normally apply 160 lb-N/ac at sidedress as 28% UAN, that would be your standard rate. Based on project goals, the reduced N rate can be 20-40% less N than your standard rate. For example, if your research question is to investigate sidedress urea vs 28% UAN, your N rate treatments would be both sources at standard rate of 160 lb-N/ac and both sources at reduced rate 130 lb-N/ac. 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). If N application equipment width varies by source, buffers may be needed between strips to account for that difference.
- 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 nitrogen application timing (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 prior to nitrogen application.
- 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 source and N rates. This is the preferred plot plan if achievable by equipment and field size.

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	160 lb-N/ac	Rep 2
202	160 lb-N/ac	
203	200 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	160 lb-N/ac	
403	200 lb-N/ac	
404	200 lb-N/ac	

Source

	UAN 28% (UAN)
	Urea (UR)

Nitrogen rate treatments

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

Treatment code

UAN-N1	UAN 28%, 160 lb/ac synthetic N
UAN-N2	UAN 28%, 200 lb/ac synthetic N
UR-N1	Urea, 160 lb/ac synthetic N
UR-N2	Urea, 200 lb/ac synthetic N

Plot plan B

Complete replication of N source 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	

Source

	UAN 28% (UAN)
	Urea (UR)

Nitrogen rate treatments

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

Treatment code

UAN-N1	UAN 28%, 160 lb/ac synthetic N
UAN-N2	UAN 28%, 200 lb/ac synthetic N
UR-N1	Urea, 160 lb/ac synthetic N
UR-N2	Urea, 200 lb/ac synthetic N

Plot plan C

Complete replication of N source 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	

Source

	UAN 28% (UAN)
	Urea (UR)

Nitrogen rate treatments

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

Treatment code

UAN-N1	UAN 28%, 160 lb/ac synthetic N
UAN-N2	UAN 28%, 200 lb/ac synthetic N
UR-N1	Urea, 160 lb/ac synthetic N
UR-N2	Urea, 200 lb/ac synthetic N