

Nitrogen Optimization Pilot Program Trial Protocols

Cover crop nitrogen management

Study Overview

Cover crop management including species, termination timing, and termination method can influence nitrogen availability and the need of synthetic nitrogen for the crop. The goal of this study is to assess the effect of cover crop management 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 a cover crop management practice 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, or N credit or penalty from the cover crop. 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 cover crop management treatments

This protocol allows you to investigate cover crop management practices most relevant to your operation. Some examples are included below.

- Cover vs. no cover
- Cover crop species (i.e. red clover vs. rye, single species vs. multispecies mix)
- Cover crop termination method (i.e. herbicide vs. tillage)
- Cover crop termination timing (i.e. early April vs. early May)
- Cover crop seeding rate (i.e. 30 lb/ac vs. 100 lb/ac)
- Cover crop seeding method (i.e. broadcast vs. drilled)

Projects derived from this protocol are designed to answer producer driven cover crop nitrogen management 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 cover crop 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.



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Selecting nitrogen rate treatments

Consider the nitrogen rate you'd typically apply for each cover crop treatment you are investigating and select the highest of the two as the standard commercial nitrogen rate for your trial. 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 cover crop planter, nitrogen application, 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.
- Buffer: A buffer strip may be needed between cover crop treatments depending on planting method. For example, a broadcast planter may not precisely plant to plot boundaries so a buffer area may be needed.
- Field management: All other in-season field management outside of cover crop and nitrogen application (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 cover crop planting.
- Cover crop sample at time of termination (prior to killing frost if cover winter kills) in each treatment and each replicate (see UW sampling resources linked in the NOPP protocol library).
- 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 cover crop and N rates. This is the preferred plot plan if achievable by equipment and field size.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	150 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	100 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	150 lb-N/ac	
403	100 lb-N/ac	
404	100 lb-N/ac	

Cover crop treatments

	Rye cover crop (RCC)
	No cover (NC)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

RCC-N1	Rye cover crop, 100 lb/ac synthetic N
RCC-N2	Rye cover crop, 150 lb/ac synthetic N
NC-N1	No cover, 100 lb/ac synthetic N
NC-N2	No cover, 150 lb/ac synthetic N

Plot plan B

Complete replication of cover crop and N rates with cover crop plots grouped and not fully randomized. This allows for wider cover crop planting or management passes.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	100 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	150 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	100 lb-N/ac	
403	100 lb-N/ac	
404	150 lb-N/ac	

Cover crop treatments

	Rye cover crop (RCC)
	No cover (NC)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

RCC-N1	Rye cover crop, 100 lb/ac synthetic N
RCC-N2	Rye cover crop, 150 lb/ac synthetic N
NC-N1	No cover, 100 lb/ac synthetic N
NC-N2	No cover, 150 lb/ac synthetic N

Plot plan C

Complete replication of cover crop and N rates with cover crop plots grouped and not fully randomized. This allows for wider cover crop management passes.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	100 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	150 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	100 lb-N/ac	
403	100 lb-N/ac	
404	150 lb-N/ac	

Cover crop treatments

	Rye cover crop (RCC)
	No cover (NC)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

RCC-N1	Rye cover crop, 100 lb/ac synthetic N
RCC-N2	Rye cover crop, 150 lb/ac synthetic N
NC-N1	No cover, 100 lb/ac synthetic N
NC-N2	No cover, 150 lb/ac synthetic N

Plot plan D

Complete replication of cover crop and N rates, dividing the field in half to apply cover crop treatments . This plot plan is conducive with operations that cannot implement cover crops treatments in strips. Note: Fields with any sort of gradient (change in soil type, fertility, slope), would not be a suitable location for this sort of plot plan, since you could unintentionally favor one of the cover crop treatments. This layout is not preferred and we recommend working with UW staff to discuss other layout options given equipment constraints.

Plot ID

101	150 lb-N/ac
102	100 lb-N/ac
103	150 lb-N/ac
104	100 lb-N/ac
201	100 lb-N/ac
202	150 lb-N/ac
203	150 lb-N/ac
204	100 lb-N/ac
301	100 lb-N/ac
302	150 lb-N/ac
303	100 lb-N/ac
304	150 lb-N/ac
401	150 lb-N/ac
402	100 lb-N/ac
403	100 lb-N/ac
404	150 lb-N/ac

Cover crop treatments

	Rye cover crop (RCC)
	No cover (NC)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

RCC-N1	Rye cover crop, 100 lb/ac synthetic N
RCC-N2	Rye cover crop, 150 lb/ac synthetic N
NC-N1	No cover, 100 lb/ac synthetic N
NC-N2	No cover, 150 lb/ac synthetic N