Efficient Nitrogen Fertilization for Cultivated Wildrice Varieties: Phase 3

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Original Project Summary

More efficient and effective nitrogen fertilization recommendations for wildrice on peat soils will be developed through strip trials and small plot experiments. Various combinations of ESN and urea will be compared at similar rates to current production practices. Results will be used to determine whether use of ESN can reduce or eliminate aerial topdress applications of urea without increasing the risk of lodging. Strip trials will be conducted to gain a preliminary indication of the optimum N-fertilization for a second-year crop (i.e., coming off wildrice). Soil tests will provide estimates N contribution from soil organic matter with a previous crop history of either wildrice or legume. Combinations of ESN and urea will be tested on several current and potential varieties in small plots, to determine the effect of replacing a topdressing with pre-plant ESN nitrogen fertilization for high-yielding, short-statured, and early-maturing varieties. The overall goal of this research is to develop and refine recommendations for the application of nitrogen to wildrice, in such a way as to balance maximal yield with minimal nitrogen loss or waste.

The overall **goal** of the proposed research is to develop N recommendations that will maximize yield and minimize lodging and potential N losses. The more specific **objectives** of this proposal are to:

1. Determine if ESN can be used to replace aerially topdressed urea for wildrice production.
2. Optimize the amount of ESN and urea needed for wildrice crops following legumes (e.g., soybean or field pea) vs. following a previous wildrice crop.
3. Test whether different categories of wildrice varieties (specifically: high-yielding varieties, early-maturing varieties, and short-statured varieties) respond differently to replacing top-dressed urea and/or a modest amount of pre-plant urea with ESN.

Methods

Objectives 1 and 2: Nitrogen Fertilization Trials

For the 2015 growing season, on-farm strip trials were established in the Fall of 2014 on peat soils at each of the two major wildrice growing areas: Aitkin, and Clearbrook. At each location, two paddies with different crop histories are being used: paddies coming off a rotation that ended in a legume (either soybean or pea) and paddies that produced wildrice the season prior to the experiment. For each paddy with a different crop history, plot-combine-sized strips (10' x 30') were fall-fertilized with urea and/or ESN for a total N fertilization of 80 or 120 lb A-1. The design was split-plot with overall N as the main plot and topdress level as the subplot:

Main plot ID	Subplot ID	preplant urea lb of N A^{-1}	preplant ESN lb of N A^{-1}	topdressed urea lb of N A^{-1}
80N	80 TD	0	0	80
80N	40 TD	0	40	40
80N	0 TD	0	80	0
120N	80 TD	0	40	80
120N	40 TD	0	80	40
120N	0 TD	0	120	0
120N/40 ppu	80 TD	40	0	80
120N/40 ppu	40 TD	40	40	40
120N/40 ppu	0 TD	40	80	0

With this design, the effect of substituting ESN for 1 or 2 topdresses can be investigated when the level of total fertilizer N is held constant at either 80 or 120 lb A^{-1}; in addition, replacement of topdressed nitrogen with pre-plant ESN can be compared with and without a typical application of pre-plant urea (Objective 1). Furthermore, by replicating the experiment in paddies with a prior crop of wildrice or with a prior crop of a grain legume at three locations, the contribution of the prior legume crop to wildrice can be estimated while narrowing in on the optimum nitrogen fertilization regime for each rotation (Objective 2).

The following field data will be collected: soil total-N and ammonium-N at the beginning of the season and from each plot at harvest; total N in plant tissue at three times during the growing season; greenness estimates of mature leaves at the tissue sampling times; lodging; disease rating; grain yield; and grain moisture (to observe maturity differences). In addition, soil porewater ammonium concentration in the flooded soil will be measured at various points throughout the season to follow the changes in ammonium-nitrogen available for plant growth. For efficient yield and grain moisture measurements at multiple locations, a plot combine is being acquired by the Minnesota Cultivated Wild Rice Council for use on this project.

Objective 3: Variety x ESN Trials

A small-plot trial planted in 2015 was to test varietal response to replacing topdressed N with preplant ESN. The trial was fall-planted in Nov. 2014 on-farm near Aitkin, MN. The design is split-split-plot, with two main plots of N-fertilization regimes totaling 120 lb. N A^{-1}: one nitrogen treatment was all pre-plant ESN and the other was established with a pre-plant ESN rate of 80 lb. N A^{-1}, with a urea topdressing of 40 lb. N A^{-1} to be added around the boot stage. Subplots will be two different harvest dates, since varietal entries will differ in maturity, and the later harvest date may provide more time to see differences in yield due to N treatments for some varieties. Sub-subplots consist of ten varieties or elite breeding populations. There are three replicates of 40 plots, each plot being 5' x 24'. Varieties within the sub-plots include: four early-maturing, one short-statured (with higher yield potential than the variety used in previous trials), one pistillate variety (with more potential grains to fill per panicle), three later-maturing high-yielding

breeding populations, and one high-yielding, widely-grown check variety. The main plot fertilizer treatments will enable a comparisons of how each type of variety responds to the replacement of topdressed urea with ESN. The treatment combinations for each variety are:

Main plot treatment	Sub plot treatment (harvest timing)	Preplant ESN (lbs. A^{-1})	Topdressed urea (lbs. A^{-1})
1	early	120	0
1	later	120	0
2	early	80	40
2	later	80	40

Tissue and soil samples will be collected in a manner similar to the experiments described for Objectives 1 and 2. The following field data will be collected: soil total-N and ammonium-N at the beginning of the season and at harvest; total N in plant tissue at the end of the growing season; greenness estimates of mature leaves just prior to harvest; lodging; disease rating; grain yield; and grain moisture. A plot combine will be used to harvest these plots as well. Analyses will help determine the optimum N-fertilization regime for future recommendations for these upcoming varieties.

Due to broadcast seeding from the grower at this plot in Aitkin, seed drifted in and the plots were not harvested due to the uncertainty of the contamination to the known seed varieties, as well as the amount of transplanted seed in each plot that were not from the known seed varieties. This objective was not completely meet within the scope of the research and more is needed to be known about varietal interaction per nitrogen source and rate.

Summary of Results

For 2015 Trials

Trials for the 2015 season proved to be difficult to conduct. Lack of water in the spring resulted in late flooding for the trial at Clearbrook on a second year wildrice stand to be late flooded, ultimately causing the crop to fail and no useable yield data to be collected. Also, in the second year wildrice stand at the Aitkin location, a lack of a useable stand also was a problem. Plant density was below the threshold of 1 plant per square foot, making yield data here as well not feasible. Data collected for yield on the nitrogen strip trials was restricted to just those fields coming out of a legume crop at both the Aitkin and Clearbrook site. The Clearbrook site had yields significantly lower due to disease issue and week later than usual harvest due to we conditions in the field not allow the harvest equipment through the field. Data for that is shown in graphic below. This again help with clarifying the original objectives 1 and 2.

No data was again collected this growing season for objective 3, looking at varietal response to ESN. Low plant densities, and the presence of volunteer plants floating in for the grower fields, made it impossible to conclude what was a plot and what wasn't. This uncontrollable variability and issues with this type of on-farm research (having to put varietal yield plots within a broadcast seeded growers paddy) made this objective unachievable.

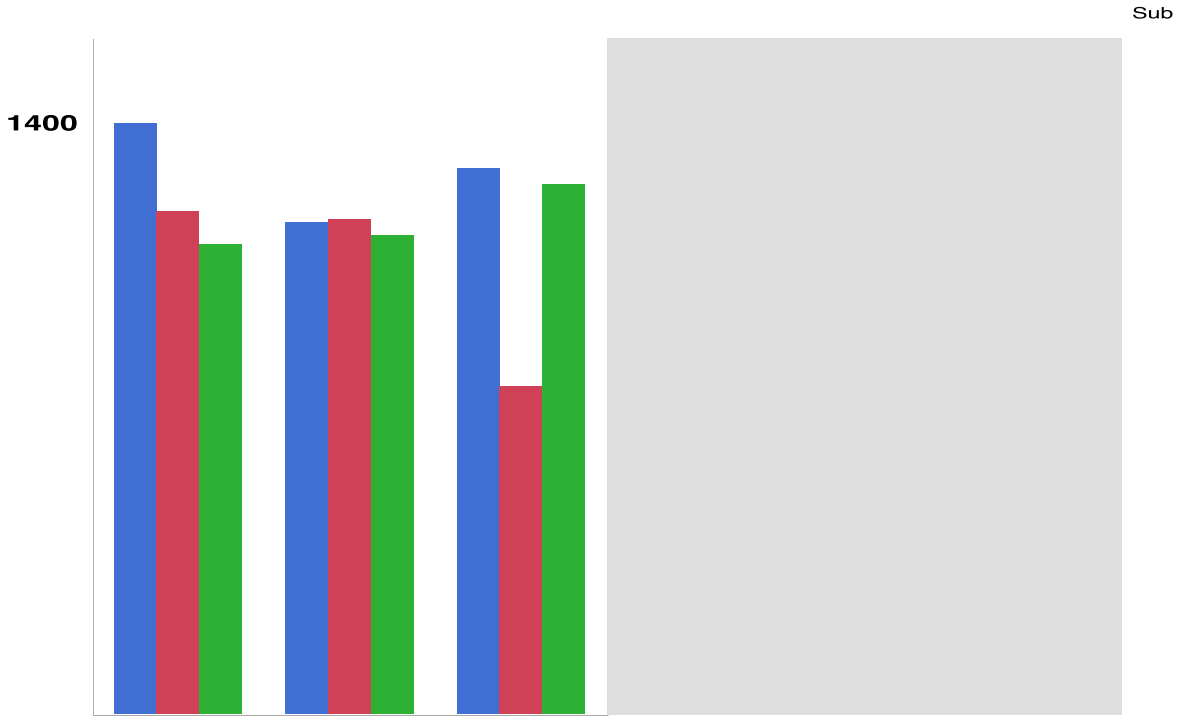

Fig. 5 Results showing wildrice harvest (September) yields (adjusted to 35% moisture) of two locations, Clearbrook and Waskish, on field coming out of a previous legume crop. Main plots are 120 total N as ESN pre-plant, 120 total N as ESN blended with 40 lbs N/A urea, and 80 total N as ESN. Color bars represent three subplots with 0, 1 and 2 40 lb N/A topdress.

Again in 2015, few significant contrast results were found among varying main plot treatments of 120 N lb/A , and those at 80 N lb/A. This was also the case when looking at replacing ESN pre-plant with either pre-plant Urea, or through a combination of both and one or two top-dress applications. Lack of results with with the added nitrogen at 120, especially in a first year stand of wildrice, lead to the conclusion that is in profitable to add that extra 40 N lb/A. Aslo, there appears to be no set way to apply your fertilizer at the rate of 80 N/A. With this said, growers may want to gage market conditions as to whether they use ESN or not, and and whether they have a pre-plant blend, and eliminate at least one top-dress application. Many considerations need to be look at in this factor, such as if fall-flooding is occurring or not, and soil-type crop is grown on. Overall, the main goal for the grower is to have the most efficient use of his fertilizer without detrimental impacts to the environment and his fields.

BMP's for Nitrogen in Wildrice

First Year Production Considerations	**Rec. Considerations**
• Previous Cropping History – Legume vs. – Small grains or other crops • Soil Type – Mineral vs. Organic • Fall vs. Spring Seeded – Flooding Timing Spring/Fall • Fertilizer Source – Anhydrous, Urea, ESN, – Ammonium Sulfate, Blend • Pre-plant/Top-dress	• Estimate approximately 20 lb/A N credit for soybeans • N Credit from mineralization in higher organic soils. – Drainage high influence on this • Fall N applications should be 5% higher than due to some denitrification losses. • N Pre-plant and top-dress rate recommendations will vary depending on N source and Fall/Spring apps.

Old Seedings (2nd yr +) Considerations • Wildrice Previous Crop – Limited N credits • Soil Type – Mineral vs. Organic • Fall vs. Spring Flooding • Fertilizer Source – Anhydrous, Urea, ESN, – Ammonium Sulfate, Blend • Pre-plant/Top-dress	**Rec. Considerations** • Need More N than new Seedings, total of 100-120 lb N/A • 20 lb N higher in Mineral soils upwards of 140 lb N/A • Source of N due to flooding concerns • Probably going to need 2 top-dress applications

Nitrogen Application BMP's

- Fall applications of N should occur when soil temps fall below 50ºF
  - Fall flood if possible to retain NH4
  - Consider use of Nitrification inhibitor or ESN/Urea blend with fall applications
  - Incorporate

Challenges Encountered

One of the biggest challenges encountered during this funding cycle was the loss of the Nitrogen x Variety Trials, which was to address Objective 3 of the proposal. This was very unfortunate because of the need to test whether different categories of wildrice varieties respond differently to replacing top-dressed urea and/or a modest amount of pre-plant urea with ESN.

On-farm research provided some challenges as well. Working and communicating with growers can at times be difficult, due to the nature of a large farming operation. At our nitrogen strip trials in Waskish, we learned about the delicate balance it takes to work with a farmer because of his broad concerns about his whole farm operations, yet still maintaining the integrity of the small amount research being conducted on these farms. A grower has many things going on day to day besides just keeping track of our research needs. In this instance, there was miscommunication with his pilot who was applying Coron, a foliar nitrogen application. Both trials, one coming off a legume field, as well as the other trial in a second year wildrice stand, received a top-dress of Coron. The unplanned treatment caused some concern regarding the data that was collected from the Waskish site. We did learn though that it takes a lot of time with the growers, trying to help them understanding the importance of how treatments can effect results, combined with a better line of communication with all parties involved in the farming operations to make the research go smoothly.