Assessment of ESN® as an N Source for Efficient Fertilization for Cultivated Wildrice

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Introduction

Industrial food production has driven efforts to commercialize and domesticate wildrice. This in turn has prompted efforts and use of conventional breeding methods to develop higher producing varieties. In the United States today, a high proportion of wildrice acreage is grown mostly in north central and northwest Minnesota, on peat (highly organic) and some mineral soils. Fertility requirements in cultivated wildrice have not been adjusted over the years as more efficient seed varieties become available, but it has been estimated that total nitrogen use is about 150 lbs. A^{-1} annually. There is a growing need to decrease nitrogen loss and increase use efficiency as a result of poor fertility management practices currently being used. Field trials conducted side by side comparisons to determine if Environmentally Safe Nitrogen (ESN®) can be an effective fertilizer source for wildrice production, as well as optimize the amount of ESN® needed for different varieties of wildrice, specifically high-yielding varieties, early-maturing varieties, and short-statured varieties. The overall goal is to develop N recommendations that will maximize yield and minimize lodging and potential N losses.


Aerial photo of NCROC wildrice research complex

Materials and Methods


Fall fertilization by ATV and 5 foot Gandy drop spreader of small plot trials in Waskish, Minnesota

-Small and large plot field trials were conducted over growing seasons from 2012 to 2014, comparing varying rates of ESN® with other types of currently utilized fertilization practices.

-Small plot trials (4 row, 5 x10 ft. plots) in 2012 and 2013 focused on variety x ESN® interactions.

-Large strip nitrogen fertilization trials plots (10 x 50 ft.) in 2014, focused on ESN® use efficiency depending on previous cropping system, such as a previous legume (soybean or pea) or a previous wildrice crop, along with varying blends of ESN® and urea.

-Combinations of pre-plant urea blended with ESN® or pre-plant urea was replaced by one or two urea in season top-dressings.


Aerial photo of large plot nitrogen strip trials in Clearbrook, Minnesota. Photo was taken from airplane during early flowering stage of the wildrice plant.

-All fertility research was carried out on wildrice grower farms in northwest and north central Minnesota. Fields were fall planted and flooded in the spring.

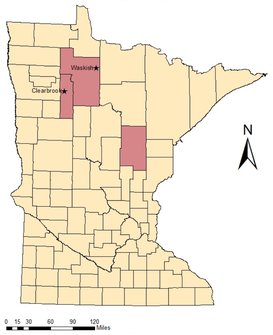


Figure 1. Map of Minnesota counties with high wildrice production (red) and 2012-2014 research sites at Clearbrook, Waskish, MN

Table 1. Fertility Research site soil and general planting and harvest timings

	Waskish	Clearbrook
Soil Type	Histosol	Histosol
Soil pH	6.5	6.8
% Organic matter	77.1	62.5
Fertilization Date	Fall	Fall
Planting Date	Fall	Fall
Flooding Date	Spring	Spring
Harvest Date	Early September	Early September
Growing Degree Days (Base 40)	2987	3169

Materials and Methods

Table 2. Wildrice varietal treatment list and ESN® application rates for 2012 and 2013 small plot ESN® x variety trials in Waskish, MN and Clearbrook, MN

Waskish 2012			Clearbrook 2013		
Treatment	Varietal Entry	ESN Rate	Treatment	Varietal Entry	ESN Rate
1	VE-C10	0 lbs./A	1	VE-C10	0 lbs./A
2	14S-C4	0 lbs./A	2	14S-C5	0 lbs./A
3	Itasca C12	0 lbs./A	3	Itasca C12	0 lbs./A
4	PBM-C17	0 lbs./A	4	PBM-C18	0 lbs./A
5	14PD-C4	0 lbs./A	5	14PD-C5	0 lbs./A
6	VE-C10	40 lbs./A	6	VE-C10	40 lbs./A
7	14S-C4	40 lbs./A	7	14S-C5	40 lbs./A
8	Itasca C12	40 lbs./A	8	Itasca C12	40 lbs./A
9	PBM-C17	40 lbs./A	9	PBM-C18	40 lbs./A
10	14PD-C4	40 lbs./A	10	14PD-C5	40 lbs./A
11	VE-C10	80 lbs./A	11	VE-C10	80 lbs./A
12	14S-C4	80 lbs./A	12	14S-C5	80 lbs./A
13	Itasca C12	80 lbs./A	13	Itasca C12	80 lbs./A
14	PBM-C17	80 lbs./A	14	PBM-C18	80 lbs./A
15	14PD-C4	80 lbs./A	15	14PD-C5	80 lbs./A
16	VE-C10	120 lbs./A	16	VE-C10	120 lbs./A
17	14S-C4	120 lbs./A	17	14S-C5	120 lbs./A
18	Itasca C12	120 lbs./A	18	Itasca C12	120 lbs./A
19	PBM-C17	120 lbs./A	19	PBM-C18	120 lbs./A
20	14PD-C4	120 lbs./A	20	14PD-C5	120 lbs./A

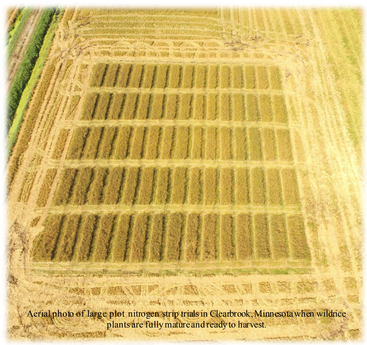
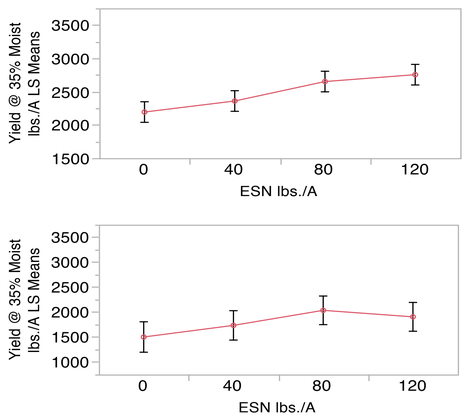

Aerial photo of large plot nitrogen strip trials in Clearbrook, Minnesota when wildrice plants are fully mature and ready to harvest.

Table 3. 2014 Waskish and Clearbrook large strip nitrogen fertilization trials split-plot design treatment list showing nitrogen application rates

Main plot ID	Subplot ID	preplant urea lb. of N A^{-1}	preplant ESN® lb. of N A^{-1}	Top-dressed 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


Wildrice harvest photo of large plot nitrogen strip trials in Clearbrook, Minnesota. Plots strips were harvested with a Zuern 150 combine.

Results



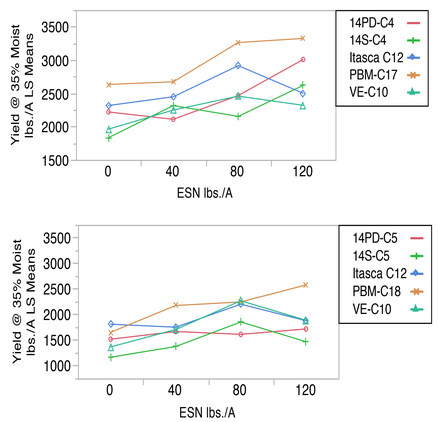


Figure 2. Overall means for adjusted yields at 35% moisture for each ESN® treatment at the (Top) Waskish in 2012 and (Bottom) Clearbrook in 2013, small plot sites (linear contrast when Prob>F = 0.0019 for Waskish, linear contrast when Prob>F = 0.0051 for Clearbrook).

Figure 3. Individual variety adjusted yield responses to ESN® treatments at the (Top) Waskish and (Bottom) Clearbrook small plot sites in 2012 and 2013 respectively.

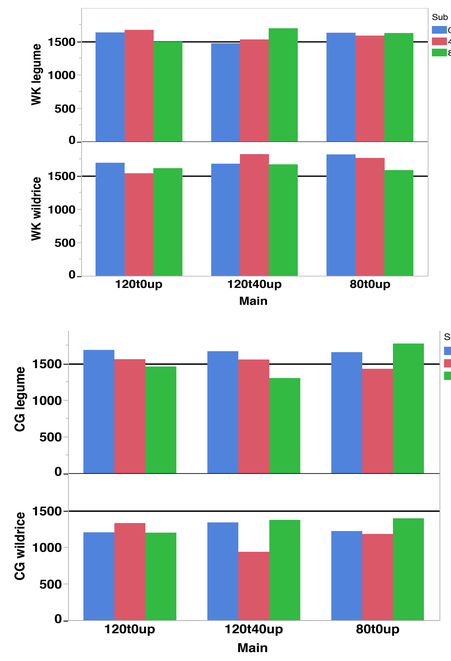


Figure 6. Mean harvest yield adjusted to 35 % at the 2014 (Top) Waskish and (Bottom) Clearbrook large plot fertilization trials comparing yield responses to ESN® or replacement of ESN® with one or two urea top-dresses with total actual N treatments on the three main plot N treatment 80 lbs. total N with no pre-plant urea, 120 lbs. N with no pre-plant urea, or 120 lbs. total N with 40 lbs. pre-plant urea. Graph Shows both fields coming out of soybeans and a field with a previous crop of wildrice.

Result Highlights

Small Plot variety x ESN® trial

- **Significant linear contrast trends for 14PD-C4, 14S-C4, and PBM-C17 at the Waskish site. The trends of 14PD-C4, and14S-C4 are interesting to note since they are short-statured varieties**
- **Significant linear contrast was found on the overall average of the adjusted harvest yields across all five varieties for each ESN® treatment at the Waskish site**
- **A significant linear contrast was noted on the overall average of the adjusted harvest yields across all five varieties as ESN® levels rose to 80 lbs. A^{-1} , after which they subsequently leveled out as the ESN® levels approached the 120 lbs. A^{-1} treatment at the Clearbrook site**

Large strip plot nitrogen fertility trial

- **Overall, 80 lb. N treatments performed as well (yielded as well) as 120 lb. N treatment, but not significantly different**
- **Some significant contrast differences where found when ESN® pre-plant was replaced with a 40 lb. urea top-dress at both the Clearbrook and Waskish site**
- **Yield trends varied from treatment, site to site, and with previous cropping history**

Summary

Drawing conclusions from data spread across two site locations from different cropping years is a complicated task. Making these inferences even more difficult is the varying cropping history that occurred at each of the two sites from 2012-2014. Considering these issues, generally wildrice varieties responded well to ESN® as a pre-plant treatment. In both small plot field trials, overall means across varietal entries responded positively to increasing levels of ESN®, with the Clearbrook location in 2013 showing less of a linear increase above 80 lbs. A^{-1}. These data support the idea that not all varieties respond equally to increasing levels of ESN®. The fact that varietal response to ESN® had so much variation indicates that some varieties have greater potential for higher nitrogen efficiency.

The large plot fertility strip trials, which focused primarily on the potential of ESN® to replace costly and inefficient aerial top-dressing, showed that in most cases, regardless of the combination of pre-plant ESN®, amount of pre-plant urea, or replacement of pre-plant fertilizer with one or two aerial top-dressings, a total treatment of 80 lbs. A^{-1} of nitrogen was as efficient as 120 lbs. A^{-1} nitrogen treatment. These results were consistent across total nitrogen treatments, but a trend was not seen in the various pre-plant vs. replacement top-dress applications.

Acknowledgements

Minnesota Cultivated Wild Rice Council

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