Is ESN Releasing Fast Enough to Supply Winter Wheat Nitrogen Demand?

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Abstract

The purpose of this study is to investigate nitrogen release from various split rate applications of seed-placed environmentally smart nitrogen (ESN) and spring-applied dribble banded Agrotain-UAN (urea and ammonium nitrate solution) and broadcast Agrotain-urea in winter wheat. Cool spring soil conditions have the potential to limit nitrogen (N) release from ESN potentially limiting grain yield potential. Plant root simulator (PRS™) probes were used to monitor N soil supply. It was discovered that N supply did not vary significantly between the split-rate treatments. There were also no significant differences between grain yield and protein content. These results suggest that N release from ESN was not limited by cool spring temperatures and allowed plant vigour similar to traditional spring-applied methods.

Introduction

Environmentally Smart Nitrogen (ESN) was originally developed to prevent leaching and volatilization losses for mid-western U.S.A.'s high N-demanding crops. ESN is a polymer-coated urea designed to increase N release parallel to the N demand of the crop (1). ESN release rates are dependant on moisture and temperature and recommended uses are region specific (2).

Seed-placed N has previously been discouraged due to the toxic effects of urea on the localized seed area. However, ESN's slow release mechanism has been shown to eliminate this seed toxicity (3,4). Depending on the agronomic practises of the producer, the ability to apply N in the seed row could be advantageous.

In western Canada, ESN is recommended for use as 100% of all N requirements of winter wheat (2). However, it is unclear if ESN is suitable for winter wheat agronomy in Western Canada as cool soil conditions in spring could constrain N release. Any N limitation, even if early in the vegetative phase, could limit grain yield potential.

The purpose of this study is to investigate N release from seed-placed ESN, dribble banded Agrotain-UAN and broadcast Agrotain-urea. PRS™ probes simulate plant roots by adsorbing nutrients on a fixed cation or anion exchange membrane. By using PRS™-probes during the vegetative phase, N flux data can be used to ascertain its bioavailability and release rates.

The winter wheat cultivar Sunrise was planted by the winter wheat program, Department of Plant Sciences, Saskatoon SK, in September of 2009. ESN was applied with the seed in the fall. UAN and urea were both Agrotain-treated and applied in spring by dribble banding and hand-broadcasting, respectively (Table 1).

Table 1. Nitrogen treatments used in this study.

Type	Lbs/Acre (N)		Type	Lbs/Acre (N)	Total Lbs/Ac (N)
ESN	120	+	none	0	120
ESN	0	+	UAN	120	120
ESN	60	+	UAN	60	120
ESN	90	+	UAN	30	120
ESN	0	+	Urea	120	120
ESN	60	+	Urea	60	120
ESN	90	+	Urea	30	120
ESN	0	+	Urea/UAN	0	0

PRS™ probes were placed (at Feekes stage 3) mid-row and in-row in each treatment to ascertain N bioavailability and release rates from the N sources specific to location (Figs 1-4). N supply rates gradually increased over the growing season from both fertilizer release and organic matter mineralization. Crop uptake decreased N supply after week 3. It was expected that in-row N supply would eventually be lower than mid-row with localized plant uptake. However, plots with 100% urea had similar N supply regardless of placement (Fig 1).

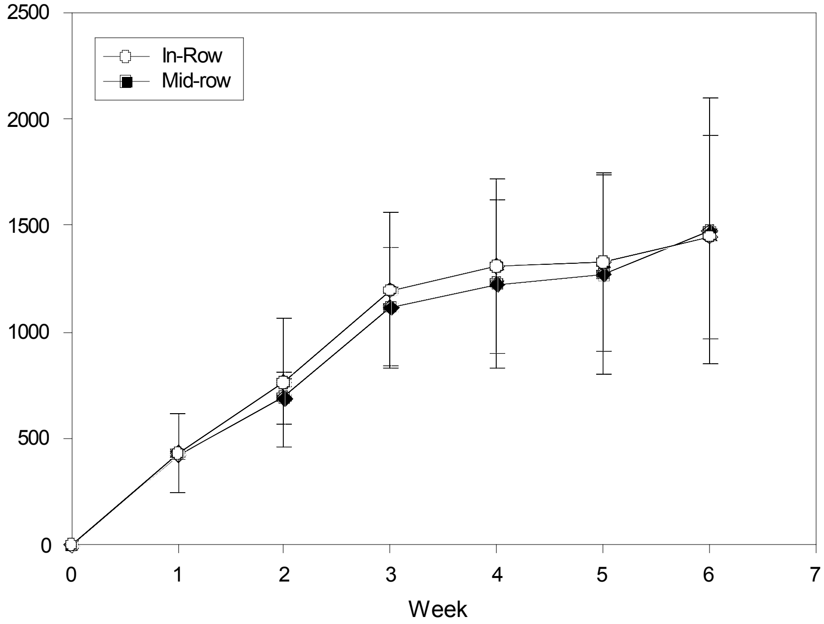

Figure 1: Cumulative N supply rates from 100% urea. Data shown are means and error bars are 1 SD (n=4).

The expected results were observed with 100% UAN application and crop uptake in-row decreased N supply compared to mid-row (Fig 2).

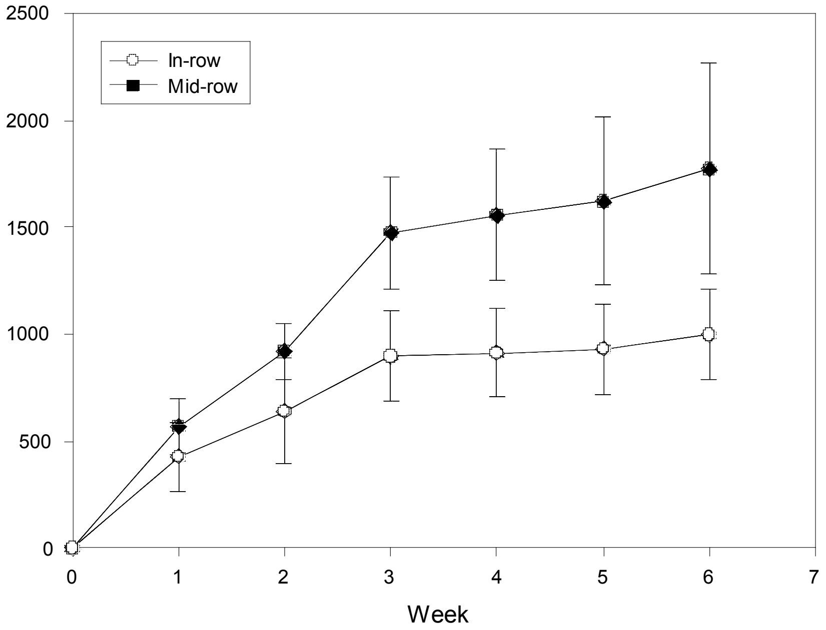

Figure 2: Cumulative N supply rates from 100% UAN. Data shown are means and error bars are 1 SD (n=4).

N supply increased in-row when half the N rate was ESN. ESN was placed in the seed row during planting and therefore localizes more N in-row (Fig 3 and 4). N supply rates of split ESN treatments were similar to the 100% UAN and urea treatments which suggest that N release from ESN is not hindered by early spring conditions. Also noteworthy is the large standard deviations in the ESN/urea treatments compared to ESN/UAN.

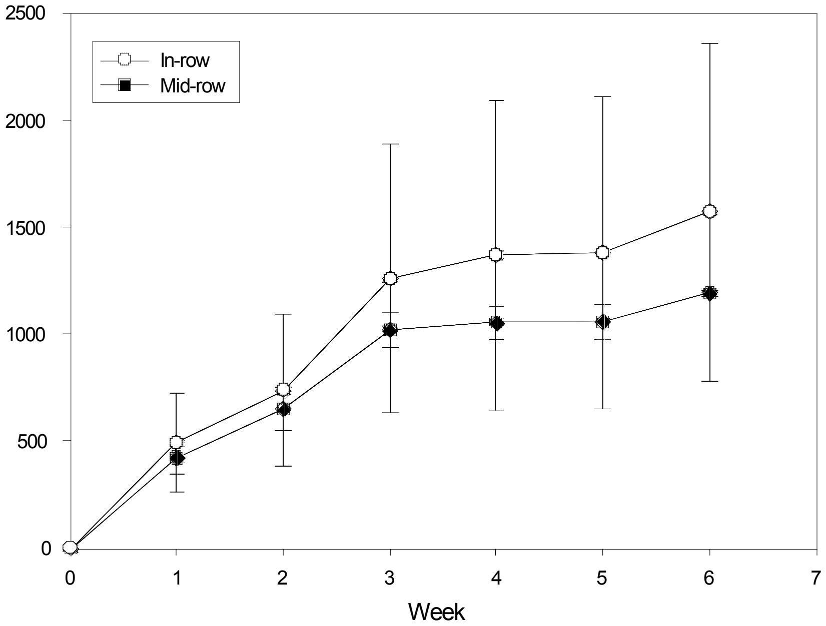

Figure 3: Cumulative N supply rates from 50% urea and 50% ESN. Data shown are means and error bars are 1 SD (n=4).

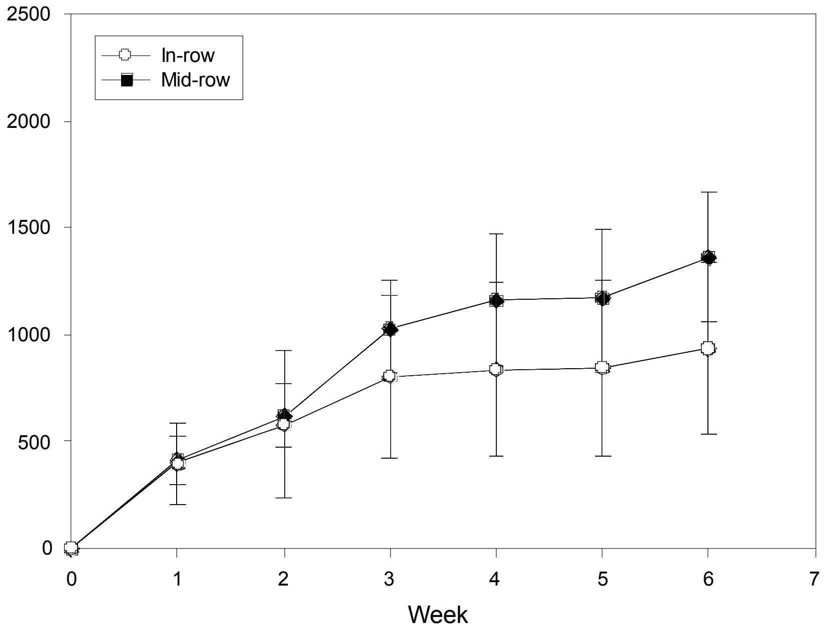

Figure 4: Cumulative N supply rates from 50% UAN and 50% ESN. Data shown are means and error bars are 1 SD (n=4).

Most of the N supply will be from mineralization of organic matter in the 0N treatment (Figure 5). During spring warming, N was steadily released but was significantly (p≤0.05) less in the 0N than the treatments that received N.

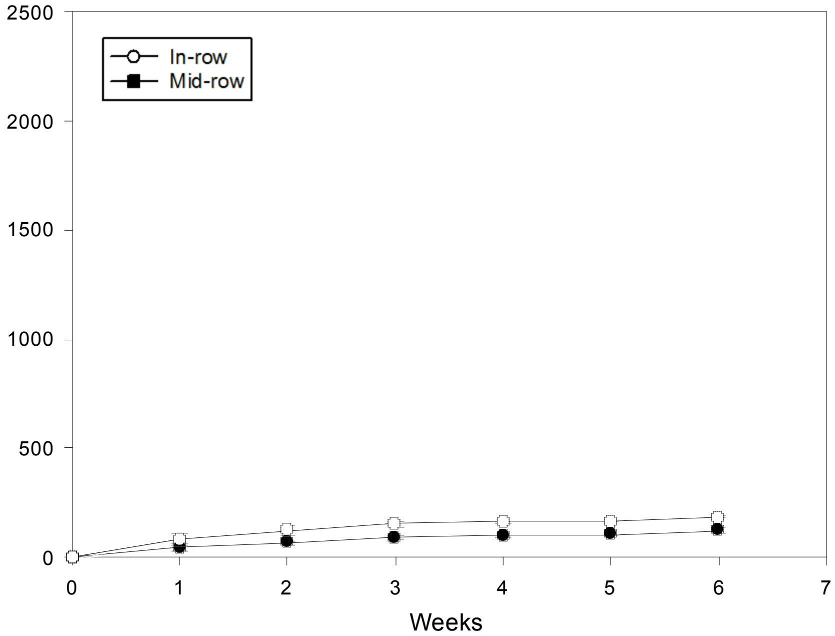

Figure 5: Cumulative N supply rates from 0 N treatment. Data are means and errors 1 SD (n=4).

Grain yield was similar throughout the study except for the 0 N treatment (Fig 6). This shows a yield response to the N treatment.

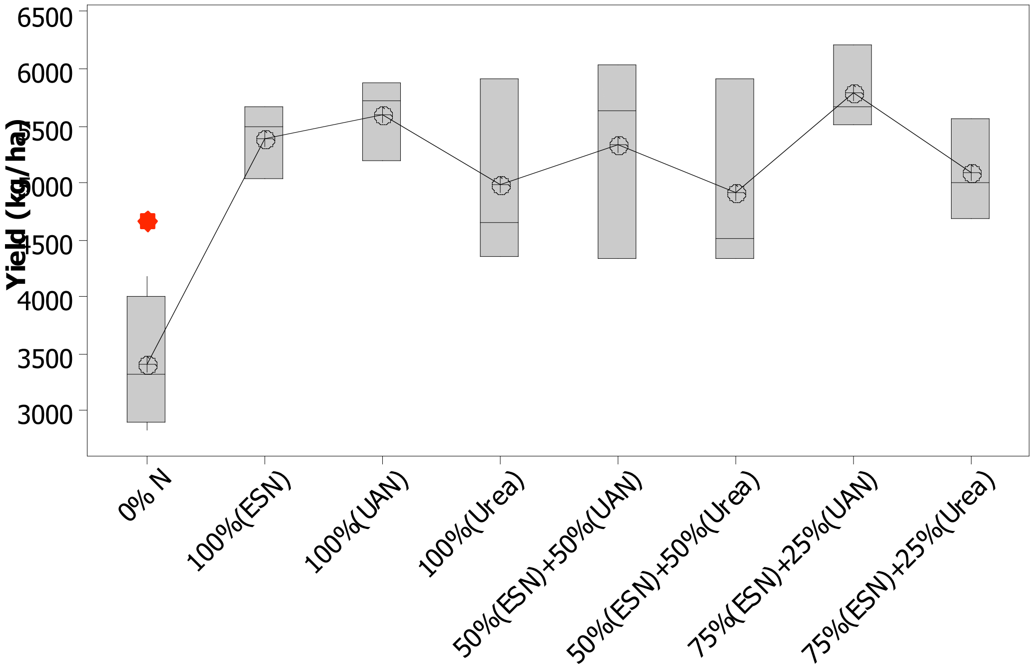

Figure 6: Total grain yield. Staggered line displays the means and bars display the distribution (n=3). Significant difference is denoted * ($p \leq 0.05$).

Grain protein content was similar throughout all treatments (Fig 7). Although the 0 N treatment had minimal N supply from soil organic N mineralization, grain protein % was similar to the other N treatments. Mean grain yield was significantly lower in the 0N treatment (35-40%), which suggests that N limited plants limit yield to ensure protein content. Viable seed requires adequate protein content (at a minimum of ~9%) for germination and seedling growth and a winter wheat plant will not compromise yield for seed health

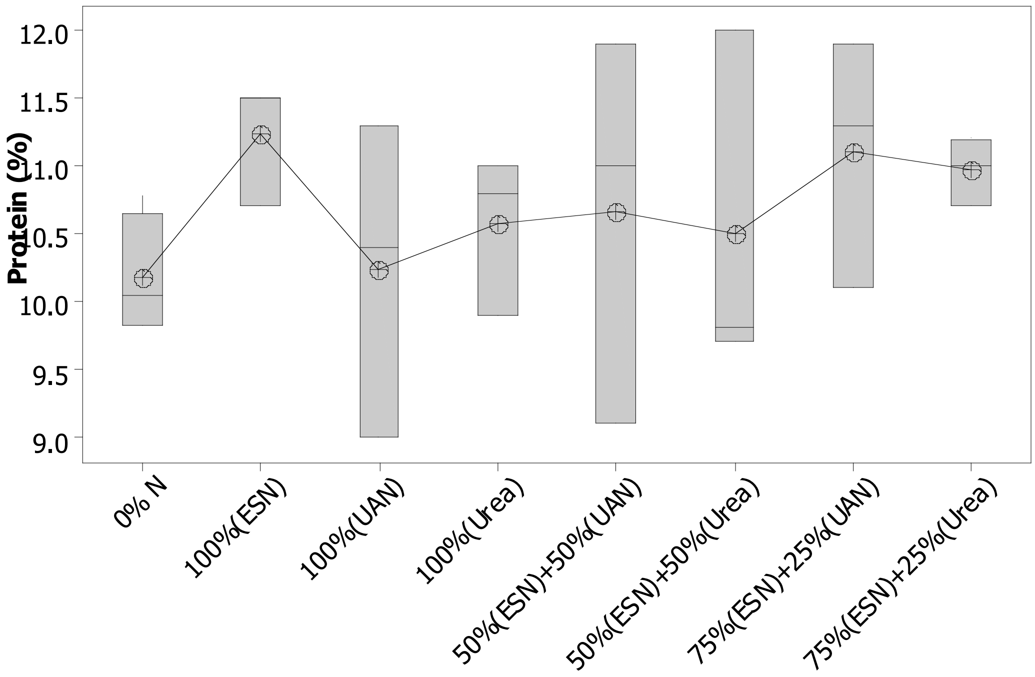

Figure 7: Protein content of grain. Staggered line displays the means and bars display the distribution (n=3).

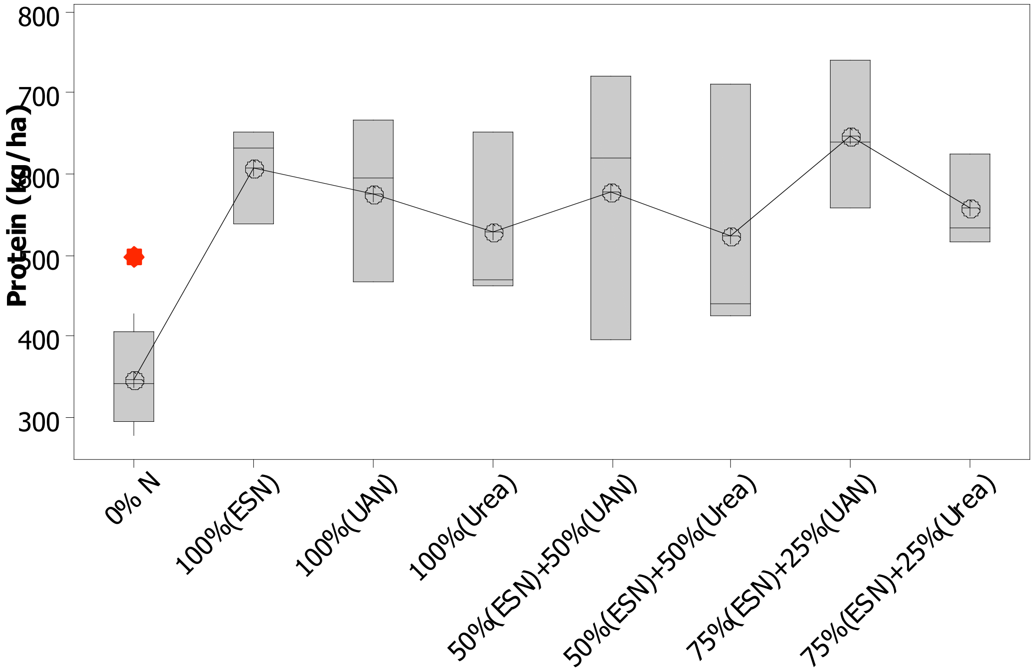

Figure 8: Total protein yield. Staggered line displays the means and bars display the distribution (n=3). Significant difference is denoted * (p≤0.05).

With the exception of the 0 N treatment, none of the N split applications were statistically more or less suitable to winter wheat yield or grain quality (Figs 5-8). The results suggest that N bioavailability in this study is not dependant on fertilizer source or method of application and applying all N as ESN with seed is viable alternative to top-dressing in spring. The preference and economics of the producer will decide what practice to use.