2018 Annual Report
for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Demonstrating 4R Nitrogen Management Principles for Wheat

(Project #20170321)

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Project Identification

1. **Project Title:** Demonstrating 4R Nitrogen Principles for Wheat
2. **Project Number:** 20170321
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation
4. **Project Location(s):** Indian Head, Saskatchewan, R.M. #156
5. **Project start and end dates (month & year):** October 2017 to February-2019
6. **Project contact person & contact details:**

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Objectives and Rationale

7. **Project objectives:**

Developing Best Management Practices (BMPs) for nutrient applications has long been focussed on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right placement. These factors are not necessarily independent of each other. For example, depending on the source, application timings or placement options that would potentially be considered high risk can become more viable. The objective of this project was to demonstrate the overall CWRS wheat response to nitrogen (N) fertilizer along with the relative performance of various management strategies involving different forms, timing of application, and placement options relative to side-banded, untreated urea as a benchmark. While certainly not all inclusive, the treatments that were evaluated encompassed all four considerations for 4R nutrient management (source, rate, time and placement) and included several practical options for Saskatchewan wheat growers.

8. **Project Rationale:**

Nitrogen is the most commonly limiting nutrient in annual crop production and N fertilizer is often one of the most expensive crop inputs, particularly for crops with high N requirements like spring wheat. Most inorganic N fertilizers contain NH_4-N but some, such urea ammonium-nitrate (UAN), also contain NO_3-N. Since the advent of no-till and innovations in direct seeding equipment, side- or mid-row band applications and single pass seeding/fertilization quickly became the standard and most commonly recommended BMP for N fertilizer. Side- or mid-row banding is effective with the major forms of N including anhydrous ammonia (82-0-0), urea (46-0-0) and UAN (28-0-0) with the combination of concentrating fertilizer (safely away from the seed-row) and placing it beneath the soil surface dramatically reducing potential for environmental losses while maintaining seed safety compared to previous options. Fall applications of N have always been popular, at least on a regional basis, in that fertilizer prices are usually lower, and applying N in a separate pass can reduce logistic pressure during spring seeding when labour and time are more limited. It is primarily for these logistical reasons that an increasing number of producers have been considering two-pass seeding/fertilization strategies. While the N fertilizer timing and/or placement options associated with two-pass seeding/fertilizer systems are usually not ideal, enhanced efficiency formulations (EEF) can reduce the potential risks associated with applying N well ahead of peak crop uptake (i.e. fall applications) or sub-optimal placement methods (i.e. surface broadcast). The most common examples of EEF products include polymer coatings (i.e. ESN), volatilization inhibitors (i.e. Agrotain) and volatilization/nitrification inhibitors (i.e. Super Urea) Enhanced efficiency N products are more expensive than their more traditional counterparts; however, this higher cost may be justified by the potential improvements in efficacy and logistics advantages of alternative fertilization practices.

This project is relevant to producers because, for many, there has been a movement back to two-pass seeding fertilization systems in order to increase efficiency at seeding. While the intent is not to encourage growers to revert to two-pass seeding/fertilization system, it is important that they have flexibility in how they choose to manage N fertility on their farms. By demonstrating different N fertilization strategies according to the 4R principles and providing data on their efficacy relative to benchmark BMPs, we can help farmers make informed decisions while taking into consideration both the advantages and potential disadvantages of the various options. Spring wheat is a good candidate for this project since it is a rotationally and economically important crop in Saskatchewan and sensitive to N management with regard to both yield and grain protein concentrations. A similar project was also conducted with canola (ADOPT #20170320).

Methodology and Results

9. Methodology:

A field trial with CWRS wheat was initiated in the spring of 2018 near Indian Head, Saskatchewan (50.546 N, 103.569 W) to demonstrate the overall crop response to N rate and a selection of management strategies where N, application timing, and placement were varied. Indian Head is situated in the thin-Black soil zone of southeast Saskatchewan and the soil is classified as an Indian Head clay with typical organic matter concentrations of 4.5-5.5%. The design was a four-replicate RCBD with 14 treatments (Table 1). The rates were 0, 0.5, 1 and 1.5x of a baseline soil-test recommendation rate of 130 kg N/ha (residual NO_3-N plus fertilizer N). The placement/timing options were side-banding at seeding, fall surface application and fall in-soil band while the forms included untreated urea, Agrotain (volatilization inhibitor), SuperUrea (volatilization plus denitrification inhibitors) and ESN (polymer coated urea). ESN was excluded from the fall broadcast treatments due to budget limitations and because broadcasting this product without incorporation is generally not recommended in potentially dry environments. The 1x rate was utilized in all N management strategies and was chosen to be close to optimal for maximizing yield potential but not excessive and therefore likely to reduce our ability to detect differences in efficiency amongst the treatments.

Table 1. Wheat 4R N Management treatments evaluated at Indian Head in 2018

#	Rate (soil + fertilizer)	Form	Time	Placement
1	0x (10 kg N/ha)	Urea	At Seeding	Side-band
2	0.5x (70 kg N/ha)	Urea	At Seeding	Side-band
3	1.0x (130 kg N/ha)	Urea	At Seeding	Side-band
4	1.5x (190 kg N/ha)	Urea	At Seeding	Side-band
5	1.0x (130 kg N/ha)	Agrotain	At Seeding	Side-band
6	1.0x (130 kg N/ha)	Super Urea	At Seeding	Side-band
7	1.0x (130 kg N/ha)	ESN	At Seeding	Side-band
8	1.0x (130 kg N/ha)	Urea	Late Fall	Surface Broadcast
9	1.0x (130 kg N/ha)	Agrotain	Late Fall	Surface Broadcast
10	1.0x (130 kg N/ha)	Super Urea	Late Fall	Surface Broadcast
11	1.0x (130 kg N/ha)	Urea	Late Fall	In-soil Band
12	1.0x (130 kg N/ha)	Agrotain	Late Fall	In-soil Band
13	1.0x (130 kg N/ha)	Super Urea	Late Fall	In-soil Band
14	1.0x (130 kg N/ha)	ESN	Late Fall	In-soil Band

Selected agronomic information along with dates of certain measurements are provided in Table 2. The field trial was established in the fall of 2017 with soil nutrient sampling (September 21) and fertilizer applications (October 17). The previous crop was glufosinate ammonium tolerant canola and the site was heavy harrowed prior to flagging. As required by protocol, fall-applied N fertilizer was either broadcast on the soil surface (no incorporation) or placed 4-4.5 cm beneath the surface in bands spaced 30 cm apart. For the side-band treatments, N fertilizer was placed at a similar depth as the fall band applications and was below and to the side of the seedrow. Fertilizer banding and seeding was completed with an eight opener SeedMaster drill. The variety CDC Landmark VB was seeded on May 16. Nitrogen was applied as per protocol and 30-15-15 kg P_2O_5-K_2O-S/ha was applied to all treatments except Trt. 1 where no fertilizer was applied and it was assumed that N would be the most limiting nutrient. Weeds were controlled using registered pre-emergent and in-crop herbicides and foliar fungicides were applied at both the flag-leaf stage and early heading to prevent disease. No insecticides were required. Pre-harvest glyphosate was applied on August 10 (past physiological maturity) and the centre five rows of each plot were straight-combined using a Wintersteiger plot harvester on August 14.

Various data were collected over the growing season and from the harvested grain samples. The average NDVI of each plot was measured using a handheld GreenSeeker at three separate dates starting at the beginning of flag leaf emergence and continuing through full flag. The relative chlorophyll content of the flag leaf was measured using a SPAD-502 meter at two stages; once at the full flag-leaf stage (June 26) and again at the early dough stage, prior to senescence in the upper canopy (July 20). Leaves from ten randomly selected plants per plot were measured and averaged at both stages. No lodging was observed in any treatments, therefore detailed ratings were not completed. Grain yields were determined by weighing the harvested grain samples and are corrected for dockage and to a uniform moisture content of 14.5%. Grain protein concentrations were determined using an NIR instrument.

All response data were analysed using the Mixed procedure of SAS with treatment effects considered fixed and replicate effects treated as random. Individual treatment means were separated using Fisher's protected LSD test and contrasts were used to both describe the response to N rate and compare specific groups of treatments (i.e. side-band vs. fall broadcast; urea vs. Agrotain). All treatment effects and differences between means were considered significant at $P \leq 0.05$.

Table 2. Selected agronomic information for the wheat 4R N management demo at Indian Head in 2018.

Factor / Field Operation	Indian Head 2017-18
Previous Crop	Canola
Soil Sampling	September 21, 2017
Fall N Applications	October 17, 2017
Pre-emergent herbicide	894 g glyphosate/ha May 11, 2018
Seeding Date	May 16, 2018
NDVI	June 18, 21, & 25, 2018
In-crop Herbicide 1	280 g bromoxynil/ha + 280 g MCPA/ha + 15 g proxsulam/ha June 7, 2018
In-crop Herbicide 2	554 g MCPA ester/ha + 99 g clopyralid/ha + 62 g pinoxaden/ha June 18, 2018
NDVI	June 18, 21, & 25, 2018
SPAD	June 26 & July 20, 2018
Foliar Fungicide 1	75 g azocystrobin/ha + 125 g propiconazole/ha June 27, 2018
Foliar Fungicide 2	100 g prothioconazole/ha + 100 g tebuconazole/ha July 7, 2018
Pre-harvest Herbicide	894 g glyphosate/ha August 10, 2018
Harvest date	August 14, 2018

10. Results:

Growing season weather and residual soil nutrients

The fall N treatments were applied relatively late in the season under cool conditions which is preferred to mitigate losses; however, the winter was dry with well below normal snow cover from November through February. While March snowfall improved conditions for seeding, the site was well drained and did not stay saturated for long in the early spring. Weather data for the 2018 growing season at Indian Head is provided with the long-term (1981-2010) averages in Table 3. Although there was less initial sub-soil moisture than previous seasons, the wheat was seeded into adequate soil moisture for germination and timely late-May/early-June rains got spring seeded crops in the area off to a strong start. For May and June combined, precipitation was 88% of the long-term (1981-2010) average; however, July and August were much drier with only 34 mm of total precipitation, or 30% of the long-term average. Temperatures for the 2018 growing season were well-above average in May and, to a lesser extent, June but below average in July and approximately average in August. Over the four-month period, the mean temperature in 2018 was 16.4 °C compared to an average of 15.6 °C. Overall, the yield potential of the wheat was limited to a certain extent due to the dry conditions but maturity was early and grain quality was generally high.

Table 3. Mean monthly temperatures and precipitation amounts along with long-term (LT; 1981-2010) averages for the 2018 growing season (May through August) at Indian Head, SK.

Year	May	June	July	August	Avg. / Total
	------------ Mean Temperature (°C) ------------				
IH-2018	13.9	16.5	17.5	17.6	16.4
IH-LT	10.8	15.8	18.2	17.4	15.6
	------------ Precipitation (mm) ------------				
IH-2018	23.7	90.0	30.4	3.9	148
IH-LT	51.8	77.4	63.8	51.2	244

Results from the composite soil sample (0-15 cm, 15-60 cm) collected in the fall are provided in Table 4. The site had a pH of 8.2 and soil organic matter content of 3.8% in the upper 15 cm profile which is relatively low for the region. Residual soil NO_3-N was extremely low and likely to be limiting; therefore, the site was ideal for evaluating the relative efficiency of contrasting N management strategies. Phosphorus levels were also extremely low while K and S levels were considerably higher; however, these nutrients were intended to be non-limiting in all treatments.

Table 4. Selected soil test results for wheat 4R N management demo at Indian Head, Saskatchewan (2018).

Attribute / Nutrient	0-15 cm	15-60 cm	0-60 cm
pH	8.2	8.3	–
S.O.M. (%)	3.8	–	–
NO_3-N (kg/ha)[Z]	3	6	9
Olsen-P (ppm)	2	–	–
K (ppm)	447	–	–
S (kg/ha)	12	18	40

Field Trial Results

Individual treatment means and contrast results are deferred for the Appendices (Tables 5 and 6) while key results are presented graphically below in Figs. 1-10.

While NDVI is affected by factors other than nutrient status such as crop type and growth stage, the relative values can be useful for quantifying differences in growth amongst the treatments and have been shown to be well correlated with grain yield. Measurements were completed three times over a seven-day period (up to the flag leaf stage) and the results were averaged prior to analyses. The overall F-test for wheat NDVI was highly significant ($P < 0.001$) with values ranging from 0.350-0.585. The orthogonal contrasts were also significant ($P < 0.001$) showing a large increase in NDVI from the control to the 0.5x rate but no further changes as the N rate was increased beyond this point (Fig. 1). Differences in NDVI amongst the fertilized treatments were rare at the flag-leaf stage (Fig. 2). The only significant contrast comparing groups of treatments occurred between side-banded versus fall broadcast N ($P = 0.009$; Table 6) and, unexpectedly, favoured the fall broadcast treatments. It is possible that, under the dry conditions and particularly with untreated urea, there was some stand reduction associated with side-banded N which could have reduced NDVI. This possibility cannot be verified as emergence counts were not completed but may be supported to a certain extent by the fact that NDVI for side-banded ESN was higher than for the equivalent rate of side-banded urea. Due to its polymer coating and slow release, ESN is known to be relatively safe for seed-row placement and, as such, has often been recommended for these properties, particularly with single shoot seeding equipment where the only option is to place fertilizer with the seed. That being said, conditions for emergence were good overall, no visibly apparent establishment issues or differences between plots were observed, and this response was not observed in the canola demonstration conducted at a nearby location.

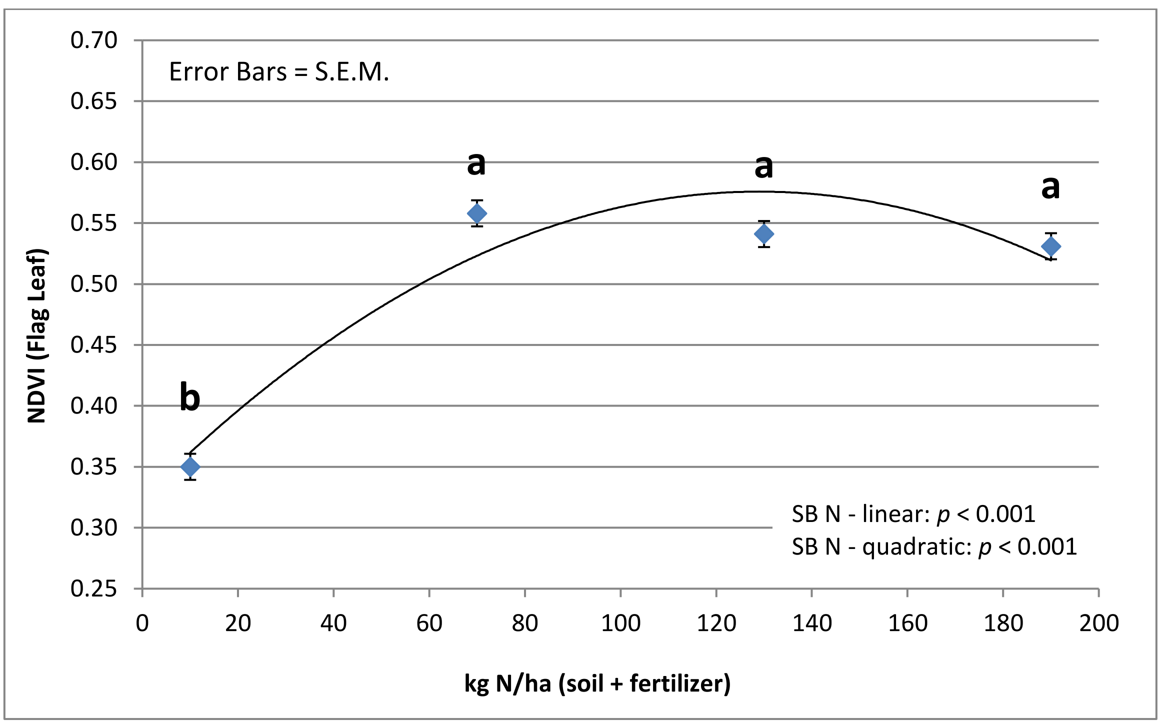

Figure 1. Side-banded urea rate effects on NDVI in wheat (3 dates from June 18-25, early through full flag-leaf stage) at Indian Head in 2018.

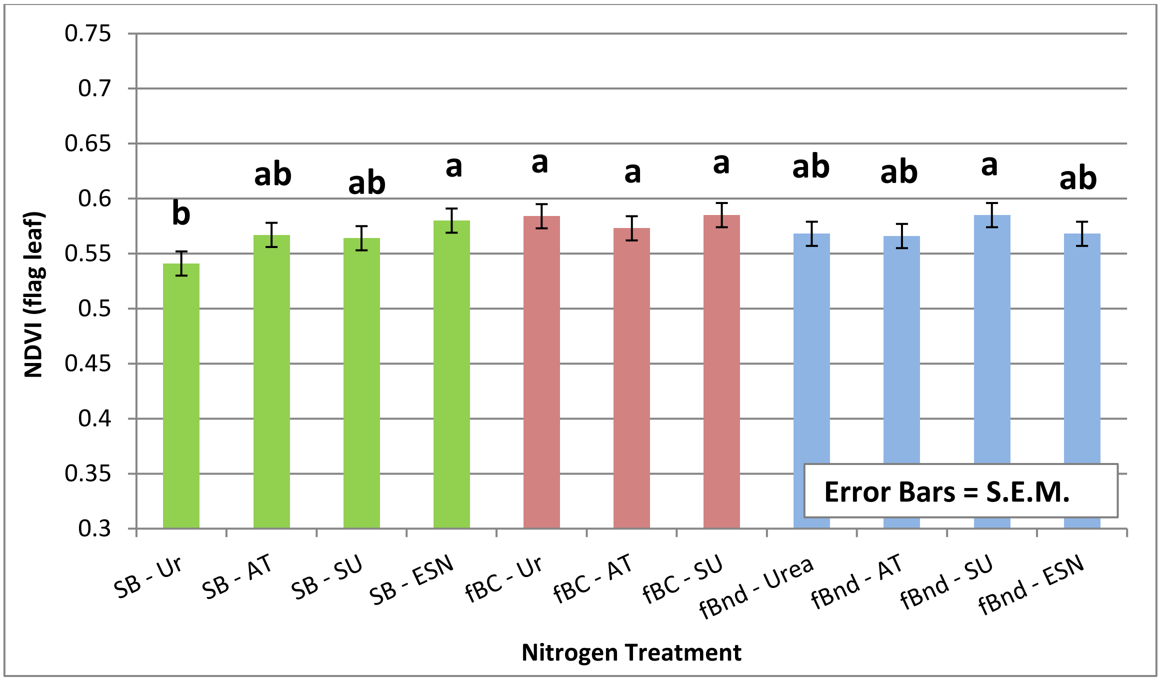

Figure 2. Nitrogen form/placement/timing effects on NDVI in wheat (3 dates from June 18-25, early through full flag-leaf stage) at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

The first set of leaf chlorophyll measurements coincided with the last of the NDVI measurements and the trends were similar; however, this measure appeared to be more sensitive to N status with greater separation between rates. The mean SPAD values were lowest in the control, intermediate at the 0.5x N rate and highest at the 1-1.5x rates (Fig. 3). The SPAD values at the flag-leaf stage were similar amongst all treatments that received the 1x rate of fertilizer, regardless of form or timing/placement method (Fig. 4). This observation was consistent with all of the group contrast comparisons, none of which were significant (*P* = 0.302-0.912; Table 6).

Roughly three weeks later at the late milk/early dough stage, the treatment effects on SPAD measurements followed similar trends but with greater separation between the control and fertilized measurements compared to the earlier measurements (Fig. 5). While the groupings from the means separations between the 0-1.5x rates of side-banded urea were identical for the two dates, the values in the fertilized treatments increased substantially over this period while those in the control were essentially unchanged. Although the mean SPAD values amongst the different N strategies (1x N rate) were slightly more variable at the later date, significant differences between treatments were rare and none of the contrast comparisons were significant (*P* = 0.271-0.968) which would indicate that all forms/placement/timing options were performing similarly.

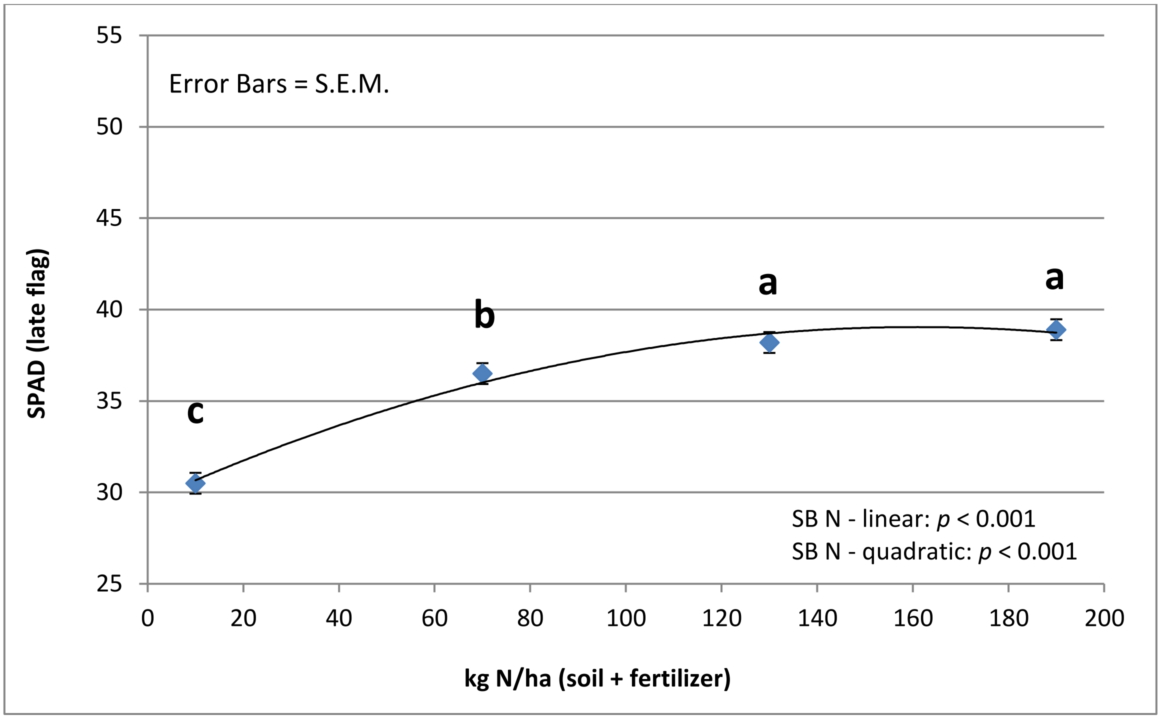

Figure 3. Side-banded urea rate effects on leaf chlorophyll (SPAD) measurements in wheat (June 26, late flag leaf stage) at Indian Head (2018).

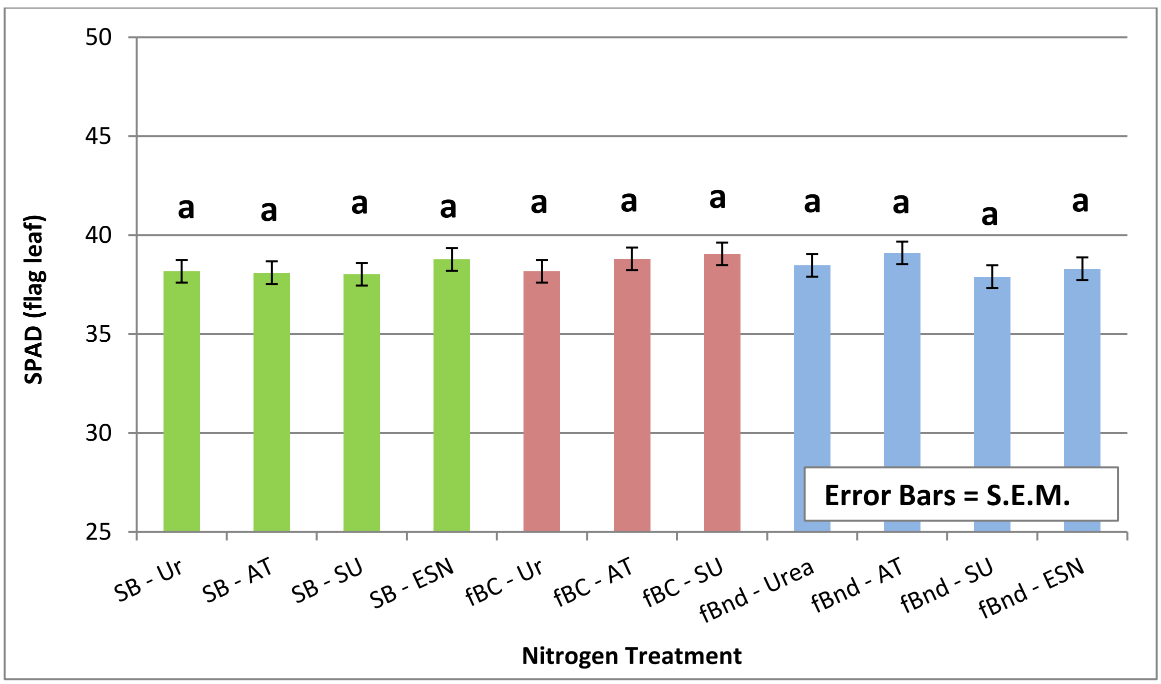

Figure 4. Nitrogen form/placement/timing effects on leaf chlorophyll (SPAD) measurements in wheat (June 26, late-flag leaf stage) at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

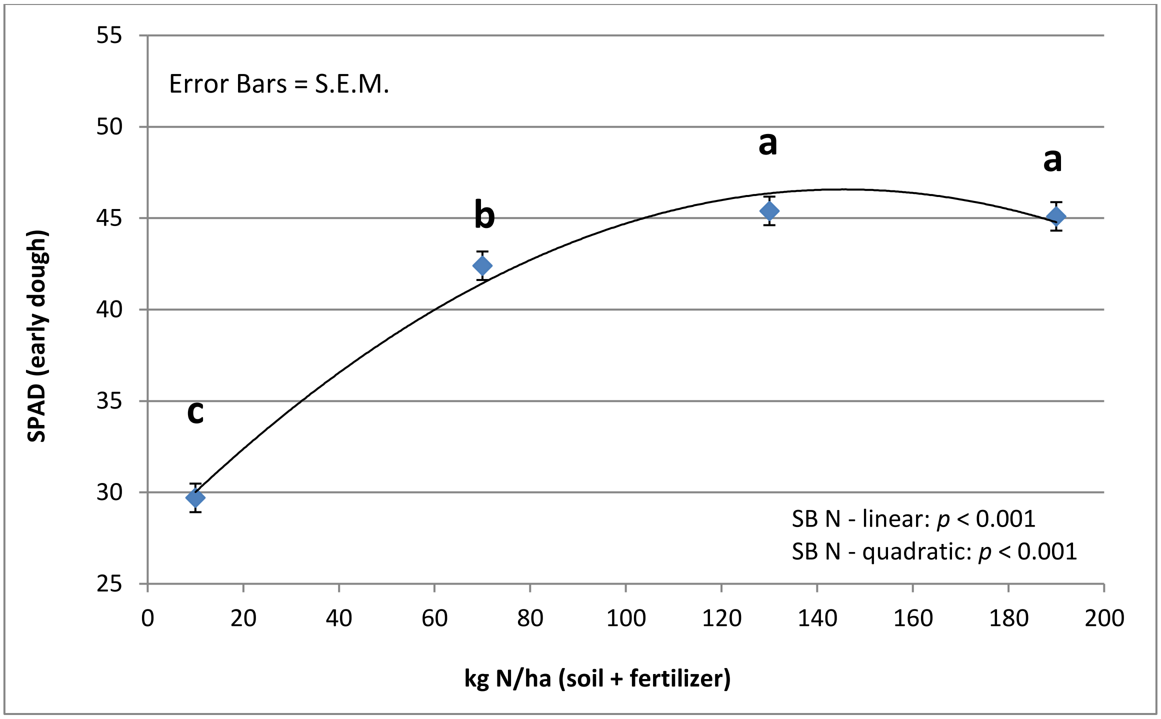

Figure 5. Side-banded urea rate effects on leaf chlorophyll (SPAD) measurements in wheat (July 20, early dough stage) at Indian Head (2018).

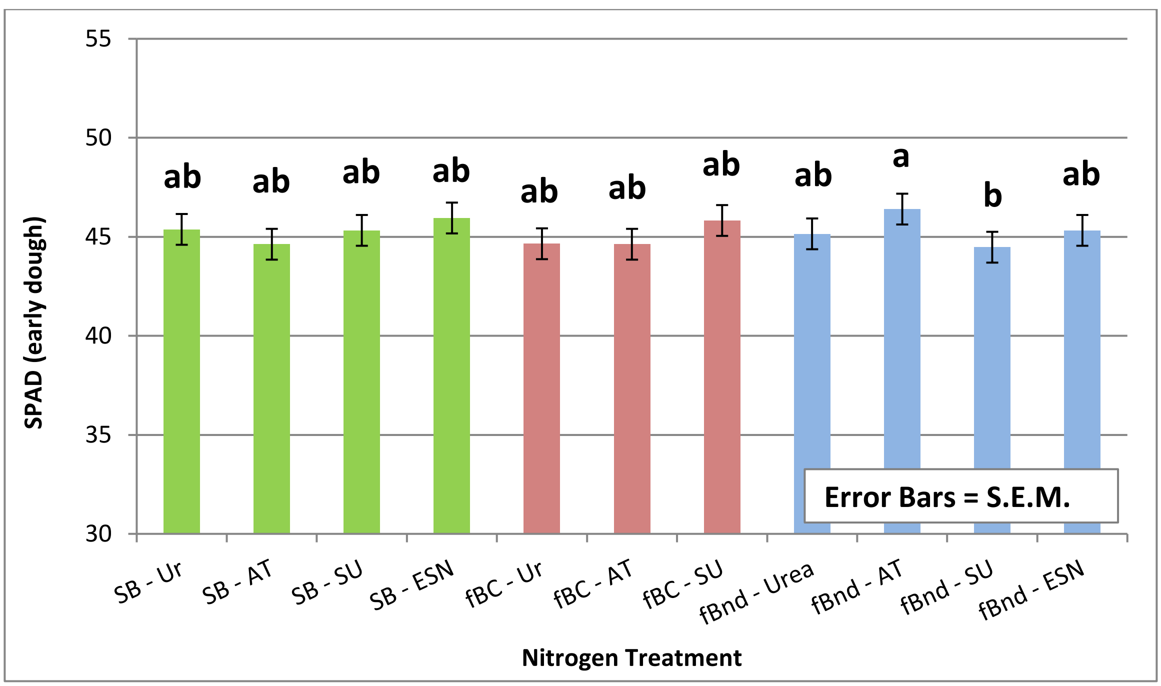

Figure 6. Nitrogen form/placement/timing effects on leaf chlorophyll (SPAD) measurements in wheat (July 20, early dough stage) at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

With the late-season drought, overall yields were considered somewhat below average but still adequate considering the conditions. There was a strong yield response to N fertilizer with yields increasing from 1858 kg/ha to 3205 kg/ha (by 72%) from the control to the 0.5x rate (70 kg total N/ha; Fig. 7). Yield increases with subsequent increases in N rate were small and not statistically significant with only a 5% further yield increase going from the 0.5x to 1.5x rates and a maximum of 3365 kg/ha. Although variability was rather high and differences amongst the N strategies were relatively few, the tendency was for the lowest yields with fall broadcast urea and Agrotain and the highest yields with fall banded ESN. The majority of N management strategies produced yields that were intermediate and not significantly different from any other treatments. (Fig. 8). Furthermore, none of the contrasts comparing either placement/timing options (P = 0.262-0.491) nor N forms (P = 0.206-0.821) were significant.

As expected, the N treatments affected wheat protein concentrations with a highly significant F-test and an observed range of 10.1-14.6% amongst individual treatments (Table 5). The overall rate effect on grain protein was strong with significant linear and quadratic orthogonal contrasts ($P < 0.001$; Fig. 9; Table 6). Although protein tended to climb further going from the 1-1.5x N rates (from 14.2% to 14.5%), the values did not significantly differ between the two highest rates. Percent protein in the control was only 10.1% while at the 0.5x rate the average value was intermediate at 12.1%. Unlike yield where there was no effect, the contrasts comparing the three timing/placement options (Table 6) were all significant (P < 0.001-0.019) and showed the highest protein concentrations with side-banding (14%), followed by fall in-soil banding (14.1%), and finally fall surface-broadcast applications (13.5%). No differences in grain protein were detected amongst the various N fertilizer forms when averaged across timing/placement methods (P = 0.166-0.876). For individual treatments, differences between forms within timing/placement options were not significant and any trends were somewhat inconsistent; however, there was a tendency for slightly higher protein with SuperUrea compared to untreated urea or Agrotain specifically amongst the fall surface-broadcast treatments (Fig. 10). Grain protein concentrations with fall-broadcast SuperUrea did not significantly differ from those achieved in six out of eight treatments where the N was banded beneath the soil surface. In contrast, values for fall surface-broadcast urea and Agrotain were significantly lower than all of the in-soil banded treatments.

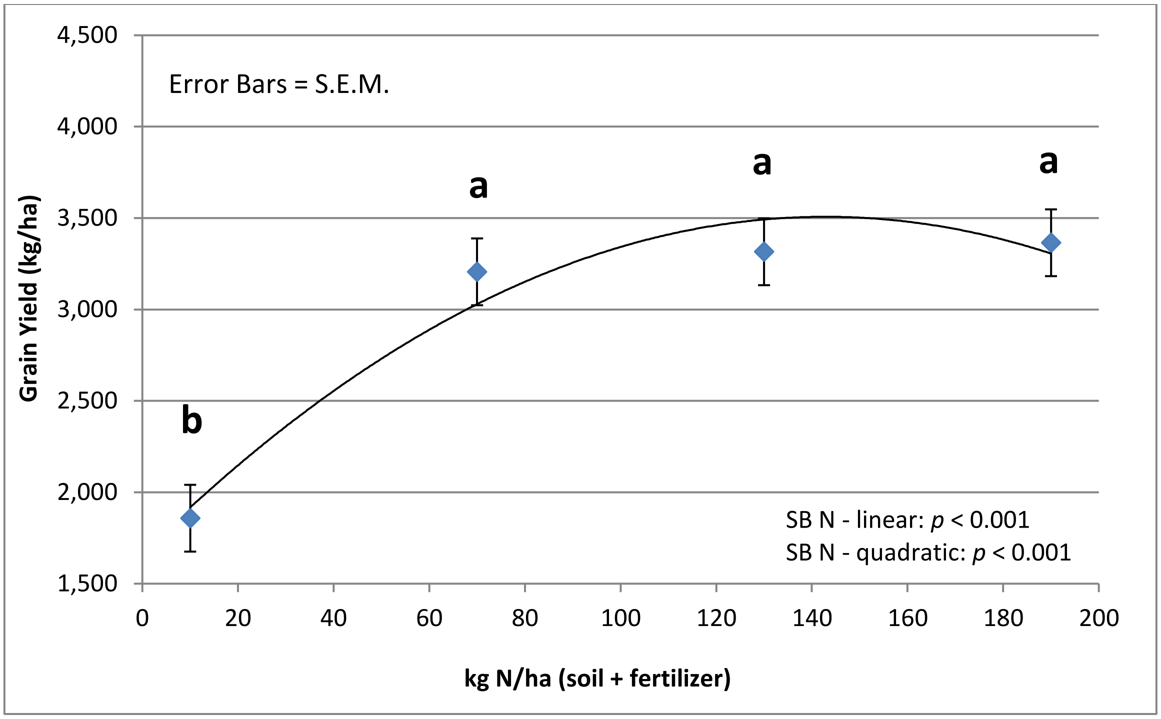

Figure 7. Side-banded urea rate effects on wheat grain yield at Indian Head (2018).

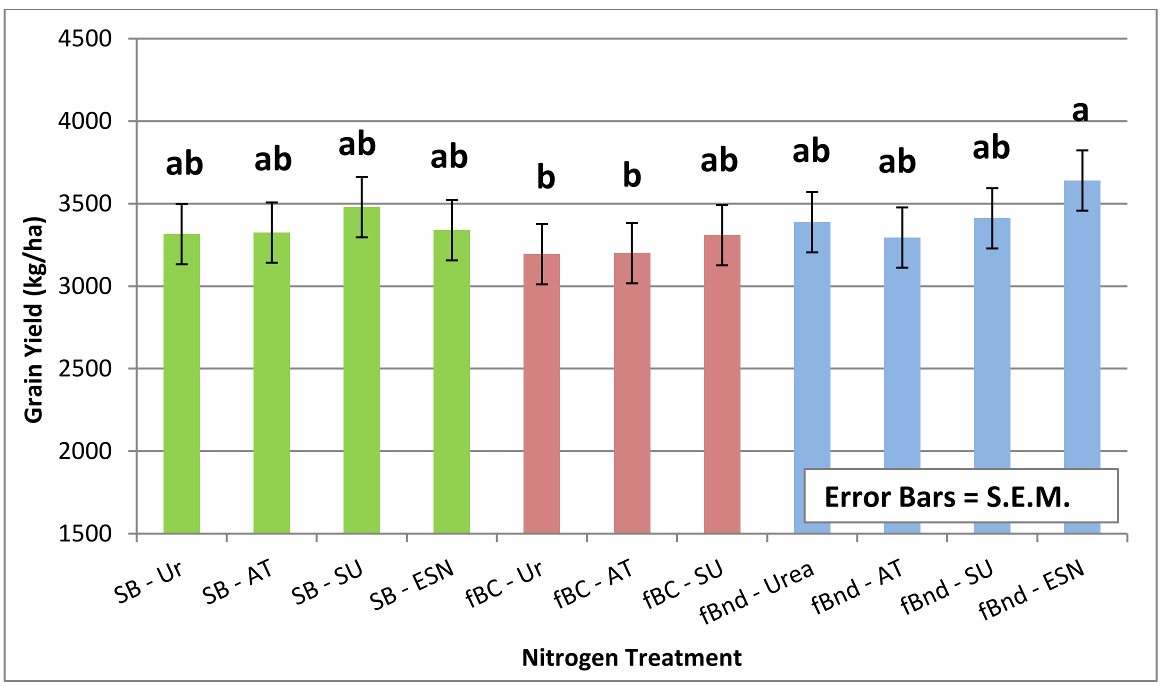

Figure 8. Nitrogen form/placement/timing effects on wheat grain yield at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

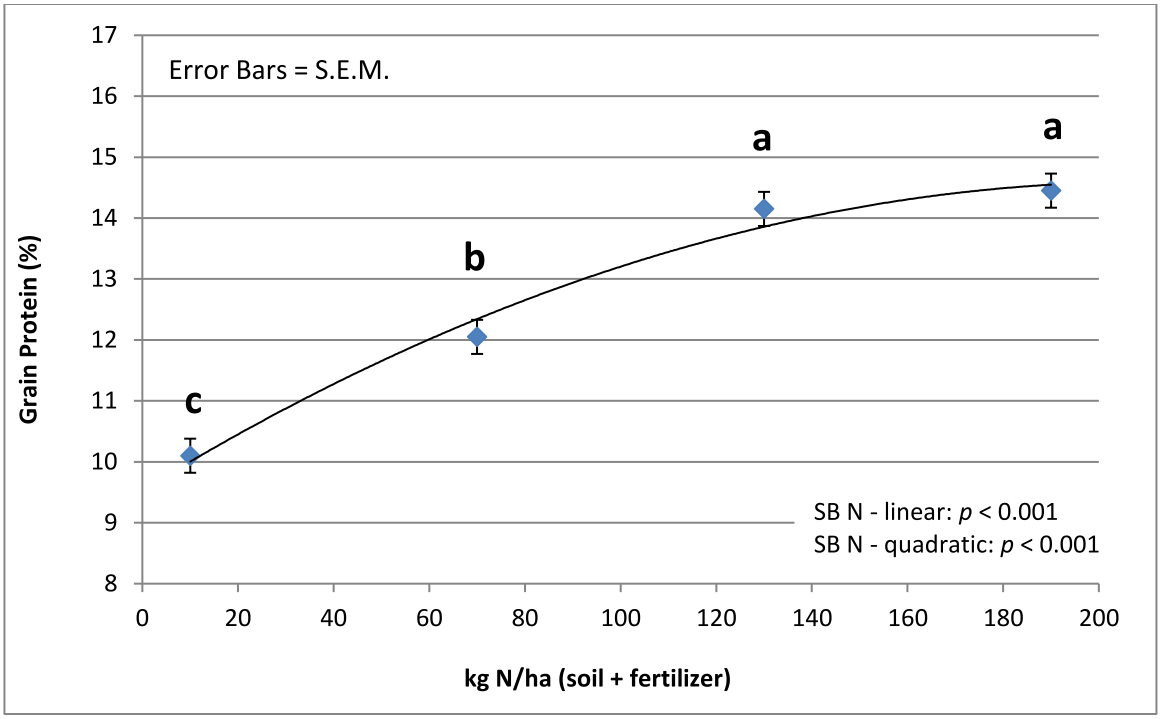

Figure 9. Side-banded urea rate effects on wheat grain protein concentrations at Indian Head (2018).

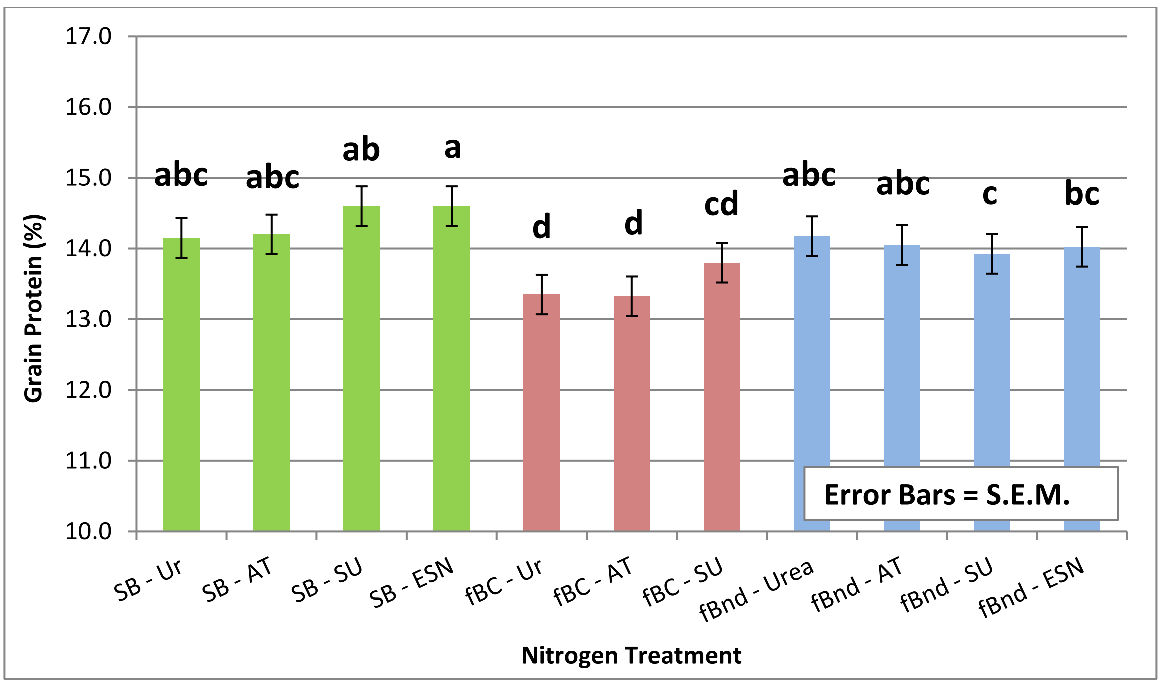

Figure 10. Nitrogen form/placement/timing effects on wheat grain protein concentrations at Indian Head (2018). SB – side-band, fBC – fall surface broadcast, fBnd – fall in-soil band, Ur - untreated urea, AT–Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea.

Extension Activities and Dissemination of Results
This project was discussed and the plots were toured by approximately 200 guests at the Indian Head Crop Management Field Day on July 17, 2018. In addition to Chris Holzapfel discussing the specific field trial and past results from similar projects, Dr. Dan Heaney (Fertilizer Canada) also provided a broader discussion of 4R Nutrient Stewardship designation and certification opportunities. The full project report will be made available online on the IHARF website (www.iharf.ca) and potentially elsewhere in the winter of 2018-19. Results may also be made available through a variety of other media (i.e. oral presentations, popular agriculture press, fact sheets, etc.) as opportunities arise and where appropriate. This project was conducted at multiple Agri-ARM locations and results will be compiled where appropriate for future extension purposes.

Conclusions and Recommendations
Despite the dry weather and somewhat below-average yield potential, this project demonstrated strong wheat responses to N fertilization along with the relative responses associated with several contrasting N management strategies. The in-season NDVI and SPAD measurements were both reasonably good indicators of the potential yield response to N. While the SPAD measurements tended to be more sensitive to the actual N status of the plants, NDVI has the advantage of being easier to measure across large areas and is generally better suited for characterizing spatial variability in productivity. Neither measurement was sensitive enough to pick up differences in protein concentration amongst the different placement/timing options. Overall, the eventual N response was reasonably strong with a maximum yield increase of 87% over the control with fertilization and protein increases from 10.1% to as high as 14.5% at the highest N rate. Focussing on timing/placement, all of the options resulted in a strong N response and, particularly for yield, significant differences amongst individual treatments were rare with no significant contrasts comparing timing/placement options or forms. Protein, however, was more sensitive to N management with the highest values achieved with side-banding (14.3%), followed by fall in-soil banding (14.1%) and finally fall surface broadcast applications (13.5%). The lack of significant contrasts comparing N fertilizer forms or differences between forms within timing/placement options for both yield and protein suggests that the wheat responded similarly to all forms under the conditions encountered. The greatest exception to this was specifically for fall, surface-broadcasting where grain protein with SuperUrea (13.8%) tended to be higher than with untreated urea or Agrotain (13.3-13.4%) and did not significantly differ from six out of eight individual treatments where the N was banded beneath the soil surface. While this is true with many subjects of agronomic research and demonstration, N fertilizer management is very much affected by weather events and environmental conditions; therefore, the actual results that producers might experience with these N forms and placement options can vary greatly.

Supporting Information

11. Acknowledgements:

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Inputs and Crop protection products used for both plot maintenance and treatments were provided in-kind by Bayer CropScience, Corteva Agriscience, Koch Agronomic Services, and Nutrien. IHARF also has a strong working relationship and memorandum of understanding with Agriculture & Agri-Food Canada.

12. Appendices

Table 5. Treatment means, overall F-tests, and measures of variability for wheat NDVI, SPAD measurements, grain yield and grain protein concentrations. Means within a column followed by the same letter do not significantly differ (Fisher's protected LSD test, *P* ≤ 0.05).

Treatment [Z]	NDVI (average)	SPAD (flag)	SPAD (milk)	Yield (kg/ha)	Protein (%)
1. 0.0x N	0.350 d	30.5 c	29.7 d	1858 c	10.1 g
2. 0.5x N SB Ur	0.558 abc	36.5 b	42.4 c	3206 b	12.1 f
3. 1.0x SB Ur	0.541 bc	38.2 a	45.4 ab	3316 ab	14.2 a-d
4. 1.5x SB Ur	0.531 c	38.9 a	45.1 ab	3365 ab	14.5 abc
5. 1.0x SB AT	0.567 ab	38.1 a	44.6 ab	3325 ab	14.2 a-d
6. 1.0x SB SU	0.564 ab	38.0 ab	45.3 ab	3479 ab	14.6 ab
7. 1.0x SB ESN	0.580 a	38.8 a	46.0 ab	3339 ab	14.6 a
8. 1.0x fBC Ur	0.584 a	38.2 a	44.7 ab	3194 b	13.4 e
9. 1.0x fBC AT	0.573 a	38.8 a	44.6 ab	3200 b	13.3 e
10. 1.0x fBC SU	0.585 a	39.1 a	45.8 ab	3309 ab	13.8 de
11. 1.0x fBnd Ur	0.568 ab	38.5 a	45.2 ab	3388 ab	14.2 a-d
12. 1.0x fBnd AT	0.566 ab	39.1 a	46.4 a	3295 ab	14.1 a-d
13. 1.0x fBnd SU	0.585 a	37.9 ab	44.5 b	3411 ab	13.9 cd
14. 1.0x fBnd ESN	0.568 ab	38.3 a	45.3 ab	3640 a	14.0 b-d
$LSD_{0.05}$	0.0301	1.57	1.89	400.9	0.56
S.E.M.	0.0107	0.57	0.78	182.7	0.28
Pr > F (p-value)	<0.001	<0.001	<0.001	<0.001	<0.001

[Z] Including residual NO_3-N, total N rates were 10 (0.0x), 70 (0.5x), 130 (1.0x), and 190 kg N/ha (1.5x); SB (side band at seeding), fBC (fall surface broadcast) and fBnd (fall in-soil band) Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea

Table 6. Results of orthogonal contrasts and group comparisons for N management effects of selected wheat variables. Data were analyzed using the Mixed procedure of SAS and p-values greater than 0.05 indicated that a response or difference between groups of means was not significant.

Contrast	NDVI (average)	SPAD (flag)	SPAD (milk)	Yield (kg/ha)	Protein (%)
	--------------------	--------------------	p-value	--------------------	--------------------
N Rate - linear	<0.001	<0.001	<0.001	<0.001	<0.001
N Rate – quadratic	<0.001	<0.001	<0.001	<0.001	<0.001
fBC vs. fBnd	0.358	0.685	0.571	0.262	0.001
SB vs. fBC	0.009	0.208	0.890	0.233	<0.001
SB vs. fBnd	0.234	0.655	0.968	0.491	0.019
Ur vs. AT	0.631	0.388	0.771	0.821	0.876
Ur vs. SU	0.131	0.912	0.782	0.384	0.217
Ur vs. ESN	0.072	0.701	0.573	0.331	0.447
AT vs. SU	0.297	0.451	0.988	0.275	0.166
AT vs. ESN	0.466	0.910	0.851	0.206	0.376
SU vs. ESN	1.000	0.302	0.271	0.752	0.703

^{Z} SB (side band at seeding), fBC (fall surface broadcast) and fBnd (fall in-soil band) Ur - untreated urea, AT– Agrotain (NBPT) treated urea, SU – SuperUrea (NBPT + DCD), ESN – polymer coated urea

Figure 11. Wheat grown without N fertilizer at Indian Head, Saskatchewan (2018).

Abstract

13. Abstract/Summary:

A field trial was established near Indian Head, Saskatchewan to promote 4R N stewardship and to demonstrate the overall wheat response to N fertilization along with the relative performance of N fertilizer management strategies where the forms, timing of application and placement were varied. The weather was dry with below average snowfall the preceding winter and only 61% of the long-term average growing season precipitation. For the first objective, 0x, 0.5x, 1.0x, and 1.5x of a baseline rate of 130 kg N/ha (soil residual plus fertilizer) was supplied as side-banded urea. Data collection included NDVI, leaf chlorophyll (SPAD), yield, and protein – all of which were affected by N rate in a similar manner. The maximum yield increase was 87% over the control with similar yields between the 1-1.5x rates while protein ranged from 10.1% in the control to 14.4% at the highest N rate. Focussing on N management strategies, the demonstration included four forms (untreated urea, Agrotain, SuperUrea, and ESN) and three timing/placement options (fall surface-broadcast, fall in-soil band, and side-band). Averaged across forms, yields did not significantly differ between timing/placement options; however, grain protein was highest with side-banding (14.3%), followed by fall in-soil banding (14.1%), and finally fall surface-broadcast applications (13.5%). All N forms performed similarly under the conditions encountered when averaged across timing/placement methods. Specifically for fall-surface broadcast N, grain protein concentrations with SuperUrea tended to be higher than for urea or Agrotain and did not differ from 75% of the individual treatments where N was in-soil banded. Nitrogen fertilizer management is sensitive to weather and environmental conditions; therefore, the actual results that producers might experience with these strategies may vary greatly. Broadly speaking, soil testing is advised to account for the inherent fertility of the soil and better determine appropriate rates. Side-banding continues to be recommended as a safe and effective practice that will perform consistently across a broad range of environmental conditions. In the current demonstration, fall in-soil banding was also reasonably effective and, although the benefits can vary depending on the specific conditions encountered, enhanced efficiency fertilizer products can improve performance particularly with potentially risky practices such as fall-surface broadcasting.