LIQUID N FERTILIZER EVALUATION IN SPRING WHEAT

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ABSTRACT

Several liquid N products are currently marketed for fertilization in various crops, including spring wheat. Urea ammonium nitrate (UAN) - the most commonly used liquid N fertilizer - is associated with crop damage due to corrosiveness. This study aimed to answer the following questions: (1) Are liquid urea (LU) and High NRG-N (HNRGN) superior to UAN in improving spring wheat grain yield and protein content? And (2) what is the optimum dilution ratio of foliar fertilizers and the threshold at which spring wheat grain yield is reduced due to leaf burn? A total of 6 site-years (3 experimental sites and 2 growing seasons) data are summarized in this report. The results showed that the dilution ratio had no significant effect on grain yield, protein, protein yield, nitrogen (N) uptake or N use efficiency (NUE). Although HNRGN has resulted in superior NUE values, LU has performed well across the site-years in terms of grain yield and protein production. Due to much higher HNRGN source per unit of N compared to LU and UAN, we recommend LU as most appropriate liquid fertilizer N source for spring wheat production in the Northern Great Plains region.

INTRODUCTION

The Ohio State University's Extension (Johnson, 1999) survey revealed that "Are liquid fertilizers equal to or better than dry fertilizers?" and "Are liquid fertilizers more available than granular fertilizers?" - are among questions most asked by crop producers. Conflicting results in comparing liquid and dry N products in wheat are widely reported. Many researchers found that there are no substantial differences in the efficiency of liquid and dry fertilizers (Silva, 2011; The Mosaic Company, 2013). Others recorded significant ammonia loss from liquid N sources, and lower NUE (Watson et al., 1992). Some studies indicated that liquid N sources may be superior in terms of crop yield and quality and more profitable, including considering the per-unit cost advantage of the dry product over the liquid (Boyer et al., 2010). Furthermore, they have been found to be more environmentally sound, due to higher plant availability and efficient uptake (Holloway et al., 2001; Lombi et al., 2004). Currently, several fluid N fertilizers are currently available on the market, including UAN, LU, and HNRGN. Urea ammonium nitrate (28-0-0 or 32-0-0) is a non-pressurized solution – is the most widely used liquid N product. The liquid mix of urea and ammonium nitrate offers fast acting and long lasting plant nutrient supply: nitrate-N ensures quick response, and the ammonic-N - long-lasting response; the water soluble organic N in urea supplies continuous nutrition (simplot.com, 2012). Liquid urea is a water-based urea solution (20-0-0). Some benefits of LU include slower plant uptake for maintaining adequate N levels within the soil-plant system. Liquid urea is recommended for application during the warm time in the growing season for rapid correction of N deficiency (fertizona.com, 2012). High NRG-N, especially formulated to minimize N loss and improve uptake by plants, contains several forms of N, sulfur (S), and trace amounts of chlorophyll building elements - iron (Fe), magnesium (Mg), manganese (Mn), and zinc (Zn) as well as several proprietary enhancements. Liquid urea and High NRG-N are less corrosive and posses a lesser risk for plant damage due to leaf burn (Brown and Long, 1988; agroliquid.com, 2012). The objectives of this study were: i) to compare the efficacy of liquid N fertilizers (UAN, liquid urea, and HNRGN) applied to spring wheat, and ii) to determine the optimum N rate and dilution ratio of liquid fertilizers and the threshold at which spring wheat grain yield is reduced due to leaf burn.

METHODS

This field study was conducted in 2012 and 2013 at three locations: two dryland - at Western Triangle Agricultural Research Center (WTARC, near Conrad, MT) and in a cooperating producer's field (Jack Patton, Choteau County, MT), and one irrigated – at Western Agricultural Research Center (near Corvallis, MT). Hard red spring wheat (cv. Choteau) was seeded into plots measuring 5 by 25 feet at the seeding rate of 17 plants per sq foot, utilizing the drill. At-seeding N fertilizer was applied with the seed. Appropriate weed and pest management control were employed when necessary. Treatment structure is reported in Table 1.

Table 1. Treatment structure, Patton, WTARC, and WARC, 2012 and 2013.

Trt	Preplant N Fertilizer (urea) Rate, lb N/a	Topdress N Fertilizer Source	Topdress N Fertilizer Rate, lb N/a	Topdress N Fertilizer/Water Ratio, %
1	0	-	-	-
2	80	UAN	40	100/0
3	80	UAN	40	66/33
4	80	UAN	40	33/66
5	80	LU	40	100/0
6	80	LU	40	66/33
7	80	LU	40	33/66
8	80	HNRGN	40	100/0
9	80	HNRGN	40	66/33
10	80	HNRGN	40	33/66

At seeding, urea was applied at 80 lb N/a to all treatments except for the unfertilized check plot. At Feekes 5 growth stage (early tillering), 40 lb N/a was applied utilizing an all-terrain vehicle (ATV)-mounted stream-bar equipped sprayer. Three liquid N sources – UAN, LU, and High NRG-N and three dilution ratios of fertilizer%/water% - 100/0, 66/33, and 33/66 - were evaluated. Because High NRG-N contains Fe, Mg, Mn, Zn, soil analysis will be used to ensure that any of these nutrients are not deficient, and can be corrected, prior to topdress application. Similarly, because High NRG-N contains S, plant samples will be taken prior to topdress application to determine possible S deficiency and correct it as needed. At maturity, spring wheat was harvested with Wintersteiger classic plot combine (Wintersteiger Ag, Ried, Austria). The harvested grain was dried in the drying room for 14 days at the temperature of 95 F°; then, the by-plot grain yield was determined. The by-plot subsamples were analyzed by the Agvise Laboratories (Northwood, ND) for total N content utilizing near infrared reflectance spectroscopy (NIR) with a Perten DA 7250 NIR analyzer (Perten Instruments, Inc., Springfield, IL). The effects of N source and the dilution ratio (fertilizer/water) on N uptake (NUp), N use efficiency (NUE), spring wheat grain yield (GY), and grain protein content (GP) and protein yield (PY) were assessed. Grain N uptake was calculated by multiplying yield by total N concentration. N use efficiency was determined using the difference method (Varvel and Peterson, 1990) by deducting the total N uptake in wheat from the N-unfertilized treatment (check plot) from total N uptake in wheat from fertilized plots and then divided by the rate of N fertilizer applied. The analysis of variance was conducted using the PROC GLM procedure in SAS v9.3 (SAS Institute, Inc., Cary, N.C.). Mean separation was performed using the Orthogonal Contrasts method at a significance level of 0.05.

RESULTS AND DISCUSSION

Because the dilution ratio had no significant effect on grain yield, protein and other evaluated variables, all the data presented in this report is averaged over the dilution ratios – to assess the effect of product. In Figures, the means in the same group followed by the same letter are not significantly different, $p<0.05$. In 2012, grain yields ranged from 37.6 bu ac^{-1} to 96.0 bu ac^{-1} (Figure 1). In 2013, the yields ranged from 27.6 bu ac^{-1} to 75.9 bu ac^{-1} (Figure 2). Grain yields were lower in 2013 at WARC due to significant, difficult to control weed pressure. Although the effect of product on grain yield was more pronounces in 2012, compared to 2013, in both growing seasons, HNRGN resulted in higher yields compared to UAN. At dryland locations, LU performed as well as HNRGN. At the irrigated location, there was little difference in yield associated with N product. In 2012, at WARC, lower yield but higher grain protein was observed with LU, compared to other N sources. Grain protein contents obtained in this study were excellent and ranged from 10.6% to 17.2% (data not shown). Evaluation of product effect on protein yield and NUE allow us to assess how efficiently N products were taken up, assimilated and utilized to produce both grain yield and quality. Protein yield was clearly higher with HNRGN at both dryland sites in 2012 and in 2013 (Figures 3 and 4). Even where the differences were not statistically significant (WARC, 2012 and Patton, 2013), over 30 lb ac^{-1} advantage in protein yield accumulation was observed with HNRGN compared to UAN (Figure 6). The effect of N source on NUE was very pronounces in favor of HNRGN at dryland locations in both growing seasons (Figures 7 and 8). The lowest NUE values were observed with UAN; LU produced intermediate results. The irrigated WARC location had similar NUEs for all products, except for 2012, when LU resulted in lower (not statistically significant) NUE (Figure 7). The cost per unit of N of HNRGN at the time of application was approximately 25% higher than cost of LU and UAN. Many growers chose to produce their own LU on-site; they prefer non-corrosive LU to readily available for purchase UAN.

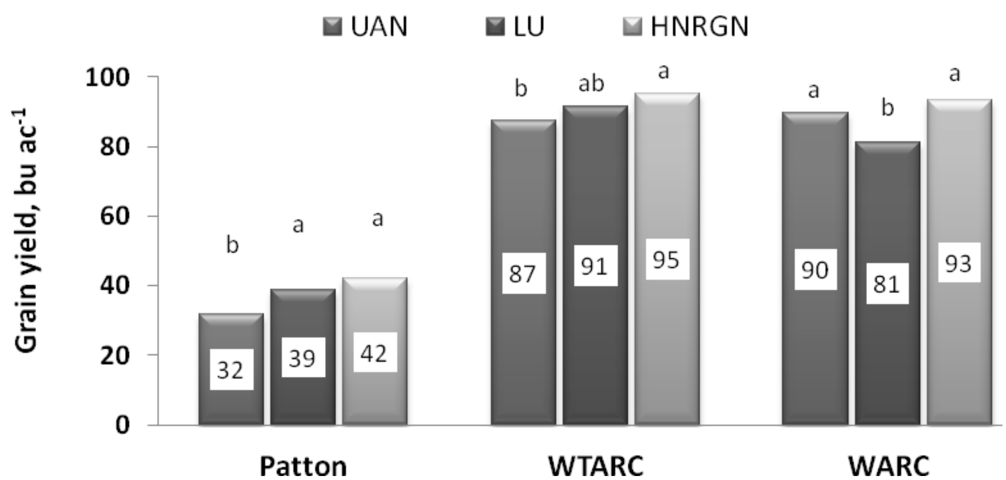

Figure 1. Fertilizer N source effect on spring wheat grain yield, Patton, WTARC, and WARC, 2012.

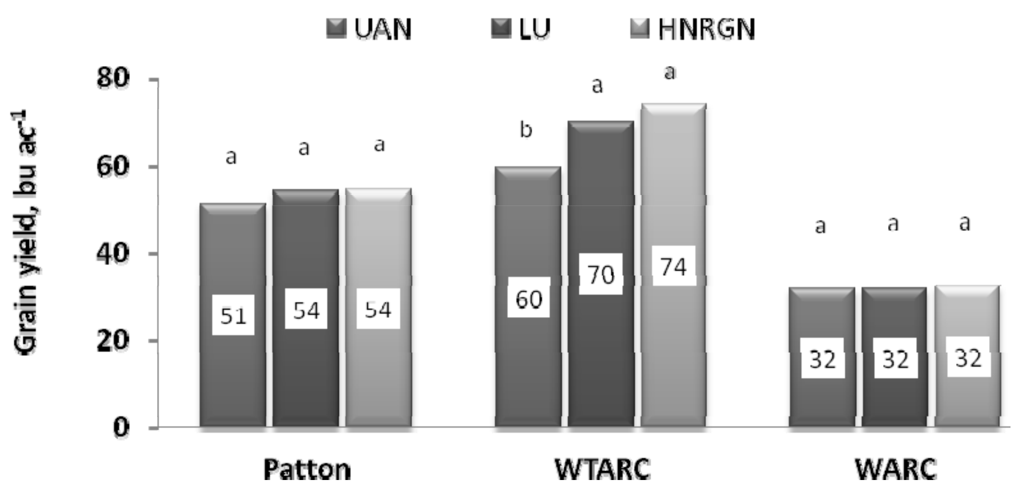

Figure 2. Fertilizer N source effect on spring wheat grain yield, Patton, WTARC, and WARC, 2013.

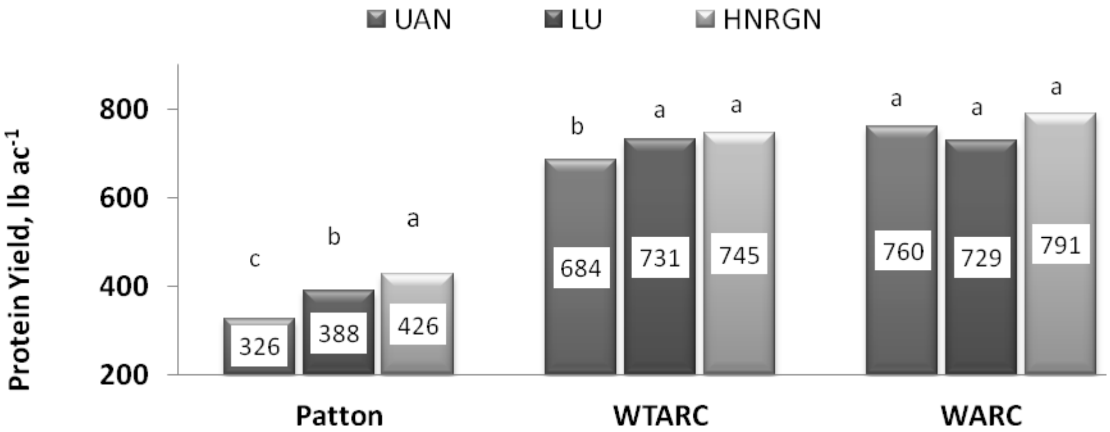

Figure 3. Fertilizer N source effect on spring wheat protein yield, Patton, WTARC, and WARC, 2012.

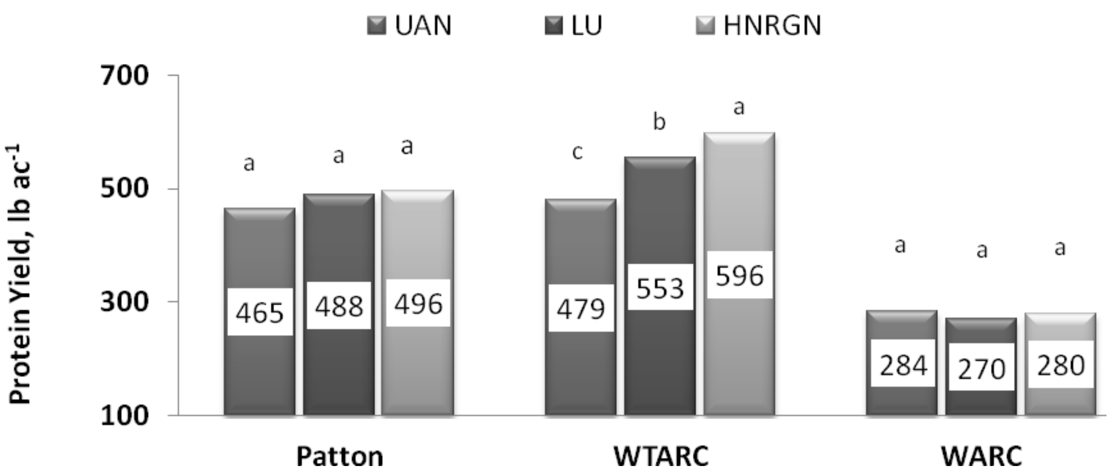

Figure 4. Fertilizer N source effect on spring wheat protein yield, Patton, WTARC, and WARC, 2013.

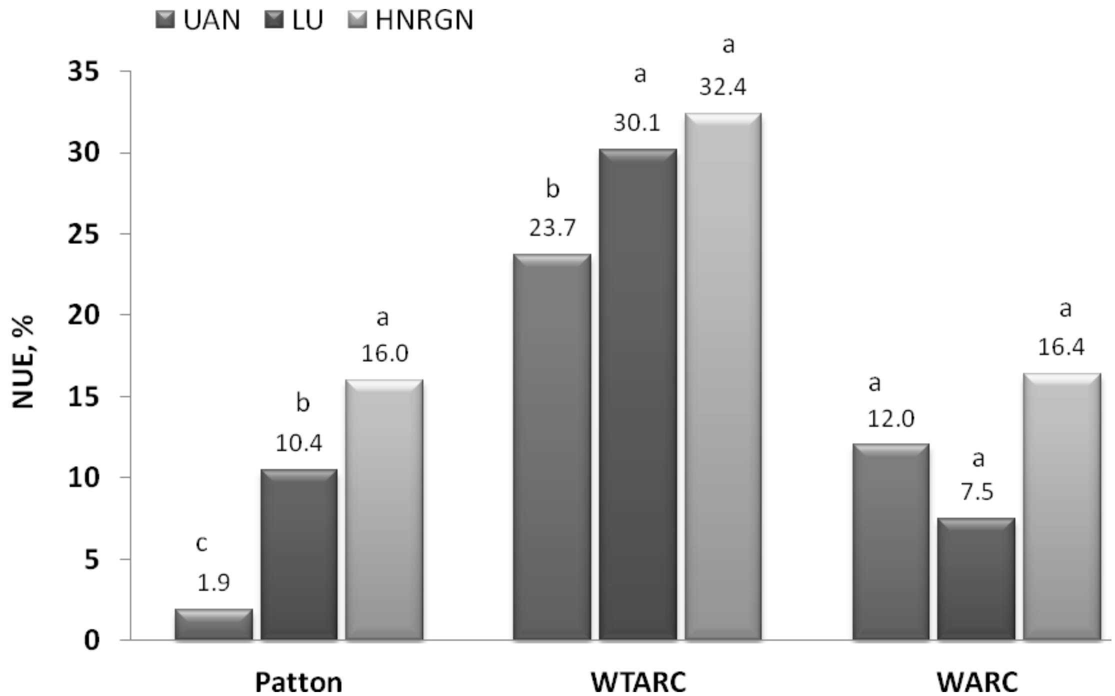

Figure 5. Fertilizer N source effect on NUE, Patton, WTARC, and WARC, 2012.

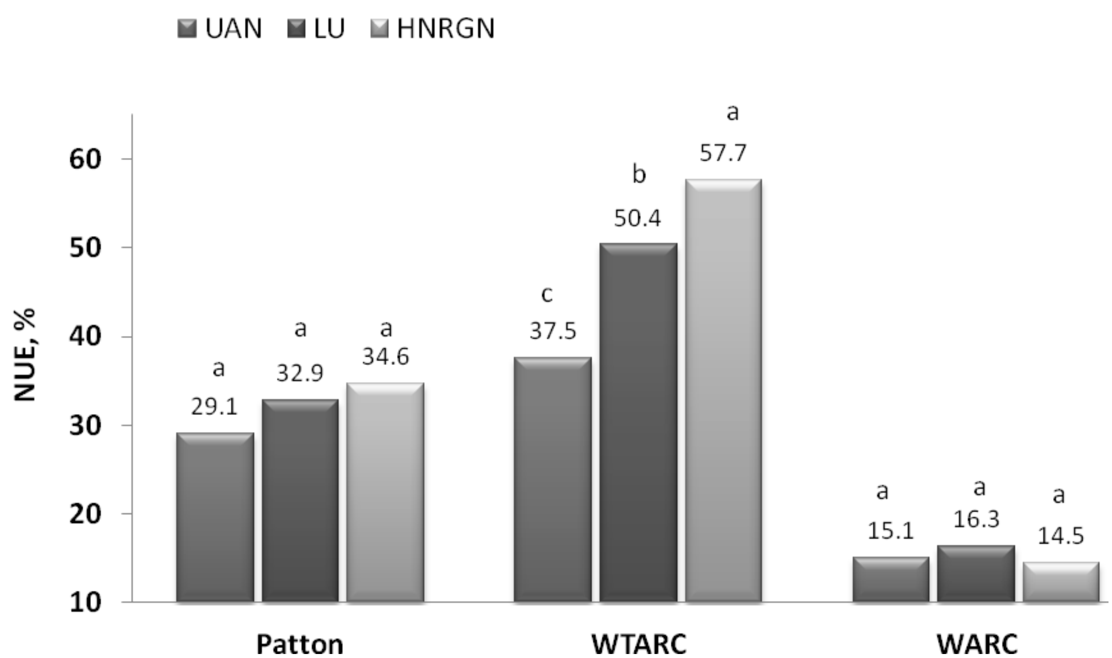

Figure 6. Fertilizer N source effect on NUE, Patton, WTARC, and WARC, 2013.

SUMMARY

This study's results support manufacturer's claims in regards to lower corrosiveness of LU and HNRGN compared to UAN. On the other hand, the dilution ratio of fertilizer/water had no significant effect on grain yield, protein or any other evaluated parameters. Results showed that the N source choice may be more important in a dryland situation compared to irrigated. Although HNRGN has resulted in superior NUE values, LU has performed well across the site-years in terms of grain yield and protein production. Due to much higher HNRGN source per unit of N compared to LU and UAN, we recommend LU as most appropriate liquid fertilizer N source for spring wheat production in the Northern Great Plains region.

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