IN-FURROW PLACEMENT OF DRY UREA PRODCUTS WITH WINTER WHEAT

Lucas A. Haag[1], Alan J. Schlegel[2], and Dorivar Ruiz-Diaz[3]
[1]Kansas State University, Northwest Research-Extension Center, Colby, Kansas
[2]Kansas State University, Southwest Research-Extension Center, Tribune, Kansas
[3]Kansas State University, Department of Agronomy, Manhattan, Kansas
LHaag@ksu.edu (785) 462-6281

ABSTRACT

Previous research has shown that the application of some nitrogen fertilizer prior to or at the time of wheat seeding can positively affect the initiation of fall tillers and thus yield potential. However, there are logistical challenges in placing that nitrogen in no-till production systems. Traditionally, the placement of urea-based fertilizers in-furrow with wheat seed has not been recommended. The objectives of this project were to evaluate stand reduction and associated potential yield losses from the in-furrow placement with seed of urea, NBPT treated urea, and a polymer coated slow-release urea at varying rates. This study was conducted across 9 site-years in western and central Kansas. Across most measured parameters, the effects of injury increased with increasing nitrogen rate for all urea products. In general, the level of injury was greatest for conventional urea followed by NBPT+NPPT treated urea, with ESN urea offering the greatest level of safety for in-furrow placement with the seed. Data from this study would suggest that in the silt-loam soils of western and north-central Kansas, 10 lb ac^{-1} of conventional urea may be seed placed when sufficient soil moisture is present and 20 lb ac^{-1} of NBPT+NPPT or ESN may be seed placed.

INTRODUCTION

A great deal of flexibility exists in supplying nitrogen to a winter wheat crop. Essential however, is having nitrogen available in sufficient quantities at times of development for key yield components. In general, it is recommended that some of the crop's nitrogen supply be made available through a planting or pre-plant application. Having nitrogen easily available early in the growth and development of winter wheat can positively effect fall tiller initiation, and thus yield potential. Historically in conventional-till or reduced-till dryland production systems, this was accomplished during one of the pre-plant summerfallow tillage operations, most commonly with anhydrous ammonia applied with a sweep blade plow. With the transition to no-till production systems, producers often inquire about effective methods to efficiently apply nitrogen without the use of tillage. The increased adoption of air-seeder systems with increased bulk commodity capacity over traditional box-type grain drills has provided a less-costly and logistically simpler process to apply dry fertilizer. In addition, the introduction of new dry nitrogen products into the market has many producers asking about their relative safety to urea for placement directly with the seed. Traditionally the recommendation of Kansas State University Research & Extension has been that no urea should be placed with the seed. This is due to the risk of ammonia injury to seedlings as urea undergoes hydrolysis (Bremner and Krogmeier, 1989).

MATERIALS AND METHODS

Field experiment were conducted across three locations in western Kansas over three years and one location in north-central Kansas for two years, for a total of 11 site-years. One site-year was lost due to extremely dry conditions in the fall and subsequent failure of crop establishment. Another site-year was lost due to accidental harvesting by the cooperator. All locations are characterized by relatively flat topography and well drained silt loam soils. At each location, treatments were arranged in a RCBD design with four replications. Plots were generally 5' x 40' in size. Winter wheat was no-till planted into chemfallow at the Tribune, Colby, and Herndon, KS locations where the previous crop was either corn or grain sorghum. At the Hunter location, in north-central Kansas, wheat was no-till seeded into winter wheat stubble. At the Tribune, Colby, and Herndon locations, the variety Byrd (Haley et al., 2012) was used, at the Hunter location the variety Larry (USDA, 2019) was used. Wheat was seeded in 7.5" rows in 2016 and 2017, and in 10" rows in 2018. Seeding rates were 1.1 million seeds acre^{-1} in 2016 and 2018, and 1 million seeds acre^{-1} in 2017.

Three urea fertilizer products: conventional urea, polymer coated slow release urea (ESN, Nutrien), and NBPT+NPPT coated urea (Limus, BASF), were placed in-furrow with the wheat seed at three target rates of applied nitrogen: 10, 20, 30, and 60 lb ac^{-1}. Additionally, two control treatments were also included: a treatment of no fertilizer in furrow and MAP at the rate of 91 lb ac^{-1}, for a nitrogen application of 10 lb ac^{-1}. The key objective of this study was to evaluate potential injury of seed placed nitrogen, not necessarily nitrogen response. Therefore, at all locations, the typical nitrogen fertilization plans for wheat were carried out over the entirety of the plot area.

Fall stand counts were taken at 6 site-years of the study from areas ranging between 3.75 and 7.5 ft^2 depending upon the individual site-year. At 3 site-years (Colby, Herndon, and Tribune in 2016) a spring stand count from an area of 3.75 ft^2 was obtained due to delayed germination caused by dry conditions at seeding. Head number at harvest was obtained at 8 site-years from an area between 2.5 and 7.5 ft^2 depending on site-year. The date on which 50% of the tillers had headed was recorded at 2 site-years. Plots were machine harvested using small plot combines. Seed weight was determined from 300 seeds that were oven dried to constant weight. Data for grain yield, moisture, test weight, kernel weight, and protein content were collected at all 9 site-years.

Statistical analysis was performed using PROC MIXED in SAS 9.4. A one-way analysis of each site-year was conducted for the measured and calculated response variables with replication as a random effect and treatment as a fixed effect. The across-years analysis was conducted with treatment as a fixed effect and site-year and replication nested within site-year as random effects. Means separation was performed used the PDMIX800 macro (Saxton, 1998).

RESULTS AND DISCUSSION

Fall Stand Establishment

Fall stand establishment was affected by treatment at 4 of the 6 site-years where data were collected. In-furrow fertility treatment effected fall stand establishment ($P<0.0001$). In the across years analysis fall stand establishment decreased as nitrogen rate increased (Figure 1). At the 10 through the 30 lb ac^{-1} rates, no significant difference was observed between urea products. However, at the 10 lb ac^{-1} rate, urea resulted in less stand than the control. At the 20 lb ac^{-1} rate, both urea and NBPT+NPPT treated urea resulted in less stand than the control. At the 30 lb ac^{-1} rate, all urea products resulted in less fall stand relative to the control. Differences among products on fall stand establishment were only observed at the highest rate in the study, 60 lb ac^{-1}, in which conventional urea resulted in less stand than either ESN or NBPT+NPPT urea. Conventional urea reduced fall stand establishment at any rate in the study, NBPT+NPPT urea resulted in stand reduction at rates of 20 lb ac^{-1} and above, while ESN urea resulted in stand reductions at rates of 30 lb ac^{-1} and above.

Spring Stand

At 3 of the site-years, extremely dry conditions delayed uniform germination and emergence. Spring stand counts were taken to evaluate potential injury. In an across site-years analysis, in-furrow treatment effected spring stand (P=0.0008). Stands were numerically, but not statistically reduced by any urea product at rates of 10 and 20 lb ac^{-1} (Figure 2). At the 30 lb ac^{-1} rate, stands were reduced relative to the control when conventional or NBPT+NPPT urea was applied. Product differences were further magnified at the 60 lb ac^{-1} rate when both the conventional and NBPT+NPPT urea products resulted in less stand than the control, and the conventional urea treatment resulted in less stand than the ESN urea treatment.

Maturity

Differences in maturity was an unforeseen treatment effect that we recorded with 2 site-years of data. When urea was applied in furrow at any rate, maturity was delayed relative to the control (Figure 3). Maturity was also delayed when rates of NBPT+NPPT urea of 30 lb ac^{-1} and above were applied and at the 60 lb ac^{-1} rate of ESN. The reduction of main stems and tillers due to seedling injury allowed for the initiation of spring tillers, which were later to mature.

Yield Components and Grain Yield

No treatment effect on either yield head^{-1} or kernels head^{-1} was observed. When NBPT+NPPT or conventional urea were placed in-furrow at 60 lb ac^{-1} kernel weight was reduced relative to the control (data not shown). This is likely in part to a larger number of late maturing tillers in these treatments which would be subjected to increased heat stress during grain fill, possibly reducing grain fill rate and/or duration. Heads acre^{-1} were also reduced in these two treatments relative to the control (data not shown).

Grain yields were unaffected by the use of any product at the 10 lb ac^{-1} rate. At rates of 20 lb ac-1 and higher the placement of urea in-furrow reduced grain yields relative to the control. NBPT+NPPT and ESN urea reduced grain yields when applied at the 60 lb ac^{-1} rate.

Discussion

A common occurrence in this study was increasing levels of injury across products in the order of ESN < NBPT+NPPT < urea. This agrees with research conducted in the prairie provinces of Canada (Brandt et al., 2005 and Malhi et al., 2003). The data collected in our study would suggest that for silt-loam soils in western and north-central Kansas it is possible in many cases to place conventional urea with the seed at rates up to 10 lb ac^{-1}, this would concur with recommendations from Montana State Univ. (Olson-Rutz et al., 2011). However, at two of the site-years, Tribune 2016 and Colby 2016, 10 lb ac^{-1} of urea resulted in a yield reduction of 7.8 and 7.2 bu ac^{-1} respectively. In our study, urea treated with NBPT+NPPT appeared to be safe at rates up to 30 lb ac^{-1} although within site-years some numerical reductions in yield were evident. In the across-years analysis for grain yield, ESN was not less than the control at any applied rate. However, in 3 of 9 site-years yield was reduced when 60 lb ac^{-1} of ESN was applied in-furrow (data not shown) while in none of the site years was ESN detrimental to yield at the 30 lb ac^{-1} rate. Work in the prairie provinces has shown plant stands not to be reduced with ESN until rates were above 45 lb ac^{-1} (Brandt et al., 2005). Based on this data, for silt-loam soils in western and north-central Kansas in-furrow application of conventional urea should be avoided in dry soils but may be used up to rates of 10 lb ac^{-1} when sufficient soil moisture exists. Rates of up to 20 lb ac^{-1} appear to be acceptable when using NBPT+NPPT or ESN urea. While higher rates will be safe in the majority of years, the economic costs in a year when injury occurs could be significant.

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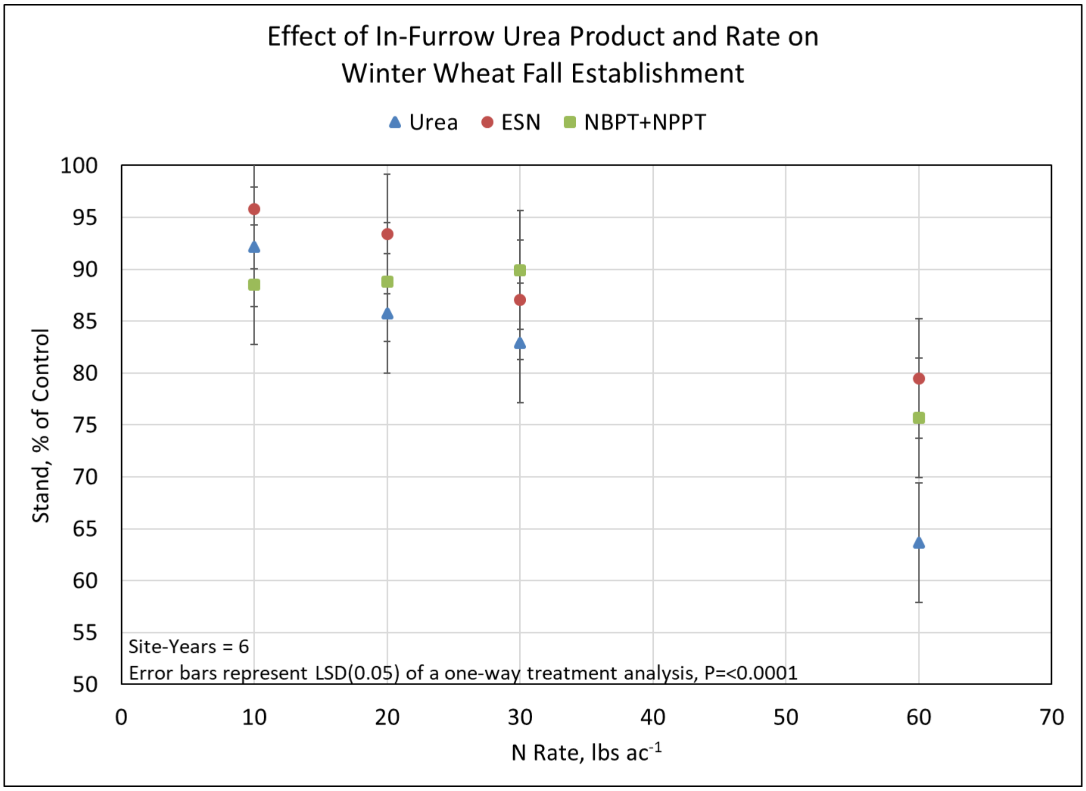

Figure 1. Effect of in-furrow urea product and rate on fall establishment of winter wheat.

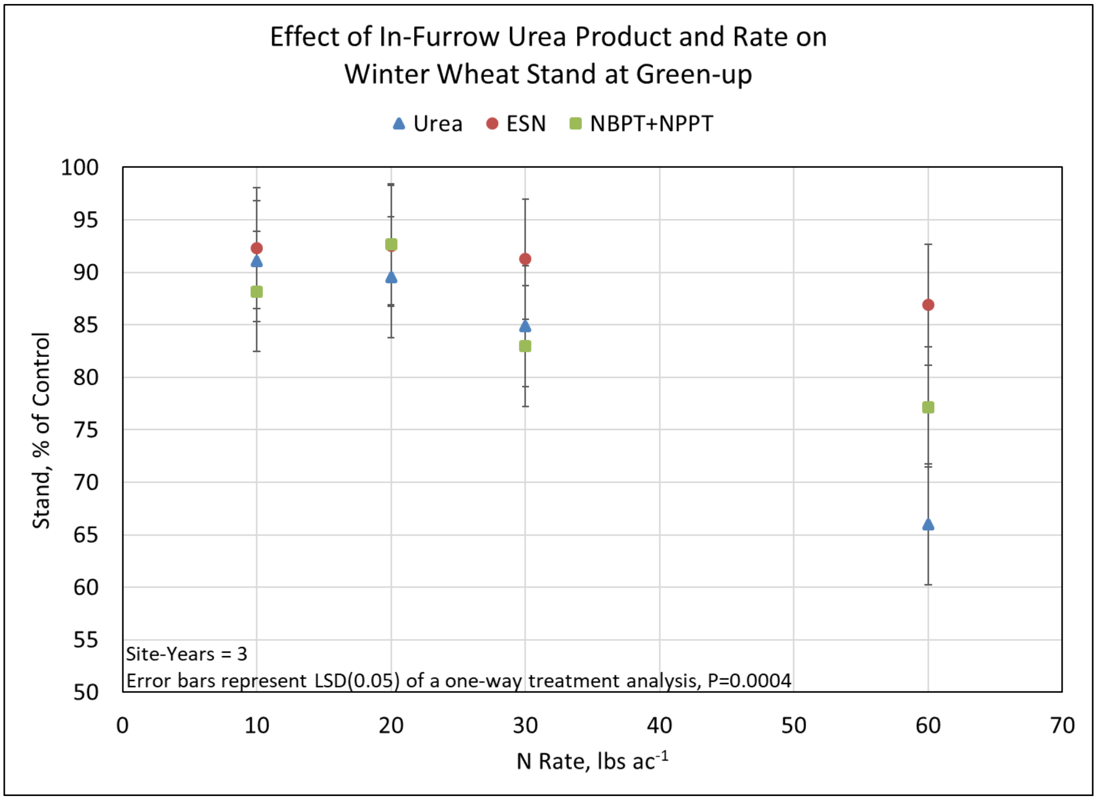

Figure 2. Effect of in-furrow urea product and rate on winter wheat stand at spring green-up.

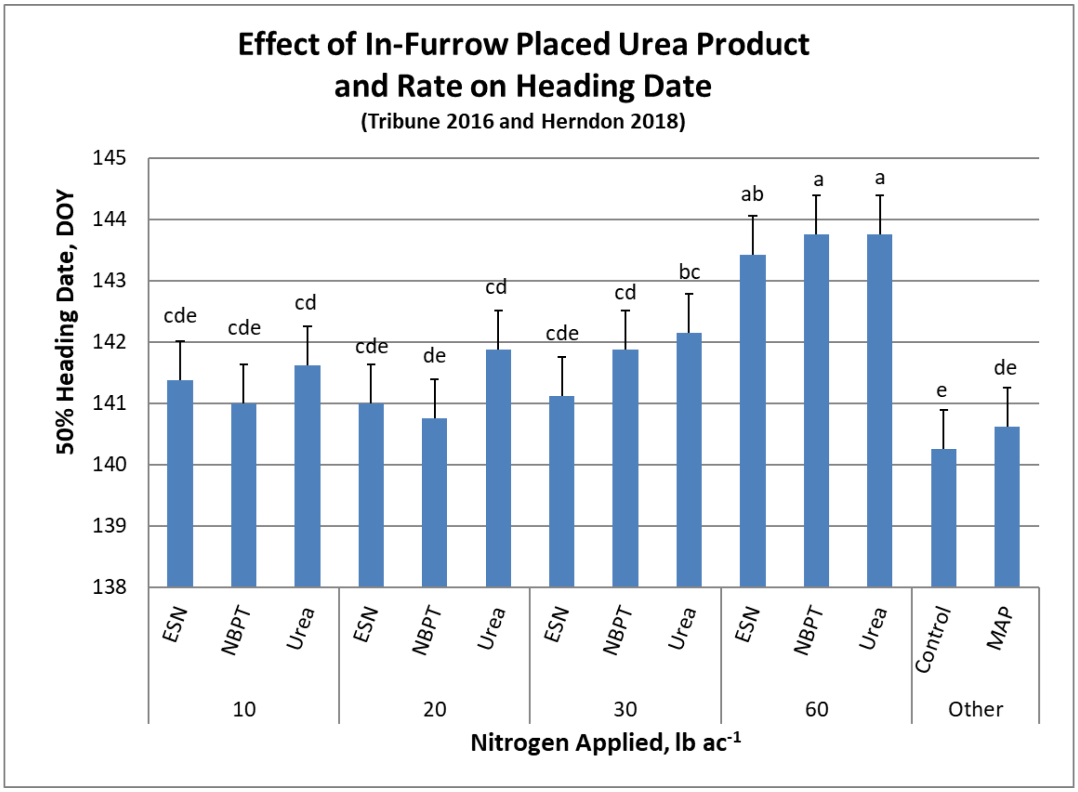

Figure 3. Effect of in-furrow urea product and rate on winter wheat heading date.

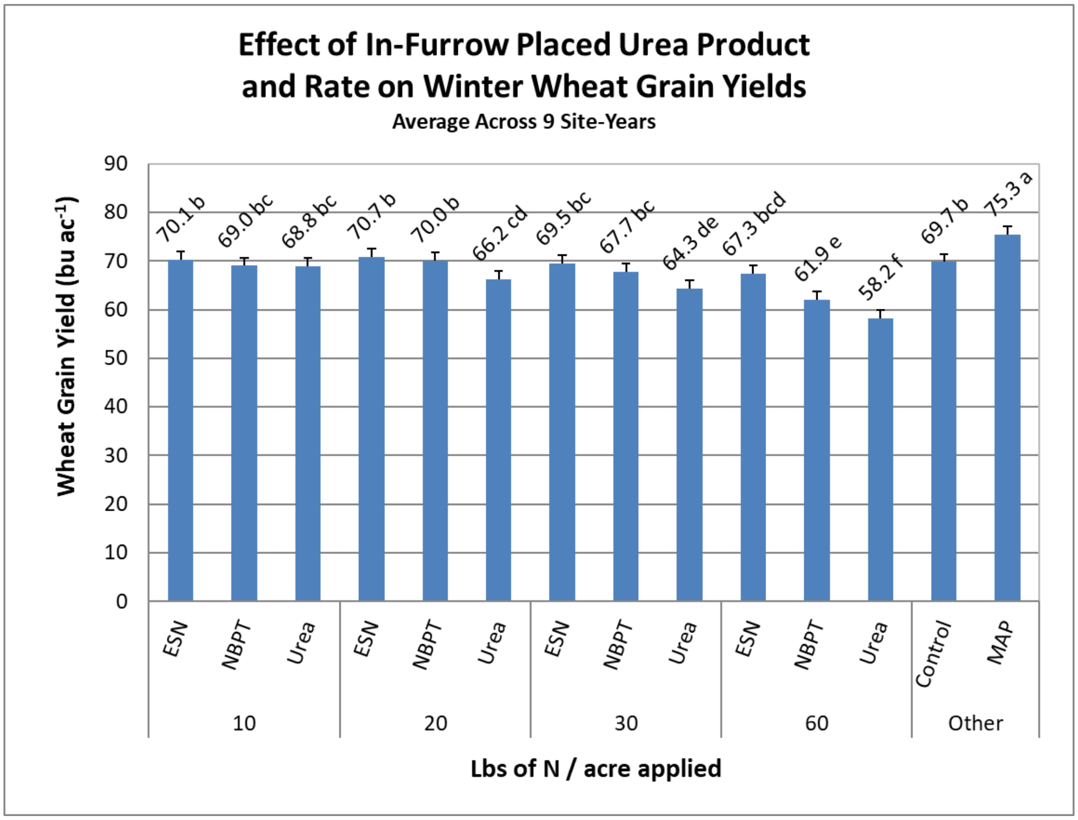

Figure 4. Effect of in-furrow urea product and rate on grain yield.