

RESEARCH PROJECT TITLE: The strategic use of broadcast and controlled release fertilizer to facilitate N applications and improve nitrogen use efficiency in direct seed systems

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PROJECT OBJECTIVES:

1. Determine whether early- or late-fall broadcast of conventional or controlled release nitrogen (N) fertilizers can replace deep banding and/or spring broadcast applications;
2. Assess the feasibility of replacing deep-banded conventional N fertilizer with seed banded controlled release fertilizer;
3. Evaluate select N timing and placement strategies in the context of a typical Palouse toposequence (assess the N treatment by landscape position interaction).

KEY WORDS: Nitrogen, Controlled Release Fertilizer, Efficiency, Hard Wheat

AGRONOMIC ZONE OF INTEREST: These studies were conducted in the high-rainfall zone of the Palouse. This zone was selected because high precipitation conditions typically result in low N use efficiency and present more challenges for N management.

PRODUCTION SYSTEM BEING INVESTIGATED: Annual cropping; direct seeded winter wheat in a legume-winter wheat-spring cereal rotation.

STATEMENT OF THE PROBLEM TO BE ADDRESSED: Early access to nutrients placed near the seed is thought to be critical in direct seed systems, especially in situations where soil test values and temperatures are low. Deep band placement of fertilizer requires heavy equipment and the power to pull it. Alternative placements that do not require deep banding of fertilizer, such as seed placement or broadcasting, could reduce heavy equipment requirements and perhaps improve profitability. Controlled release fertilizer technologies are advancing rapidly and offer the potential to place most or all the crop N requirement with the seed. The strategic use of application timing and/or controlled release N fertilizer placed with the seed offers the potential to eliminate deep banding and spring applications, and thereby facilitate N applications while increasing N use efficiency in direct seeded winter wheat.

ABSTRACT OF RESEARCH FINDINGS: Experiments were initiated in Fall 2004 at the Palouse Conservation Field Station in Pullman, WA to evaluate controlled release and conventional urea fertilizer source, placement and application timing treatments for hard red winter wheat production. Only preliminary results from the 2005 grain harvest are available at this time. Results showed no yield difference between urea and controlled release urea applied at rates of 0 to 250 lb N/acre in a deep band placed 2 inches below the seed row. Placing 150 lb N/acre as controlled release urea with the seed resulted in a 510 lb/acre (8.5 bu/acre) lower yield compared to deep band placement at the same rate of N. Controlled release urea broadcast at

150 lb N/acre at seeding resulted in a 1020 lb/acre (17 bu/acre) lower yield than urea broadcast at seeding. Broadcast applications of urea made at the rate of 150 lb N/acre at seeding, in late fall, or as 50:50 splits between seeding-late fall or late fall-early spring produced similar yields. Overall, few yield differences were observed between controlled release and conventional urea fertilizers, and among application timings of broadcast urea. Atypical weather patterns with a relatively warm and dry 2004-05 winter likely resulted in a low potential for nitrogen leaching or denitrification losses. Under winter conditions more typical of this location greater differences may be observed between sources and among application timings. This study will be repeated again in 2005-06.

RESULTS AND INTERPRETATION: This project was initiated in the fall of 2004 with a winter wheat planting. Only year 2005 preliminary yield results are available at the time this report was prepared. Project methods and preliminary results are summarized below.

Treatments outlined in Table 1 were initiated in a study placed at the Palouse Conservation Field Station in early October 2004. These treatments address, in part, Objectives 1 and 2 above. Due to space constraints, a separate timing study was placed in an adjacent location with treatments outlined in Table 2. These treatments address, in part, Objective 1.

Table 1. Treatment table for primary controlled release fertilizer study initiated in 2004 at the Palouse Conservation Field Station.

Treatment #	Treatment	N (lbs/acre)
1	Control	0
2	Urea (Deep Band placement, DB)	50
3	Urea (DB)	100
4	Urea (DB)	150
5	Urea (DB)	200
6	Urea (DB)	250
7	Urea (Broadcast placement, BC) Late Fall	150
8	Urea (BC) At Seeding	150
9	Urea (BC) Early Spring	150
10	Controlled Release Fertilizer (DB)	50
11	Controlled Release Fertilizer (DB)	100
12	Controlled Release Fertilizer (DB)	150
13	Controlled Release Fertilizer (DB)	200
14	Controlled Release Fertilizer (DB)	250
15	Controlled Release Fertilizer (Seed Banded, SB)	150
16	Controlled Release Fertilizer (BC) at seeding	150
17	Controlled Release Fertilizer (50% DB:50% SB)	150

Table 2. Treatment table for secondary application timing fertilizer study initiated in 2004 at the Palouse Conservation Field Station.

Treatment #	Treatment	N (lbs/acre)
1	Control	0
2	50% broadcast at seeding:50% broadcast in late fall	150
3	50% broadcast at seeding:50% broadcast in early spring	150
4	100% broadcast in late fall	150

The site featured a preplant residual N level of 65 lb/acre (0 to 5 feet). Individual plot dimensions are 6.25 feet wide by 50 feet long. Each study is a randomized complete block design with four replications. The conventional N source was dry urea applied in a deep band placed 2 inches below the seed using a Fabro no-till drill with separate gangs of double disk openers for delivering the fertilizer and seed. Broadcast fertilizer was applied with the Fabro drill by raising the fertilizer disks above the soil surface during seeding of these plots. The controlled release material is dry urea coated with a polymer designed to release all of the nitrogen in 60 days under standard moisture and temperature conditions. Under typical fall conditions in eastern Washington the release is expected to take 90 to 120 days.

In addition to the treatments outlined in Tables 1 and 2, the 150 lb N/acre conventional urea deep band (treatment 4 from Table 1), 150 lb N/acre controlled release deep band (treatment 12 from Table 1), and 150 lb N/acre broadcast at seeding (treatment 8 from Table 1) treatments were installed in continuous strips approximately 3,000 feet long spanning a typical Palouse hill from south-southwest facing to north facing slope. These continuous broadcast strip included six, 30-foot segments in which no fertilizer was applied (control segments). The strips address objective 3 above. All plots were seeded with Falcon hard red winter wheat at the rate of 100 lb seed/acre. A total of 50 lbs of 16-20-0 starter per acre was placed with the seed in each treatment.

Grain yield was measured by harvesting a 5 foot wide by 40 foot long section of each plot with a small combine. Meter-row samples were collected by hand from plots located in the continuous strips. Plant samples will be processed and analyzed for total above-ground N and partitioning among stover and grain. Grain samples will be analyzed for grain protein. Profile soil samples were also collected in spring before broadcast applications were made from the control and selected application timing treatments, and post-harvest from each plot. These samples will be analyzed for extractable nitrate-N and ammonium-N.

Preliminary results

The deep banded placement produced a quadratic response to N rate in hard red winter wheat yield, but no difference between conventional and controlled release urea forms (Figure 1; Table 3). Grain yields ranged from 3070 lb/acre for the unfertilized control to an average of 5540 lb/acre for the 150 lb N/acre rate. Yield was reduced slightly at N rates above 150 lb/acre.

There were no significant differences between urea broadcast at seeding, in late fall, or early spring compared to urea placed in the deep band at the 150 lb N/acre rate (Table 3).

Broadcasting controlled release urea at seeding resulted in 1020 lb/acre lower grain yield than conventional urea broadcast at seeding, and 1213 lb/acre lower yield than deep band placement of controlled release urea, at similar N rates. Placing 150 lb N/acre of controlled release urea in the seed band reduced yield by 510 lb/acre compared to a comparable rate placed in the deep band; however, splitting 150 lb N/acre as controlled release urea equally between the deep band and seed row produced yields similar to deep banding.

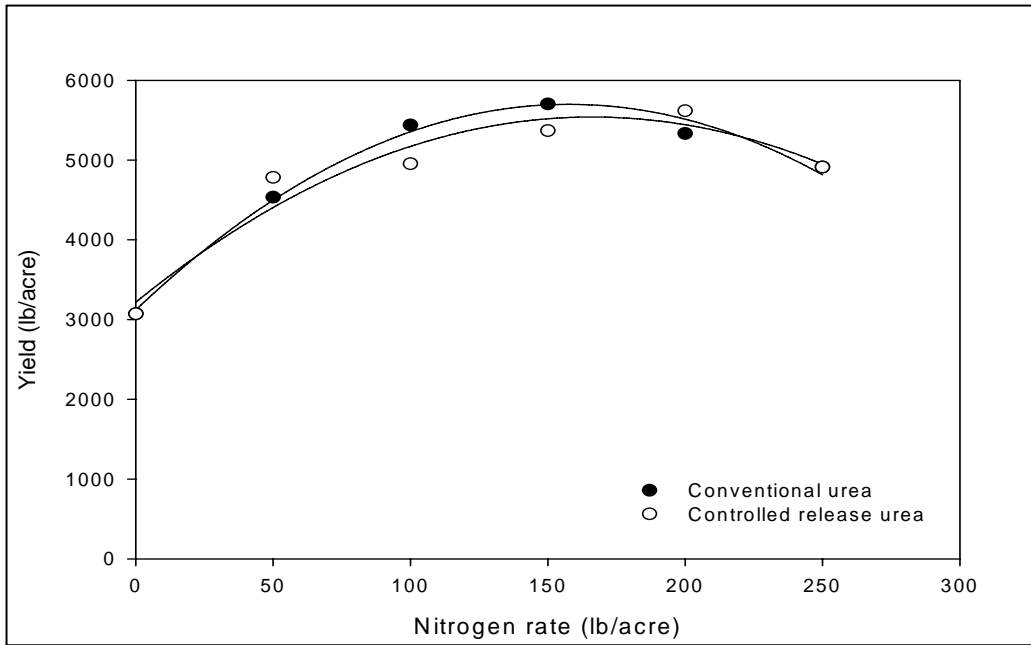


Figure 1. The effect of nitrogen rate and source on hard red winter wheat yield in 2005. There is a significant ($p = 0.02$) quadratic response to N rate, but no significant difference between nitrogen sources.

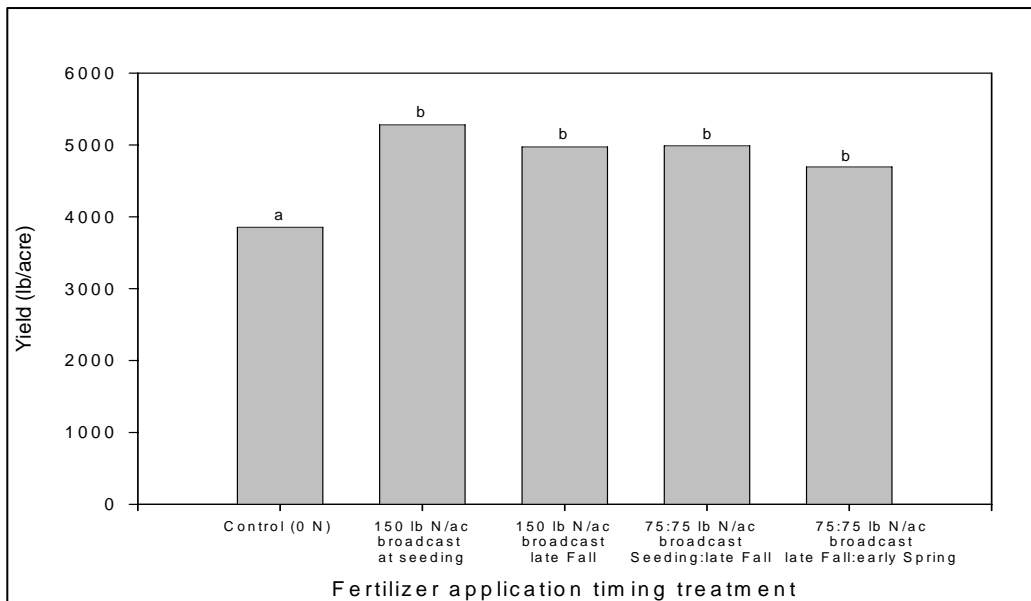


Figure 2. The effect of urea nitrogen application timing on hard red winter wheat yield in 2005. Column yields with the same letter are not significantly different according to Tukey’s test at 5% level.

In the broadcast application timing study (Table 2 treatments), grain yields ranged from 3854 to 5279 lb/acre. Grain yield was significantly higher with the urea treatments compared to the control, but there was no significant difference among urea broadcast treatments (Figure 2).

Additional data on grain protein and soil test N is forthcoming. Conclusions regarding the relative efficiency of N use among these treatments would be premature until complete data are available.

Table 3. Statistical significance for selected contrasts for treatments described in Table 1.

Contrast	p-value
Urea vs. controlled release fertilizer, deep banded, all rates	0.78
Urea broadcast at seeding vs. urea deep banded, 150# rate	0.22
Urea broadcast late fall vs. urea deep banded, 150# rate	0.46
Urea broadcast early spring vs. vs. urea deep banded, 150# rate	0.71
Controlled release urea vs. conventional urea, 150# rate, broadcast at seeding	0.08
Broadcast vs. deep banded controlled release urea, 150# rate	0.02
Seed banded vs. deep banded controlled release urea, 150# rate	0.04
Split seed-deep band vs. deep banded controlled release urea, 150# rate	0.46

INTERACTION (COOPERATION) WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITY: This project involves two STEEP researchers as principle investigators. Since improving N efficiency is an important topic for many involved in STEEP research, additional collaborations are expected as the project develops.

PUBLICATIONS AND PRESENTATIONS: None.