# Polymer-Coated Urea for Improving N Uptake in Strip-Till Sugarbeet

**W. Bart Stevens, Bill Iversen** and **Jay Jabro**, USDA-ARS Northern Plains Agricultural Laboratory, Sidney, MT

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**Figure 1.** *(Left) Modified six-row strip till implement used for evaluation of PCU in a study conducted near Williston ND from 2008 through 2011. Row spacing was 60 cm and tillage depth was approximately 25 cm.*
**Figure 2.** *(Right) Tillage shank with fertilizer delivery tube attached to the back.*

## Conclusions

- PCU improved plant growth and N uptake when there was a substantial risk of leaching in the fall due to early fertilizer application but did not provide much of an advantage when applied late in the fall.
- PCU application resulted in greater N uptake, plant growth and yield when conditions favored leaching of N in the fall following N application. Fall applied PCU did not appear to protect N from leaching loss during the spring.

## Rationale

Strip tillage (ST) provides an option for reducing tillage intensity where no-till systems may not be feasible. This practice has been shown to be potentiallly beneficial for sugarbeet (*Beta vulagaris* L.) production (Evans et al., 2010; Halvorson and Hartman, 1984). Performing ST operations soon after the previous crop is harvested allows farmers to take advantage of more favorable fall weather and soil conditions. Moreover, freeze-and-thaw cycles during the winter improve tilth in the tilled strips. A potential drawback is that N fertilizer banded during the ST operation may be leached below the seedling root zone, especially in sandy soils. Polymer-coated urea (PCU) may reduce this risk by delaying the dissolution and dispersion of urea-N thus increasing N uptake and plant vigor during the early growing season.

## Objectives

A study was initiated in 2008 near Williston, ND to evaluate PCU as a means to improve N-use efficiency when fall ST is applied to a sandy soil. Objectives of the research were to determine if:

- plant N uptake is improved with PCU compared to uncoated urea
- PCU enhances sugarbeet yield and quality compared to uncoated urea

**Acknowledgements:** *We express appreciation to Agrium Inc. (Calgary, Alberta, Canada) and its retailers for donating the polymer-coated urea (ESN®) used in this study. We also thank North Dakota State University Williston Research Extension Center for cooperation at the study site.*

## Results

Dry matter production and total N uptake at 57 DAP (days after planting) were greater with PCU than with uncoated urea in two of four and three of four years, respectively (***Fig. 3***). At 88 (***Fig 4***) and 143 (***Fig 5***) DAP, dry matter and N uptake were still greater with PCU in two of four years but the difference was either not significant or favored untreated urea in the remaining two years. In the two years (2008, 2009) when the greatest advantage of PCU was observed, fertilizer was applied early in the fall resulting in more than 30 days during which uncoated urea may have been leached (***Table 1***). In 2010 and 2011, fertilizer was applied later in the fall thus minimizing the risk of fall leaching but PCU didn't appear to protect N from leaching in the spring.

Application of PCU increased root yield by 10.2% and 6.5% in 2008 and 2009, respectively (***Fig 6***). Sucrose yield was 6.5% higher and root sucrose concentration 2.6% lower with PCU than with UREA in 2008 but differences were not significant in 2009. Yield parameters were similar for the two fertilizers in 2010 but PCU produced a small (4.6%) increase in root yield in 2011.

**Table 1.** Available N and N loss risk factors for the four years during which PCU was evaluated as a means to reduce N loss from urea applied in the fall during strip tillage for sugarbeet.

| Year | Available N | | | N Loss Risk Period† | | Risk Period Precipitation | |
|---|---|---|---|---|---|---|---|
| | Residual | Applied | Date N Applied | Fall | Spring | Fall | Spring |
| | ----- kg N ha$^{-1}$ ----- | | | ------- days ------- | | -------- mm -------- | |
| 2008 | 63 | 129 | 9/20/07 | 37 | 69 | 46 | 111 |
| 2009 | 60 | 129 | 9/11/08 | 31 | 60 | 48 | 98 |
| 2010 | 46 | 142 | 10/21/09 | 0 | 63 | 0 | 167 |
| 2011 | 102 | 91 | 10/21/10 | 6 | 73 | 17 | 207 |

†Period between fertilizer application and the beginning of rapid N uptake (approximately Jun 20) when the soil temperature at 200 mm is > 7.2 C.

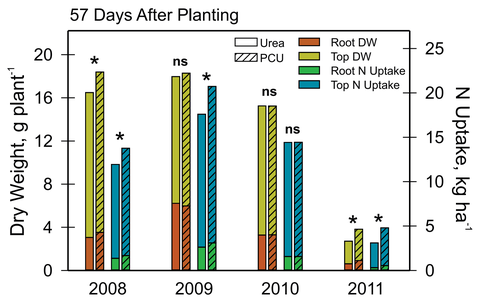


**Figure 3.** *Sample Date 1 (57 DAP) dry weight (DW) and N uptake by sugarbeet tops (leaves + petioles + crowns) and roots grown with either polymer-coated urea (PCU) or uncoated urea (UREA). Significant differences between pairs of means within a year are indicated by a '+' (P≤0.10) or an '*' (P≤0.05). Means that are not different are marked with 'ns'.*

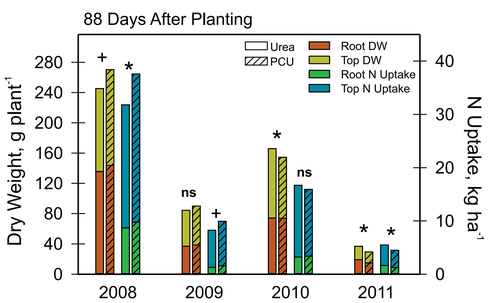


**Figure 4.** *Sample Date 2 (88 DAP) dry weight (DW) and N uptake by sugarbeet tops (leaves + petioles + crowns) and roots grown with either polymer-coated urea (PCU) or uncoated urea (UREA). Significant differences between pairs of means within a year are indicated by a '+' (P≤0.10) or an '*' (P≤0.05). Means that are not different are marked with 'ns'.*

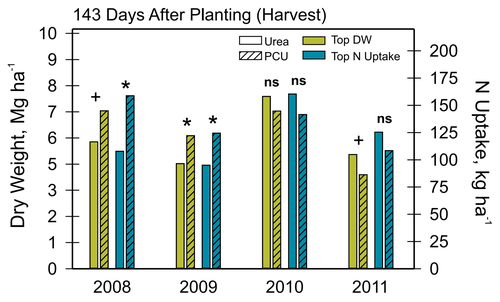


**Figure 5.** *Harvest (143 DAP) dry weight (DW) and N uptake by sugarbeet tops (leaves + petioles + crowns) grown with either polymer-coated urea (PCU) or uncoated urea (UREA). Dry matter and N uptake were not determined for harvested roots. Significant differences between pairs of means within a year are indicated by a '+' (P≤0.10) or an '*' (P≤0.05). Means that are not different are marked with 'ns'.*

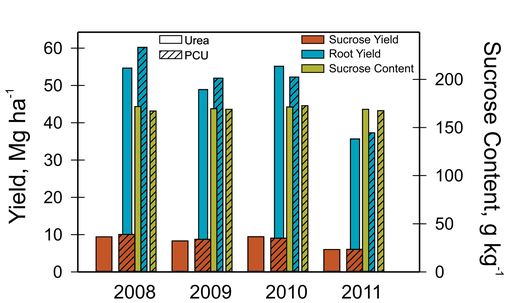


**Figure 6.** *Yield parameters for strip till sugarbeet grown with uncoated urea (UREA) or polymer-coated urea (PCU). Significant differences between pairs of means within a year are indicated by a '+' (P≤0.10) or an '*' (P≤0.05). Means that are not different are marked with 'ns'.*

## Methodology

The experiment was conducted from 2008 to 2011 at a site approximately 37 km east of Williston, ND. The soil is classified as Lihen sandy loam soil (sandy, mixed, frigid Entic Haplustoll) that is very deep and somewhat excessively or well drained.

Plots of an existing rotation study (established in 2005) were utilized to evaluated PCU in the sugarbeet phase of a rotation of sugarbeet, potato (*Solanum tuberosum* L.) and barley (*Hordeum vulgare* L.). Individual 14.6- × 61-m plots were arranged in a randomized block design with six blocks. Strip tillage was performed between Sep 11 and Oct 21 into barley stubble using a shank-type strip tiller (***Fig. 1***; Schlagel Mfg., Torrington, WY) that leaves alternating 30-cm strips of tilled and untilled soil (60-cm crop row spacing). Fertilizer was banded during the tillage operation via a tube behind the tillage shank (***Fig. 2***). Uncoated urea was applied to three of four six-row passes in each plot and PCU (ESN®, Agrium Inc., Calgary, Alberta, Canada) was applied to the remaining six-row pass. The amount of N applied was equivalent for the two fertilizer materials. Nitrogen application rate was adjusted for residual soil $NO_3$-N so that total available N was about 190 kg N ha$^{-1}$. Sugarbeet seed was planted between Apr 28 and May 7 into the ST bands at a seeding depth of 2.5 cm. Irrigations were applied using a linear overhead irrigation system.

Whole plants were collected on two dates during the growing season: Sample Date 1 (57 days after planting, DAP) and Sample Date 2 (88 DAP). Composite top and root samples were dried at 60 C, weighed, and ground to pass through a 1 mm screen. Total C and N concentrations were determined using a LECO TruSpec CN combustion analyzer (LECO Corp., St. Joseph, MI).

Yield was determined approximately143 DAP by hand harvesting two replicate 1.86-m$^2$-areas within each of the two treated portions in a given plot. Tops were separated from roots in the field. Fresh weight of the harvested tops was recorded then a subsample was collected for moisture and total C and N determinations. Root samples were transported to the Sidney Sugars, Inc. tare laboratory where clean weight and sucrose content were determined.

Data were analyzed using a paired T-test. Because of notable differences among the four years in weather and the timing of field operations, data were analyzed for each year individually. Differences were considered significant if the P>T was ≤ 0.10.

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### References

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Halvorson, A.D. and G.P. Hartman, 1984. Reduced seedbed tillage effects on irrigated sugarbeet yield and quality. Agon J. 76:603-606.

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