Timing and Release of Nitrogen From Residues

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INTRODUCTION

Recent studies have shown that sugarbeet and potato residue may contribute nitrogen to subsequent crops (Morghan and Smith, 1996; Reitmeier et al., 1998). However, there has been reluctance to apply N credits following these crops because of lack of information regarding the rate of mineralization from fall harvest to spring N needs of the subsequent crops. This study was set up in two parts in order to track N mineralization in the field and to determine the differences of decomposition and mineralization between crops.

The spring wheat management study was set up to monitor the influence of fertilizer adjustments made to spring wheat from the previous year's sugarbeet (*Beta vulgaris* L.) crop, with emphasis on monitoring the nitrogen mineralization from the 1998 sugarbeet residue.

The residue study was set up to observe relationships between C:N ratio of different crop residues and the timeliness of N mineralization. The objective was to determine N availability to subsequent crops from previous crop residue decomposition.

MATERIALS AND METHODS

Experiment 1: Spring Wheat Management Study

Two sugarbeet fields from 1998 were sampled based on a 0.5 acre grid in 1997 and 1998. Both fields (Section 29 and Section 34) were in St. Thomas township and 40 acres each. Fertilizer recommendations were made for each wheat field in 1998 using satellite images, plant total N, and soil N levels from the 1998 sugarbeet fields. Zones were delineated and fertilizer rates were adjusted (Figure 1 and Figure 2) according to soil and plant samples and satellite images obtained from the sugarbeet fields in 1998.

The center of each 0.5 acre grid was located on May 18, 1999 using an Omnistar Differential Global Positioning System (DGPS) backpack unit. Each coordinate was flagged and an 8 ft. x 8 ft. area was kept vegetation free with an application of glyphosate so that plant uptake would not interfere with the tracking of soil N levels.

Beginning when wheat was at the 2 leaf stage, the fields were soil sampled at 0-6, 6-12, and 12-24 inch depths on May 18, June 9 and June 22, 1999 (Figure 3 and Figure 4). Each sample consisted of three cores at each depth. To observe any N leaching that may have occurred throughout the growing season, each location was grid sampled at 0-6, 6-24 and 24-48 inch depths on August 30, 1999 after harvest. After each sampling, soil samples were spread out to dry before they were ground and analyzed for nitrate at the NDSU Soil Testing Laboratory. The transnitration of salicylic acid method was used to determine nitrate (Vendrell and Zupancic, 1990).

Figure 1. N application, 1999 for Section 29.

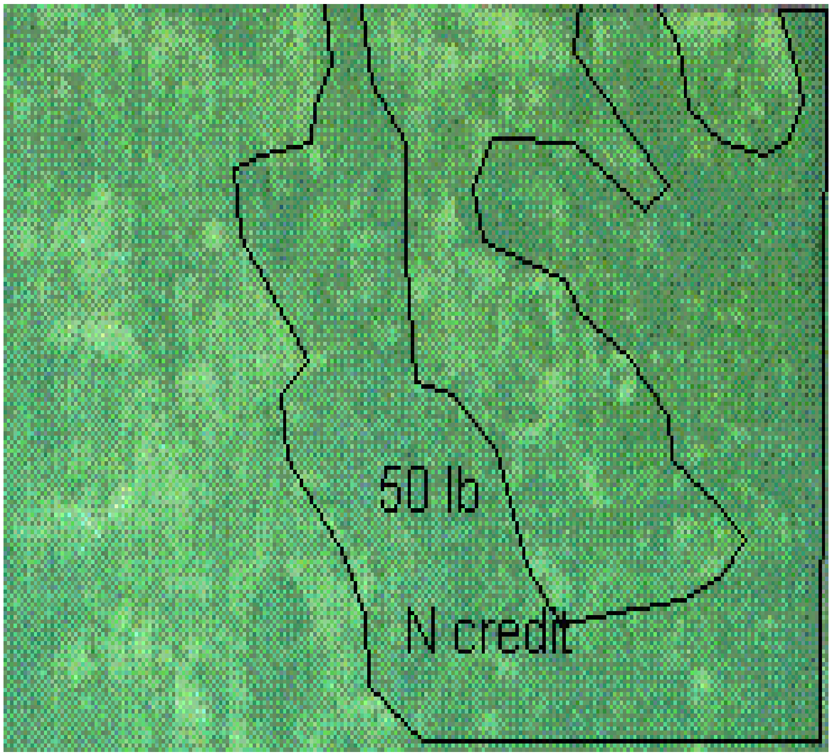
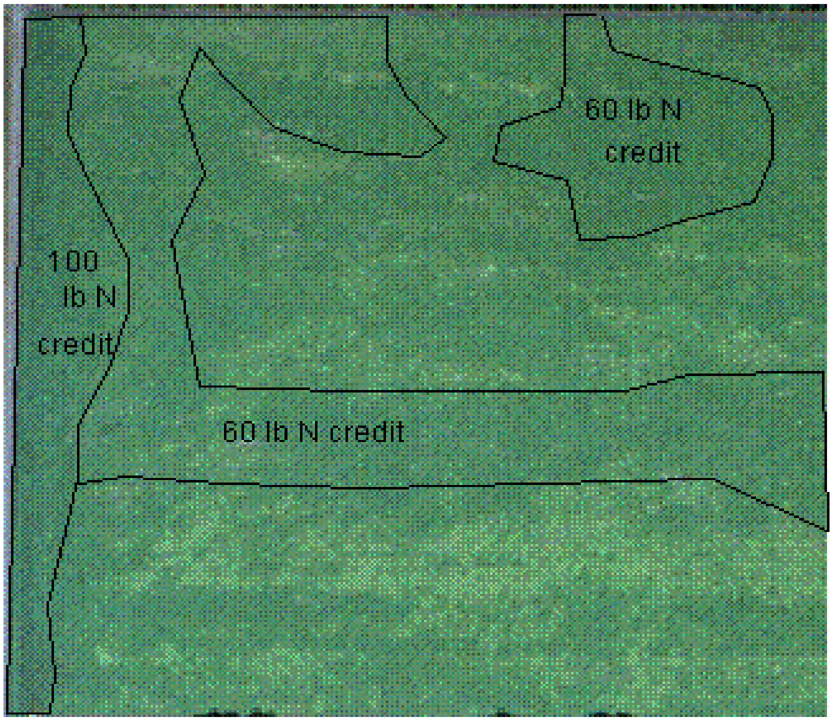


Figure 2. N application, 1999 for Section 34.



Experiment 2: Residue Management Study

Six crops were selected from producer fields: canola (*Brassica campestris* L.), corn (*Zea mays* L), potatoes (*Solanum tuberosum* L.), sugarbeets (*Beta vulgaris* L.), sunflowers (*Helianthus annuus* L.), and wheat (*Triticum aestivum* L.) in the spring of 1999. Each crop was fertilized by the grower for optimum yield.

The above ground residue of each plot was removed at appropriate harvest dates: July 28, 1999 (canola and wheat), August 18, 1999 (potatoes), September 18, 1999 (sugarbeet), September 22, 1999 (corn), and October 16, 1999 (sunflower). The canola and wheat were clipped off above the soil surface, leaving approximately 3 inches of stubble on the ground. The sunflower and corn plants and the potato vines were cut at the surface. Sugarbeets were hand harvested and the leaves were removed.

The residue was dried at 60-65 degrees Celsius for 48 hours. After drying, the canola, wheat and sunflower residue were threshed with a plot combine and then chopped further into “field size” pieces using a mechanical chopper. The ears were removed from the corn stalks and the corn stalks were processed through the chopper. Potato and sugarbeet tops were chopped prior to drying in order to promote uniform drying.

Residue was distributed in fiberglass mesh bags. Charcoal fiberglass mesh used for window screens (Hanover wire cloth 04148) was used to create 1 ft. x 1 ft. litter bags.

Residue was mixed thoroughly in order to obtain residue samples representative of all above-ground plant parts that would remain in the field after harvest. 24 g of sugarbeet, wheat, potato, corn, sunflower, and canola residue were sealed inside each bag. Bags were buried 24 inches apart, 3 inches beneath the soil surface.

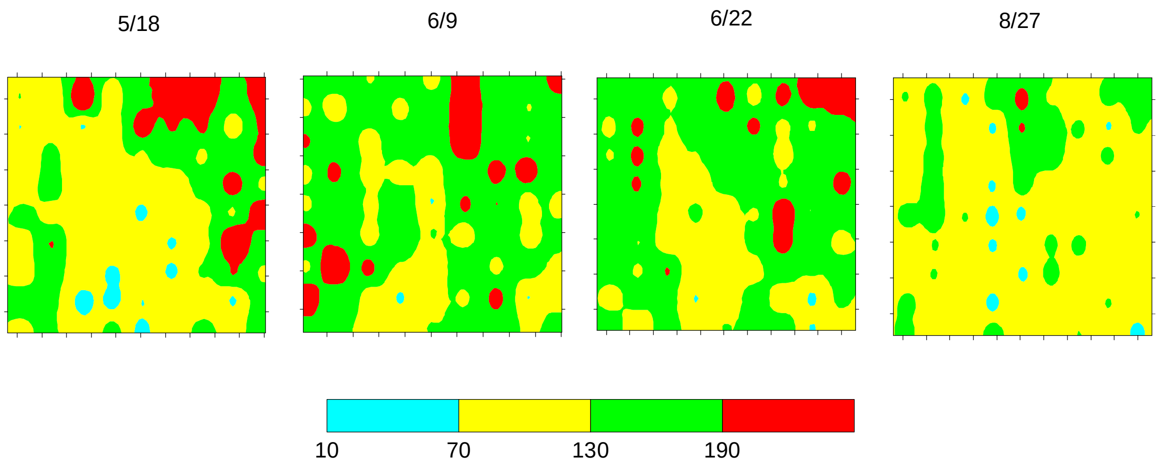
Residue plots were set up near St. Thomas, ND. The plots were organized using a randomized complete split block design. The field was fallow during the previous growing season so that residue from other crops would not interfere with the decomposition. The plot area was tilled twice with a field cultivator before the residue bags were buried to improve soil to residue contact.

The residue was sampled on May 15, May 29, June 19, and July 3, 2000. The bags were rinsed under lukewarm water to remove soil particles adhering to the bag and residue. The residue bags were dried at 65 degrees Celsius for 48 hours.

Weights were recorded on an ash-free basis according to procedures outlined by Parker (1962). Total N was determined on residue before it was buried and after each sampling date using the Kjeldahl procedure. Total C was also determined before residue was buried and again on sampled residue using a solid carbon analyzer by combustion method.

RESULTS

Figure 3. 0-2 foot NO_3-N levels, Section 29, 1999 over sampling dates.

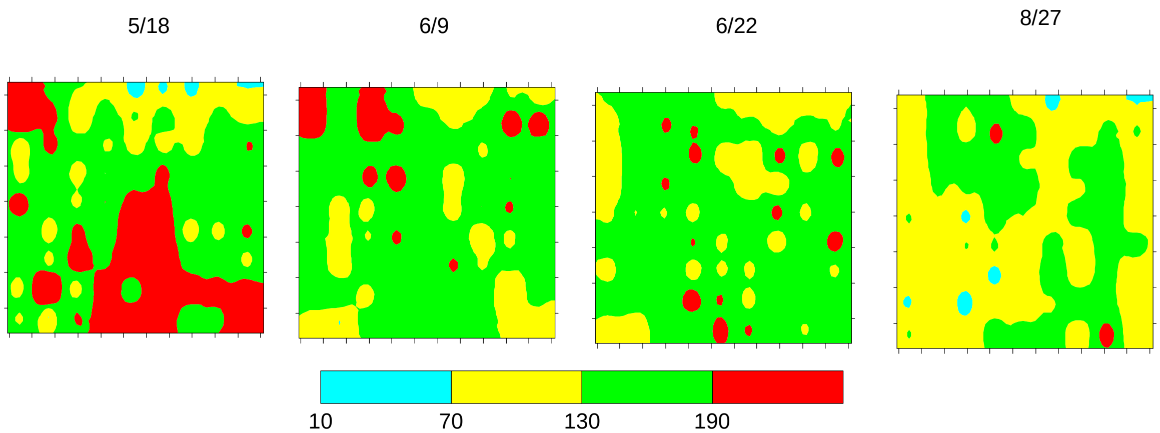


NO$_3$-N, lb/acre

Figure 3 shows a general increase in NO_3-N from 5/18 to 6/9 when nitrogen release peaked. Despite a 50 lb/acre credit given in the fall of 1998, statistically, there was not a difference between N released where credits were given and where there were no credits given. This suggests that reductions in N were justified. Had the 50 lb/acre reduction in fertilizer N been too great, lower N levels would have been present at the May and June sampling dates than were measured.

A general decrease in NO_3-N from mid-June to harvest is depicted in Figure 3 as the wheat crop continues to develop and consume soil N. Despite the 50 lb/acre N credit given (Figure 1), harvest NO_3-N levels are more uniform throughout the field. This again supports the credits of N given, as excess reductions would have increased variability throughout the field.

Figure 4. 0-2 foot NO_3-N levels, Section 34, 1999 over sampling dates.



NO_3-N, lb/acre

Figure 4 shows nitrogen release peaked around 5/18. Despite N credits as high as 100 lb/acre given in the fall of 1998, statistically, there was not a difference between N release in areas where credits were given and where there were no credits given. Again, this supports that reductions in N were justified. Had the three zones of N reductions in fertilizer N been too great (Figure 2), lower N levels would have been present at the May and June sampling dates than were measured. This again supports the theory that N from the previous year's sugarbeet tops are mineralized in time for the next year's wheat crop.

Similar to Section 29, a general decrease in NO_3-N from mid-June to harvest is depicted in Figure 4 for Section 34, as the wheat crop continues to develop and consume soil N. Despite the areas N credits given, harvest NO_3-N levels are more uniform throughout the field.

Figure 5. Kg Mineralized/1000 Kg Residue

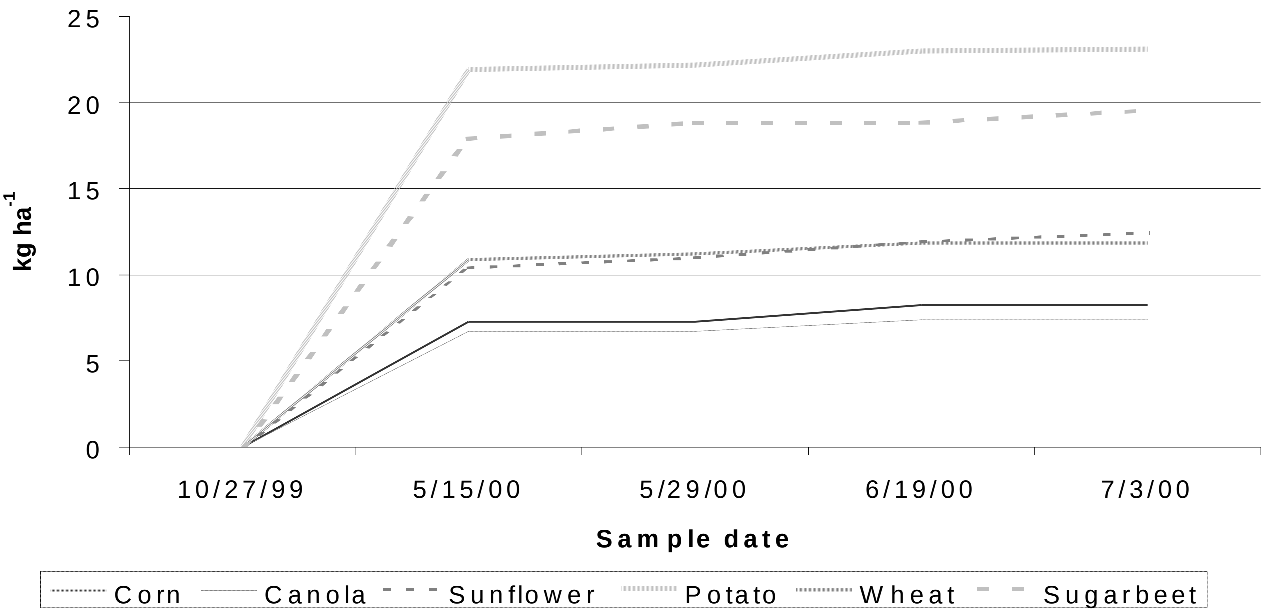


Table 1. %N Mineralized over sampling dates.

	% N			
	18-May	9-Jun	19-Jun	3-Jul
Corn	0.50 a	0.50 a	0.48 a	0.43 a
Canola	0.61 a	0.65 b	0.56 a	0.71 ab
Wheat	0.69 a	0.76 b	0.57 a	0.87 b
Sunflower	1.15 b	1.10 c	1.09 b	0.93 b
Sugarbeet	1.52 b	1.19 c	1.22 b	0.98 b
Potato	1.56 b	1.74 d	1.48 c	1.44 c

LSD = 0.05

Figure 5 shows that N mineralized from crop residues occurred by May 18, in time for most spring planted crops to utilize. There was not a statistical difference between N mineralized by May 18 and the other sampling dates, supporting our theory that most N mineralization occurs early in the growing season.

As suggested in Figure 3 and Figure 4, sugarbeet residue, as well as potato, have high N mineralization early in the growing season. This is attributed to the low C:N ratios of the two crops (Table 2). Figure 5 and Table 1 support research that sugarbeet and potato tops mineralize in time for the next year's crop to utilize (Reitmeier et al., 1998 and Franzen et al., 1999).

Corn and canola, and wheat and sunflower residue are similar in N mineralization, with corn residue mineralizing the least amount of N and also having the highest C:N (Figure 5, Table 1 and Table 2). This is evidence that residues higher in C:N ratios mineralize significantly less N than residues with a low C:N and therefore, do not justify a N credit.

Table 2. C:N over sampling dates.

C:N

	18-May	9-Jun	19-Jun	3-Jul
Sugarbeet	15.41 a	25.17 ab	19.06 a	19.07 a
Potato	16.25 a	18.95 a	17.28 a	16.15 a
Sunflower	33.18 a	40.17 bc	29.34 b	44.14 b
Wheat	56.51 b	58.28 d	70.01 c	47.67 b
Canola	65.42 bc	56.22 cd	72.29 c	45.98 b
Corn	81.30 c	86.14 e	84.48 d	77.43 c

LSD=0.05

Figure 6. Decomposition by sampling date.

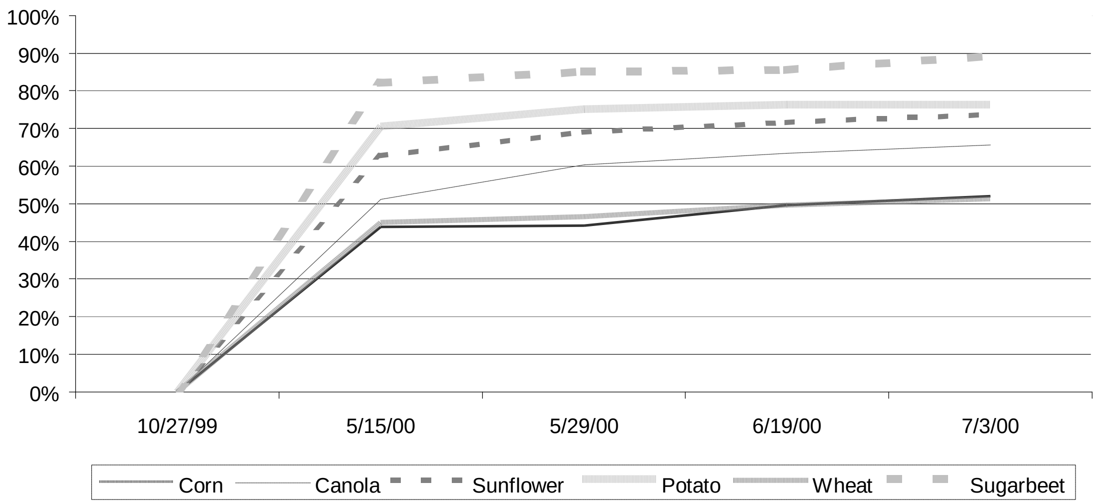


Table 3. Decomposition % over sampling dates.

% Decomposed

	18-May	9-Jun	19-Jun	3-Jul
Corn	43.86% a	44.81% a	49.58% a	51.38% a
Wheat	45.06% a	46.65% a	50.75% a	52.08% a
Canola	51.18% b	60.36% b	63.13% b	65.68% b
Sunflower	62.67% c	68.42% bc	72.96% c	73.60% bc
Potato	70.56% d	74.99% c	76.42% cd	76.66% c
Sugarbeet	82.10% e	85.11% d	85.53% d	89.25% d

LSD=0.05

Figure 6 shows that nearly all residue decomposition occurs by May 18, with very little throughout the growing season. Sugarbeet residue decomposed the most at all of the sampling dates. Potato and sunflower residue, and canola and sunflower residue decompose similarly throughout the growing season according to Table 3. corn and wheat residue also decompose at a similar rate to each other, as shown in Figure 6 and Table 3.

The wheat straw and corn stalks are 50% decomposed by July 3, whereas sugarbeet, potato, and sunflower residue are almost entirely decomposed. Again, the amount of N mineralized, rate of mineralization, and decomposition of sugarbeet and potato residue support that N credits given in our field study are appropriate.

SUMMARY

NO_3-N was available in the 0-24 inch depth in time for the spring wheat crop. By crediting areas according to their suspect N mineralization rates, it is possible to reduce fertilizer inputs, maintain yield, and result in more uniform N patterns throughout the field by harvest.

For all crops, most of the decomposition and N mineralization occurred by May 15. Potato and sugarbeet residue released the most N and was almost entirely decomposed by July 3. Wheat and corn residue had the lowest % N mineralized and decomposed the least throughout the growing season.

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