Effects of Residue Cover and Nitrogen Application Method On Strip-till Sugar Beet Production

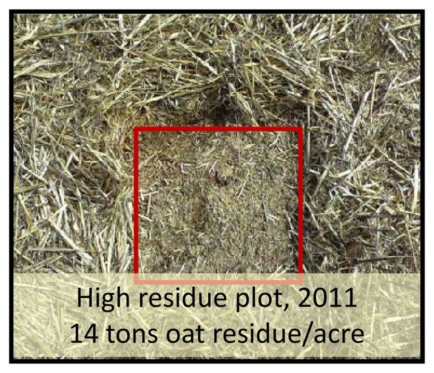
Amber Moore[1], Don Morishita[1], Oliver Neher[1] and David Tarkalson[2]
(1)Plant, Soils, and Entomological Sciences, University of Idaho, Twin Falls, ID (2)USDA-ARS, Kimberly, ID

Introduction

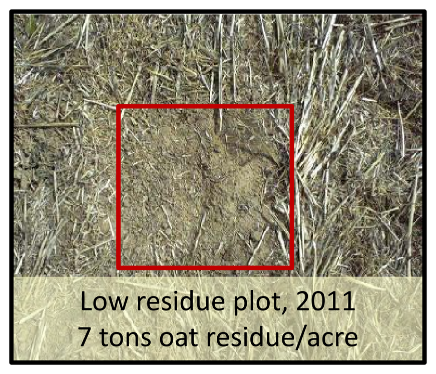
- Strip-till issue #1 – Chaff trails behind small grain combines
  - Low residue areas
    - Droughty, greater potential weed growth
  - High residue areas
    - Potential for fertilizer and pesticide binding, increased plant disease pressure, slower plant growth, uneven germination
- Strip-till issue #2 – Applying nitrogen fertilizers
  - Broadcast
    - Easy, use existing spreaders
    - Volatilization losses
    - Binding with residue
  - Shank
    - Added cost to outfit strip-till unit
    - Avoid volatilization and residue binding issues
    - Potential for seedling burn
- Project Goals:
  - Determine how residue level, nitrogen rate, and nitrogen placement impacts yield, beet quality, plant available N in the soil, and N uptake
  - Determine how residue level impacts soil temperature and soil moisture

Methods

- Experimental design
  - 3 X 3 X 2 Factorial
    - 3 residue levels, 3 N application rates, 2 N application methods
  - Randomized Complete Block Design
  - Four replicates
  - Spring strip-till
- Residue Cover
  - Wheat residue in 2009, barley residue in 2010, oat residue in 2011
  - Establishing residue levels in the fall
    - Bailed off residue, left standing stubble and finer residue pieces
    - Weighed bails to target levels
    - Hand spread over plots
    - Removed 1 ft. by 1 ft. square of residue from each, weighed to estimate residue cover amount
- Two N application methods
  - Broadcasted granular urea
  - Shanked-in liquid urea ammonium nitrate
  - 6 – 8 inch depth, Capstan fertilizer applicator
- Three fertilizer N rates, including a control
  - 0 , 4, and 6 lbs N/ton expected sugar beet yield, and including plant available N in the soil
- Response variables
  - Beet yield and quality
  - Soil N (1 ft. depth, measured post-harvest)
  - Plant N uptake
    - 8 tops per plot removed prior to harvest
    - Beet pulp from beets submitted for quality analysis
    - Pulp and tops analyzed for total N
  - Continuous soil temperature 3 and 6 inch depths – Hobo meter
  - Continuous soil moisture/tension measured at 12 inch depth – Hansen meter
  - All meters placed in low shank N plots, between rows in areas of greatest residue
  - 2010 data not included, due to clogged residue managers
    - Issue on high residue plots
    - Uneven dispersal of residue within plots
    - Increased potential for variability in growth



High residue plot, 2011
14 tons oat residue/acre



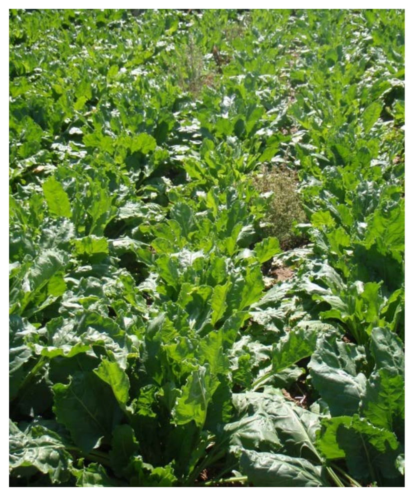
Low residue plot, 2011
7 tons oat residue/acre

Results – Residue Cover

- Significant year effect, related to differences in residue levels between years
  - 2009: 1 – 5 tons residue/acre; 2011: 7 – 15 tons residue/acre)
- 2009, Lower residue levels (1 – 5 ton/acre)
  - Significant yield losses for broadcast treatment with increasing residue levels **(Table 2)**
  - Related to both beet size and stand counts **(Table 2)**
- 2011, Higher residue levels (7 - 15 ton/acre)
  - Significant yield losses with higher residue levels (**Table 1)**
  - Beet size decreased with increasing residue levels, while stand counts were not affected **(Table 1)**
  - Residue level effects related to soil moisture tension **(Figure 1)**
    - Greater moisture under 15 ton/acre compared to 7 ton/acre
      - Increased moisture may have decreased beet size, due to greater nitrate leaching, poor root development, and decreased soil aeration

Results – Residue Cover

7 tons /acre



11 tons /acre

15 tons /acre

Visual differences in top growth for strip-tilled sugar beets grown in Kimberly, Idaho in 2011, as affected by oat residue cover amount.

Table 1. Effect of small grain residue level on strip-tilled sugar beet production parameters in 2011, averaged across N rates and N fertilizer application method.

Residue cover (ton/acre)	Beet yield (ton/acre)	Sugar content (%)	Beet Wt. (lb/beet)	Stand count (# beets/100 ft.)
7	30.3 a	18.3	11.9 a	236
11	27.8 ab	18.4	10.4 b	221
15	27.1 b	18.4	10.1 b	227
p value	*0.035*	*0.539*	*0.004*	*0.393*

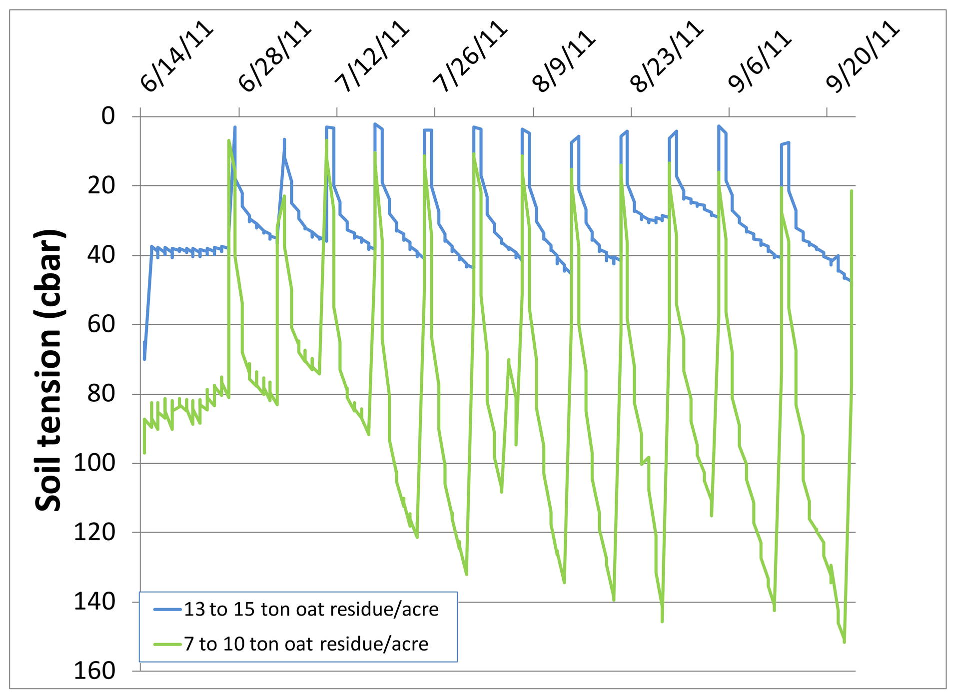


Figure 1. Soil moisture tension, as affected by oat residue cover level for strip-tilled sugar beets.

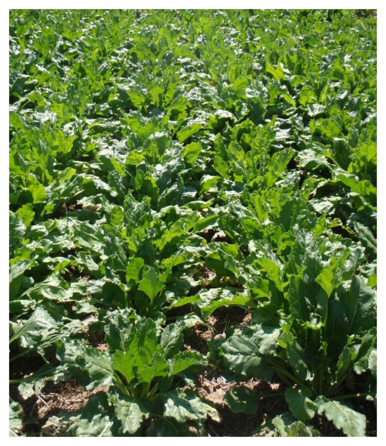
Results – N rate

- Significant year effect, related to differences in fertilizer N rate between years
  - N application rate adjusted yearly, based on soil test N
- 2009, Higher N rates (71 and 142 lb N/acre)
  - Significant N rate X application method interaction (alpha = 0.05)
    - Shanked-in Urea Ammonium Nitrate Solution
      - 71 lb N/acre rate supported optimal beet growth **(Table 2)**
      - Beets growth stunted at 142 lb N/acre rate
        - Beet weight significantly reduced with increasing N rate **(Table 2)**
    - Broadcasted Urea
      - Yields did not increase with application of broadcasted N in 2009 **(Table 2)**
- 2011, Lower N rates (47 and 124 lb N/acre)
  - No N rate X application method interaction (alpha = 0.05)
  - Significant increase in yield with application of N at 47 lb N/acre **(Table 3)**
  - Yield increases for the high N rate (124 lb N/acre) were not signification in comparison to 47 lb N/acre rate **(Table 3)**

0 lb N/acre

47 lb N/acre

124 lb N/acre



Visual differences in top growth for strip-tilled sugar beets grown in 2011, as affected by N application rate.

Results – N rate

Table 2. Effect of N rate, N application method, and small grain residue level on strip-tilled sugar beet production parameters in 2009.

N rate (lb N/acre)	Soil + fertilizer N (lb N/acre)	N App. Method	Residue cover (ton/acre)	Yield (ton/acre)	Beet Wt. (lb/beet)
71	140	Broadcast	1.2	28.1bcde	8.2abc
			2.7	28.8bcd	8.5abc
			5.3	19.4e	5.2c
		Shank	1.2	30.0bc	8.4abc
			2.7	29.4bcd	9.0abc
			5.3	38.7a	10.8ab
142	210	Broadcast	1.2	26.0bcde	8.3abc
			2.7	28.2bcde	8.6abc
			5.3	22.2cde	8.1abc
		Shank	1.2	32.4ab	12.5a
			2.7	28.3bcde	7.5bc
			5.3	20.9de	5.6c
p value				*0.003*	*0.138*

Table 3. Effect of N fertilizer rate on strip-tilled sugar beet production parameters in 2011, averaged across application method and residue level.

N rate (lb N/acre)	Soil + fertilizer N (lb N/acre)	Yield (beet ton/acre)	ERS (lb sugar/acre)
0	82	24.4a	8,025a
47	129	28.2b	9,263b
124	206	30.6b	10,043b
p value		*0.0005*	*0.0002*

Results – N application Method

- Broadcasting vs. Shank
  - Broadcasting urea significantly reduced stand counts in both 2009 and 2011, in comparison to shank treatment **(Table 4)**
    - Lower stand counts likely contributed to significantly lower beet yields in 2009, as beet weight was not affected **(Table 4)**
  - Otherwise, no effect on sugar beet production parameters (sugar content, Brei nitrate content, plant available N in the soil, plant N uptake, etc.)
  - Suggests that shanking in N may prevent yield losses related to reduced stand count, in comparison to broadcasted applications of N

Table 4. Effect of N fertilizer application on specified strip-tilled sugar beet production parameters in 2009, averaged over residue level.

N Application Method	N rate (lb N/acre)	Stand (# beets/100 ft.)
Broadcast	71	117a
	142	81b
p value		*0.0032*
Shank	71	156
	142	148
p value		*0.338*

Table 5. Effect of N fertilizer application on specified strip-tilled sugar beet production parameters, averaged over N rate and residue level.

Year	N Application Method	Yield (beet ton/acre)	ERS (lb sugar/acre)
2009	Broadcast	25.6b	6941a
	Shank	30.0a	8154b
	p value	*0.0024*	*0.0014*
2011	Broadcast	29.4	9695
	Shank	29.4	9611
	p value	*0.961*	*0.813*

Summary

- Residue cover, N application method, and N application rate can impact sugar beet production
- Lowered yields at residue levels above 6.9 ton/acre and in cases of high N rates
- Broadcasting significantly reduced stand in both years, suggesting that shanking in N may prevent stand, and in some cases, yield losses
- Shanking in N at rates of 140 lb N/acre or higher may cause yield losses