IMPACT OF RESIDUE COVER AND NITROGEN APPLICATIONS ON STRIP TILLED SUGAR BEET PRODUCTION: YEAR 2

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INTRODUCTION

Strip-tillage in sugar beets has brought new and exciting possibilities but also issues for growers. Some of these issues include uneven chaff trails and nitrogen fertilizer management. Regarding chaff trails, growers are concerned that areas with little residue will be droughty and will be more susceptible to weed growth, while areas with heavy residue coverage may have more fertilizer and herbicide binding in the residue, more soil-borne disease pressure under cooler and moister soil conditions, and higher carbon soil content. Also, determining the most effective methods for nitrogen fertilizer applications can be difficult. In a strip-till system, growers have to either broadcast nitrogen fertilizers, and rely on irrigation to move the fertilizer into the soil, or they can shank (knife) liquid nitrogen fertilizers in the spring with their strip-till equipment. How these methods of nitrogen application impact sugar beet production in a strip-till system is not known.

To address these concerns, we developed a multi-year study to look at the impacts of residue cover, nitrogen application method, and nitrogen application rates on various aspects of sugar beet production.

MATERIALS AND METHODS

The second year of this three year study was conducted at the University of Idaho Kimberly Research and Extension Center, Kimberly, Idaho. Sugar beets (BTS 2614) were planted into wheat residue cover, with residue levels of low (average of 2.4 dry tons residue/acre), medium (average of 4.0 dry tons residue/acre), and high (average of 5.1 dry tons residue/acre). Nitrogen fertilizer was applied at 0 lb N/acre (control), 26 lbs N/acre (equivalent to 4 lbs N/yield ton), and 96 lbs N/acre (equivalent to 6 lbs N/yield ton). Nitrogen fertilizer was applied either as broadcasted granular urea or shanked-in liquid urea ammonium nitrate (UAN). Four replications were used in a randomized complete block design.

Beets were harvested on October 13 and 14, 2010. Total yield, brei nitrate concentration, sugar content, and electricial conductivity were measured for the beets. Soil ammonium and nitrate were measured in the top 0-12 inches on October 22, 2010. Plant N uptake was estimated by measuring dry weights and total N content of 10 sugar beet tops per plot, as well as the total N from beet pulp collected from the Amalgamated TARE laboratory in Paul, Idaho. Weed counts were conducted throughout the growing season. Stand counts and disease observations were conducted from emergence until row closure.

Presented at the Idaho Sugar Beet Conference on January 14, 2011.

Soil temperature and moisture were measured for three low, three medium, and three high residue plots within the low N rate/shank treatment and between the rows in the areas of the greatest residue cover. Soil temperature was measured at 3 and 6 inch depths on an hourly basis from May 26 – September 30, 2010, using Hobo meters. Soil moisture was determined using Hansen meters at a 12 inch depth, with measurements taken at 4-hour increments.

RESULTS AND DISCUSSION

Challenges in 2010 included the clogging of residue managers on our new Orthman strip-till unit, and reseeding after a late freeze that partially destroyed the initially planted seedlings. The clogged residue managers contributed to uneven dispersal of the residue on the medium and high residue plots. Extenders have since been added to the strip-till unit to avoid this issue in 2011. Replanting into an existing stand of beets caused uneven beet growth throughout the field. This issue was addressed by thinning beets in yield rows to an approximate spacing of 8 inches, and will be addressed in future years by destroying the first seeding if there is another late spring frost event.

Sugar beet establishment and growth response

In 2010, N application method and N application rate had no significant effect on beet yield or brei nitrate concentrations (Table 1). The absence of a brei nitrate effect in 2010 (in comparison to a significant effect in 2009) is likely related to the lower N application rates used (26 and 96 lb N/acre in 2010 compared to 70 and 140 lb N/acre in 2009) and the increased length of time between planting and fertilizing in 2010 due to replanting after the late-season freeze. Sugar content was significantly lower for the high N rate shank treatment in comparison to the high N rate broadcast treatment. This may be related to a higher availability of N in the shank treatment, which can potentially lower sugar content. Electrical conductivity decreased significantly in the broadcast treatment with increasing N rate.

The strongest evidence of a residue level effect in 2010 was seen in the control plots. While not statistically significant, there was a decreasing trend in beet yield from the low to the high residue plots (Table 2). It is likely that the nitrogen-stressed control plants had poor emergence through the thick mat of residue above. It is also possible that the cooler temperatures on the higher residue plots may have stunted initial growth during the cool spring temperatures. Sugar content did significantly increase with residue level in 2010. It seems most likely that the decrease in yields may have contributed to this effect, as smaller beets tend to have higher sugar concentrations than larger beets.

Table 1. Yield, beet quality, soil nitrogen, and nitrogen uptake in sugar beets grown in a strip-tillage system near Kimberly, Idaho, in 2010. Data is averaged over residue levels ranging from 0.9 to 6.9 tons/acre. Numbers in the same column followed by the same letter are not significantly different at the 95% probability level.

N app. Method	N rate	Soil N + Fert. N	Beet yield	Sugar content	Brei nitrate	EC	Soil NH4 (post harvest)	Soil NO3 (post harvest)	Nitrogen uptake in tops
	-------(lb N/acre)-----		ton/acre	%	ppm		lb N/acre	lb N/acre	lbs N/acre
Broadcast	0	114	27.7	16.2ab	70	0.811a	9.9	6.0	87
	26	140	29.6	16.1ab	70	0.805ab	7.1	6.5	94
	96	210	29.6	16.5a	67	0.772b	4.1	6.0	93
Shank	0	114	27.7	16.2ab	70	0.811ab	9.9	6.0	87
	26	140	28.6	16.1ab	62	0.775ab	9.0	5.8	91
	96	210	29.3	15.8b	86	0.774ab	9.2	6.6	99
p value			*0.9611*	*0.0507*	*0.3687*	*0.0670*	*0.2895*	*0.9367*	*0.9198*

Table 2. Yield, beet quality, soil nitrogen, and nitrogen uptake in sugar beets in a strip-tillage system near Kimberly, Idaho, in 2010. Broadcast and shank treatments are averaged over two nitrogen application rates (26 and 96 lb N/acre). Numbers in the same column followed by the same letter are not significantly different at the 95% probability level.

N app. Method	Average residue level	Beet yield	Sugar content	Brei nitrate	EC	Soil NH4 (post harvest)	Soil NO3 (post harvest)	Nitrogen uptake in tops
	(dry ton/acre)	ton/acre	%	ppm		lb N/acre	lb N/acre	lbs N/acre
Broadcast	2.4	26.4	16.5a	65	0.76	5.4	8.4a	102a
	4.0	31.8	16.2ab	56	0.79	4.7	3.6b	105a
	5.1	30.7	16.1ab	85	0.82	6.7	6.7ab	73b
Shank	2.4	30.2	16.2ab	88	0.85	9.8	6.3ab	101ab
	4.0	26.9	16.0ab	65	0.80	8.7	6.2ab	88ab
	5.1	29.6	15.7ab	65	0.80	9.3	6.0ab	96ab
Control	2.4	31.3	15.6b	81	0.78	5.3	5.7ab	96ab
	4.0	29.0	16.3ab	56	0.76	15.1	6.7ab	88ab
	5.1	22.8	16.6a	73	0.77	7.6	5.5ab	78ab
p value		*0.5819*	*0.0518*	*0.4895*	*0.2367*	*0.4299*	*0.0610*	*0.1074*

Soil and plant nitrogen

Soil plant available N and N uptake (tops) data are listed in tables 1 and 2. Nitrogen application method and rate had no effect on plant available soil N or N uptake (table 1). This was expected due to the low N rates used and the delayed time between N fertilizer application and replanting. Soil nitrate concentrations decreased from low to moderate residue levels for broadcasted N (table 2), suggesting that N-tie up with carbon in the residue organic matter and/or volatilization rates increased with increasing residue levels. Nitrogen uptake in the beet tops significantly decreased with the highest residue level when N was broadcast (table 2), which coincides with the decreasing nitrate concentrations in the soil. However, this was not observed when N was shank applied and may be related to the fact that more N was available for uptake than the broadcast application.

Soil temperature and soil moisture

Temperature data were collected continuously throughout the growing season on selected low-nitrogen shank plots. At the 3 inch depth, maximum soil temperatures appeared to decrease from 90 to 81 °F while minimum temperatures were both at 44 °F with increasing residue levels (2.2 – 6.4 ton/acre), indicating that greater residue coverage decreased maximum soil temperatures. Average soil temperature also increased from 64 to 66 °F at both the 3 inch and 6 inch depths.

Soil moisture was greater on low residue plots than high residue plots from mid-May until early September, where moisture values were similar between the two treatments. Evaporative losses are expected to decrease with thicker residue coverage, therefore we had anticipated an opposite effect with greater moisture under high residue plots. We had similar results previously in 2009. These findings show that the thicker residue layer may be absorbing a significant amount of water. Therefore growers should consider increasing irrigation rates earlier in the season in order to leach water through the residue and into the soil profile.

Disease and weed pressure

In 2010, no stand reduction or root diseases caused by soil-borne pathogens were observed during the growing season. The absence of soil-borne pathogens was probably related to water management. The plots were irrigated at optimum levels and not over irrigated, which would have increased disease potential.

Similar to what was observed in 2009, weed control with glyphosate was not affected greatly by crop residue level, nitrogen rate or application method (broadcast versus shanked). Weeds evaluated in the 2010 study included common lambsquarters, kochia, redroot pigweed, annual sowthistle, Russian thistle, hairy nightshade, green foxtail and barnyardgrass. Weed seedling emergence was not affected by the different crop residue levels or nitrogen application method or rate. It appears that weed emergence and weed control in a strip tilled grain stubble field is not influenced much by crop residue level, nitrogen application rate or whether it was broadcast or shanked into the soil