Sugarbeet Performance Under Strip-Till and No-Till Management

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IMPACT STATEMENT

Conventional tillage is still widely used by sugarbeet growers in Montana. This tillage system has many unintended consequences for soils and the environment as well as a high cost of fuel, machinery, and equipment, labor. Our face to face interviews with growers in eastern Montana confirmed that conservation tillage such as no-till can offer up to $200 savings per ac (depending on the management practices) with no or minimum yield penalties. The results of present study showed sugarbeet yield and quality did not differ when strip-till and no-till were adopted.

SUMMARY

Conventional tillage (CT) is still widely used by sugar beet growers, with many unintended consequences for soils and the environment. Conventional tillage is also expensive, requiring large labor and fossil energy inputs. Therefore, shifting from CT to reduced tillage practices such as strip-till (ST) and no-till (NT) has drawn attention. Nutrient management, especially nitrogen (N), needs to be optimized when tillage system is changed. A field experiment was conducted in 2016 in Sidney Montana to evaluate the performance of sugar beet under CT vs. ST and NT under various rates of N (50, 100, 150, 200 lb ac^{-1}). No significant difference was observed between tillage systems in terms of root yield, sucrose percent, and sucrose yield. This is highly important since NT provided economic benefits (lower cost, less labor, less fuel consumption) as well as ecosystem services (less soil erosion, soil compaction, etc.) while producing similar yield as CT. No significant difference was observed regarding sugarbeet response to N rate in respect to the tillage system.

INTRODUCTION

Montana ranks 6th in the nation in sugarbeet production. Conventional tillage (CT) is still widely used by growers, which consists of five or more passes across a field for plowing or ripping, leveling, and hilling. CT has many unintended consequences for soils and the environment such as loss of organic matter and beneficial soil organisms, increased soil erosion and pesticide runoff, reduced soil fertility, loss of soil structure and porosity, compaction, surface crusting, the formation of plow pans, reduced root growth, and poor drainage. CT is also expensive, requiring large labor and fossil energy inputs. Shifting from CT to conservation tillage practices such as strip tillage (ST) and no-till (NT) would offer numerous agronomic, environmental, and economic benefits. However, more research is needed proving the benefits of conservation tillage.

The main objective of this study was to evaluate yield and quality of sugarbeet under NT and ST management compared to CT. We also evaluated if sugarbeet response to nitrogen rate varied by type of tillage in this environment.

PROCEDURES

A field experiment was conducted in 2016 at EARC irrigated farm located in Sidney MT to evaluate the response of sugarbeet to nitrogen rate (50, 100, 150, 200 lb N/ac supplied with 46-0-0) under CT, ST, and NT. Soil at this location is containing 2.3% organic matter and pH of 8.3. Soil residual N to 4 ft depth was 23 lb NO3-N/ac.

The experiment was conducted in a split plot arrangement based on a randomized complete block design with four replications. Main plots were tillage systems and subplots were nitrogen

Table 1. Monthly weather data at Sidney during sugarbeet growing season in 2016

Month	Max Temp (°F)	Min Temp (°F)	Avg Temp (°F)	Total Rainfall (inch)
Apr.	60	33	46	3.5
May	71	43	57	2.1
June	81	54	67	1.4
July	85	57	71	2.7
Aug.	84	53	68	0.7
Sept.	70	47	59	2.6

Data from https://ndawn.ndsu.nodak.edu

rate. Weather data during the sugarbeet growth period are shown in Table 1.

CT was performed in early spring consisted of three passes to deep disking and two passes of much packing. ST was performed at the same time as CT using a specialized equipment described in detail by Evans et al. (2009).

The previous crop was spring wheat and its chaff and straw were uniformly spread after combine harvest. The six-row strip tiller was set to a depth of 8 inches with a straight coulter in front of a semi-parabolic shank followed by two wavy coulters and a crowsfoot packer wheel (Schlagel TP 6524, Schlagel Mfg., and Torrington, WY) that tills 12-inch wide strips and leaves 12-inch of standing stubble between tilled rows. In NT plots, seeds were sown directly without any seed bed preparation.

Sugarbeet (cv. American Crystal S360) was planted on May 6, 2016, at a rate of 1.09 seed/ft^2 (5.5 inches between plant and 24 inches between rows). Due to sprinkler irrigation, all tillage treatments were flat-planted (no furrow created).

Nitrogen fertilizer was banded 3 inches away from the seeding row after seeding using a plot drill. All plots received an equal amount of P (20 lb/ac 11-52-0) and K (40 lb/ac potash) fertilizers which were broadcasted on soil surface three days before seeding. Roundup was applied at a total rate of 48 ounces/ac for weed control. One application of Minerva-Duo fungicide was also used to control fungal disease.

Plots were harvested on Sep 19, 2016. Prior to harvest, aboveground biomass samples were taken. At the time of harvest, plots were mechanically defoliated then a scale-mounted harvester was used to dig and weigh the roots from 30 ft long of the central row. Pre-wash root yield was recorded then a sample of 12 roots was randomly taken from each plot. The samples were transported to Sidney Sugar Inc. Tare soil and sucrose percentage were determined. Extracted juice sent to Agterra Technologies Inc. (Sheridan, WY) for impurity analysis. To measure Impurity Value and the percentage of sucrose losses to molasses (SLM). Laboratory results for Na, K, amino N, impurity index, and SLM was obtained from this laboratory as well. Based on SLM, extractable sucrose yield was determined (Eckhoff et al., 2005).

Data were analyzed using Proc GLM of SAS and menas were seprated by LSD test at $P<0.05$.

RESULTS AND DISCUSSION

The effect of tillage and nitrogen rate on sugrabeet yield and other variables are shown in Table 2. Tillage had a significant effect only on aboveground biomass and plant stand. Interestingly, aboveground biomass and plant stand were higher in no-till compared to CT and ST (Table 3). Due to a problem with irrigation system at the time of seed germination and establishment, it seems that better moisture availability in NT soil at this time led to the better establishment in this treatment. No significant difference was found between tillage systems in terms of root yield, sucrose percent, sucrose yield, and SLM. This is highly important since NT can provide economic benefits (lower cost, less labor, less fuel consumption) as well as ecosystem services (less soil erosion, soil compaction, etc.) while producing similar yield as CT. No significant response was observed with increasing nitrogen rate in either of tillage systems. Nitrogen Use efficiency (lb sucrose/lb N used) followed a decreasing trend in response to increasing rate of N regardless of tillage system (Fig. 1).

Table 2. P values for the effect of tillage and nitrogen rate on sugarbeet variables.

SOV	DF	Aboveground biomass	Plant/ac	Sugar	Root YLD	Sucrose YLD	Impurity Value	SLM	Extractable Sucrose
Rep	3	0.775	0.572	0.207	0.951	0.906	0.220	0.207	0.366
Till	2	0.003	0.040	0.334	0.755	0.848	0.687	0.710	0.833
N	3	0.258	0.688	0.613	0.778	0.678	0.884	0.873	0.564
Till*N	6	0.430	0.618	0.989	0.988	0.991	0.795	0.747	0.821
CV (%)		18.7	17.9	5.3	20.9	19.1	13.1	13.0	18.0

Based on the results obtained in this experiment, no significant variation was found in sugarbeet response to nitrogen rate based on tillage practices. More efforts are needed to optimize nitrogen fertilization for sugarbeet under various tillage practices in this region.

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Table 3. Main effect of tillage and nitrogen on sugarbeet measured variables.

Treatments		Aboveground biomass (lb/ac)	Plant/ac	Sugar (%)	Root YLD (ton/ac)	Sucrose YLD (lb/ac)	Impurity Value	SLM	Extractable Sucrose (lb/ac)
Tillage	CT	3418b	24756a	17.4	26.9	9510	0.65	0.97	8743
	ST	3503b	22148b	17.1	28.3	9620	0.68	1.01	8837
	NT	4469a	26358a	17.5	27.4	9577	0.65	0.97	8351
Nitrogen	N 50	4036	24799	17.5	28.6	10009	0.65	0.98	9147
	N 100	3974	25851	17.5	26.8	9312	0.64	0.97	8756
	N 150	3778	23650	17.1	26.3	8994	0.66	1.00	8125
	N 200	3485	23705	17.3	28.7	10000	0.66	0.99	8737

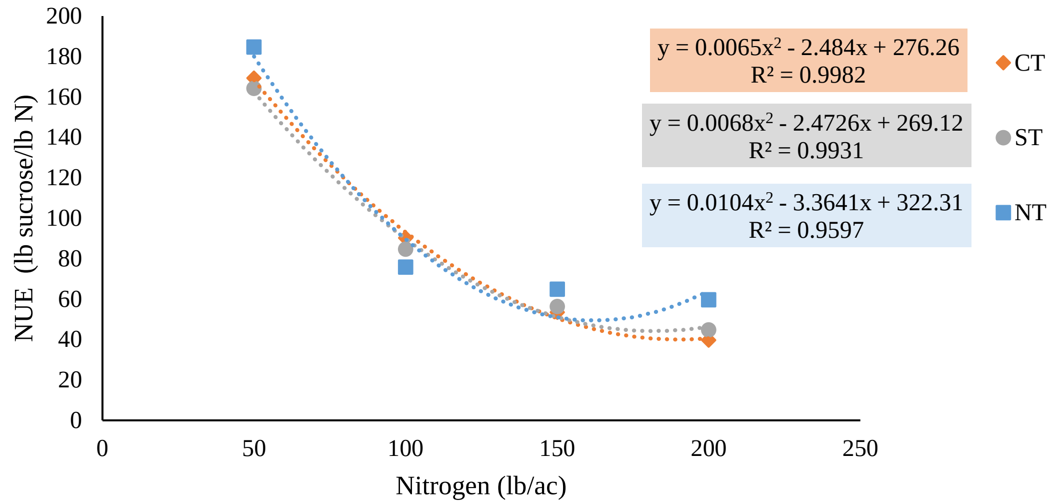

Figure 1. NUE of sugarbeet in response to nitrogen rate under conventional tillage (CT), strip tillage (ST), and no-till (NT).