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MONTANA FERTILIZER eFACTS

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Tillage, Nitrogen and Foliar Mg Effect on Sugar Beet Yield and Quality

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INTRODUCTION

Conventional tillage for sugar beet (*Beta vulgaris* L.) typically involves deep plowing using a ripper or chisel plow, followed by multiple passes of disking, mulching, and leveling to create a finely prepared seedbed to ensure optimal seedling establishment. However, these intensive tillage practices have numerous adverse effects on soils and the environment, including the depletion of soil organic matter, increased soil erosion and fertilizer runoff, and disruption of soil structure and porosity causing surface crusting. Intensive tillage practices also have high fuel use and labor costs. Researchers are exploring the viability of incorporating conservation tillage in sugar beet production to address these challenges.

Soil nitrogen (N) management is critical for optimal sugar beet root yield and sucrose concentration. Inadequate N fertilization hampers root yield, while excessive N can diminish sucrose concentration and elevate impurities in sugar beets. Imbalanced nutrients in the soil, including macro- and micro-nutrients, may also result in lower yield and sucrose concentration of sugar beet. A study was conducted at MSU Eastern Agricultural Research Center to investigate: 1) the optimal N rate and application timing for the maximal root yield and sucrose concentration in both no-till (NT) and conventional tillage (CT), and 2) the potential increase of root yield and sucrose concentration through foliar application of magnesium (Mg) or zinc (Zn).

METHODS

Two field experiments were conducted in 2019 and 2020 in Sidney, MT, using a sprinkler irrigation system. The soil at the experimental site is characterized as deep, well-drained, and nearly level Savage clay loam. Initial composite soil samples were collected to assess the soil fertility status (Table 1). Over the period from April to September, the site received 10.4 inches of precipitation and 9.8 inches of irrigation water from planting to harvesting in 2019, while from April to September 2020, the site received 5.8 inches of rainfall and 13.2 inches of irrigation water. Sugar beets were planted following spring wheat.

The sugar beet variety Crystal S696 GEM 100 was seeded with a no-till beet planter in both years. In 2019, sugar beet was planted April 24 and harvested September 24. In 2020, sugar beet was sown April 22, replanted May 1 due to frost damage, and harvested September 2.

The main treatments were tillage, i.e. no-till (NT) and conventional tillage (CT) with two fertilizer-N application times: spring application in April and fall application in the previous October. Within each tillage and fertilizer application timing, we used three N rates (120, 160, and 200 lb N/acre) with and without foliar applications of Mg and Zn. Chelated EDTA-Mg (1.0 lb Mg/acre) and EDTA-Zn (0.8 lb Zn/acre) were applied once at the 8-10 leaves stage. Fertilizer-P application was based on soil tests (Table 1) and Montana State University's recommended guidelines.

Table 1. Top 12-inch soil test value shortly before seeding sugar beet.

Year	Tillage	pH	OM	NO_3-N	P	K	Mg	Zn	Ca	Na	Fe	Mn	Cu	B	CEC
			(%)	(lb/acre)	Olsen (ppm)	(ppm)									(meq/100g)
2019	NT	8.3	3.3	32	15	351	614	0.54	6209	156	8.5	5.74	1.33	1.8	37.7
	CT	8.2	3.7	38	17	431	615	0.57	6050	148	8.1	6.08	1.18	1.8	37.1
2020	NT	7.9	1.9	42	21	162	- [1]	-	-	-	-	-	-	-	-
	CT	7.9	1.8	42	21	162	-	-	-	-	-	-	-	-	-

[1] Mg, micronutrients and CEC not measured in 2020

RESULTS

Root yield was higher with NT than CT in 2019, and not different between NT and CT in 2020 (Fig. 1A, on page 3). Tillage did not affect root sucrose concentration, impurity, and sucrose loss to molasses (SLM; Fig. 1BCD).

Spring application of N produced 6.6 tons/acre more root than fall application in 2020, yet there was no yield difference between fertilizer application timing in 2019 (Fig. 2A on page 3). The N application timing did not affect sucrose concentration, impurity or SLM (Fig. 2BCD).

The effect of N rate, Mg and Zn on root yield and quality is presented in Table 2. There was a trend of fertilizer-N application increasing sugar beet root yield both in 2019 and in 2020, and the root yield plateaued at 160 lb N/acre. Sucrose concentration decreased with increasing N rate. Foliar application of Mg consistently increased root yield, but slightly decreased sucrose concentration. When averaged across N rates, chelated Mg increased yield and decreased sucrose in 2019 (data not shown), but had no effect in 2020. Zn did not increase root yield or sucrose concentration.

FERTILIZER FACTS

- No-till planting can achieve similar root yield and sucrose concentration if seedlings can be successfully established in no-till planting.
- No-till sugar beet requires similar nitrogen fertilizer input as conventional tillage
- Spring application of N produced higher root yield than fall application in 2020, but there was no difference in 2019.
- Root yield increased, but sucrose concentration decreased, with increased N input.
- The optimum N rate is around 160 lbs N/acre considering root yield, sucrose concentration, and economics.
- Foliar application of 1.0 lb Mg/ac increased sugar beet root yield in one year but not the other.

ACKNOWLEDGEMENTS

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Table 2. Sugar beet yield and quality as influenced by combined effects of N fertilizer rate with foliar application of Mg or Zn. Values are averaged across years, tillage systems and fertilizer-N application timing.

Treatment	Root yield (ton/acre)	Sucrose (%)	Impurity value (mg/100 g sucrose)	SLM[1] (%)
N120	34.2 c[2]	18.4 a	0.526 d	0.788 d
N120+Mg	34.7 bc	17.9 bc	0.552 cd	0.828 cd
N120+Zn	34.3 c	18.0 ab	0.557 cd	0.835 cd
N160	36.8 abc	17.9 b	0.589 abc	0.883 abc
N160+Mg	38.0 a	17.5 d	0.589 abc	0.884 abc
N160+Zn	35.9 abc	17.8 bcd	0.597 abc	0.896 abc
N200	36.5 abc	17.8 bcd	0.630 a	0.945 a
N200+Mg	37.8 a	17.5 d	0.614 ab	0.920 ab
N200+Zn	37.2 ab	17.7 bcd	0.576 bc	0.864 bc

[1]SLM Sucrose loss to molasses

[2]Values within the same column with at least one letter in common are equal with 95% probability.

Edited by Clain Jones, Extension Soil Fertility Specialist, and Kathrin Olson-Rutz, Research Associate

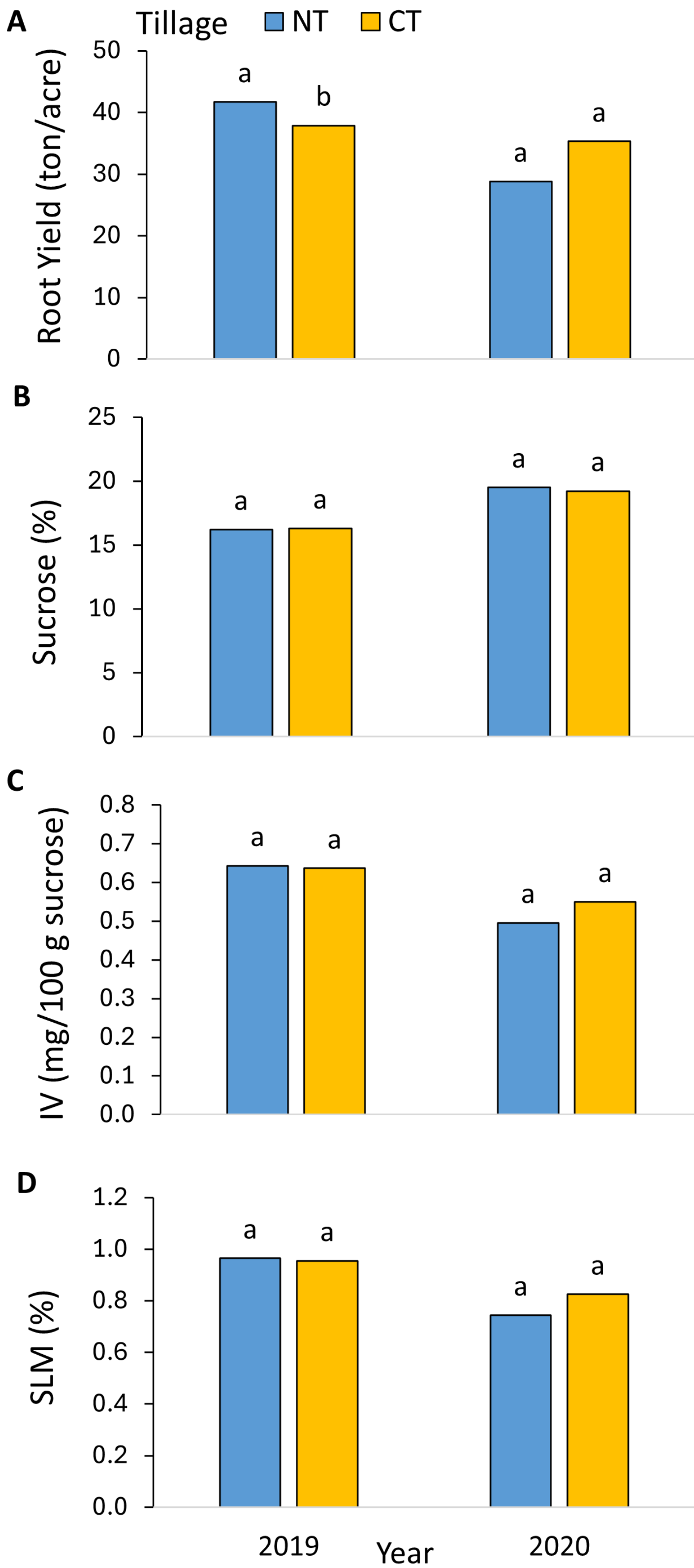

Figure 1. Tillage effect on sugar beet root yield (A), sucrose concentration (B), impurity value (IV, C), and sucrose loss to molasses (SLM, D). Bars with the same letter in the same figure and year are not different with 95% probability.

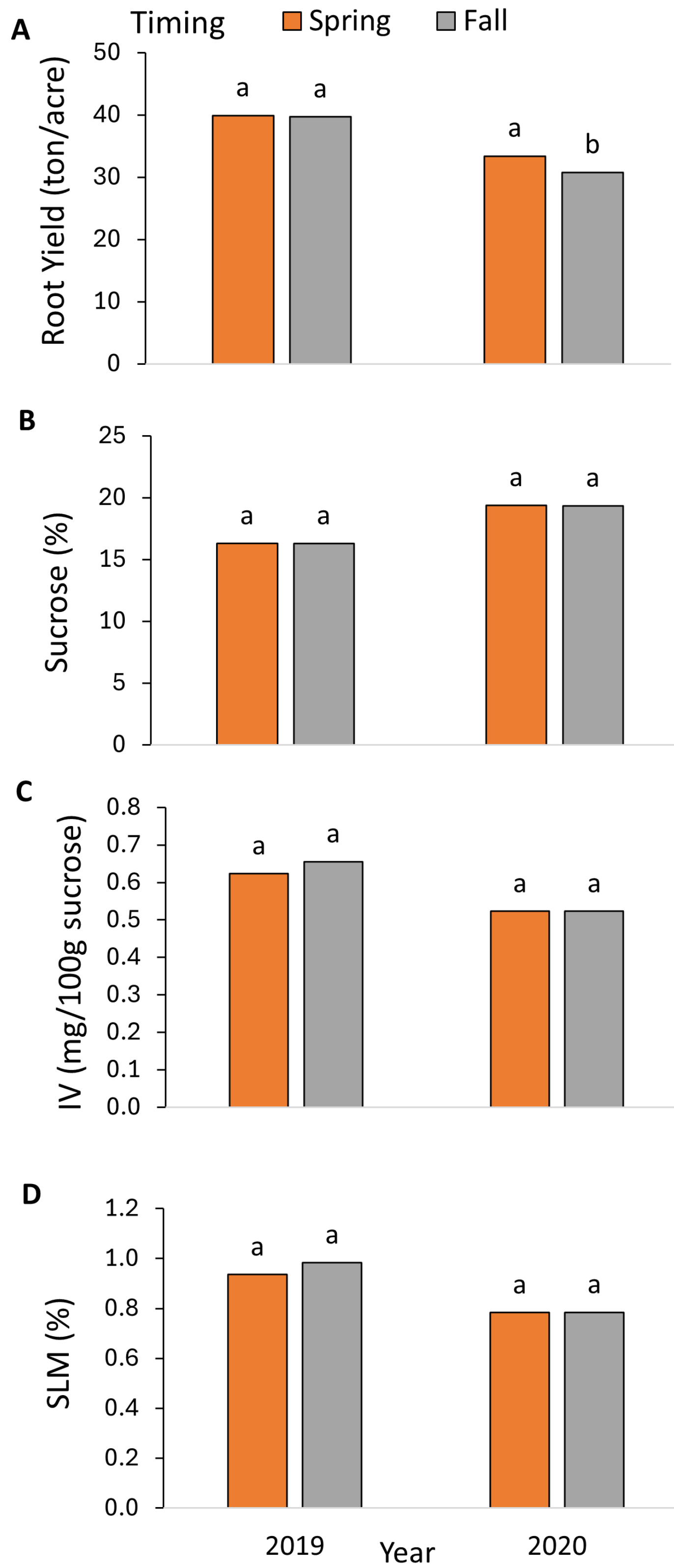

Figure 2. Nitrogen application timing effect on sugar beet root yield (A), sucrose concentration (B), impurity value (IV, C), and sucrose loss to molasses (SLM, D). Bars with the same letter in the same figure and year are not different with 95% probability.

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