INTER-SEEDING OF COVER CROPS UNDER SUGARBEET

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INTRODUCTION

Wind/water erosion are responsible for soil loss in the Red River Valley (RRV). Fields with crops having minimum residue cover after harvest are particularly prone to erosion. Consequently, the crops planted on these soils face the damage or even occasional re-seeding is necessary if the spring wind occurs before the seedlings become large enough to resist the wind and water damage. After the harvest few leaves or groundcover remain to protect the soil from wind and water erosion. Sugarbeet crops (especially sugarbeet seedlings) are negatively affected from wind storms in several aspects. Damage ranges from minimal to complete and can result in a need to re-seed the entire fields. Re-planting particularly can cause great economic loss particularly when Roundup Ready sugarbeet seed are used and there's a short window left for crop establishment. On the top, increased fluctuation in climate with frequent drought and severe, localized rainstorm events in the region has accelerated the effect.

Cover cropping practices have become more widely adopted in the RRV as a way to reduce soil loss from wind and flood events. The following criteria are some of the most important for selecting a cover crop for sugarbeet production in the RRV; holds soil in place with a sufficiently developed root system, reduces wind damages to young seedlings with its aboveground biomass, is inexpensive, and can be managed and killed so that it does not compete with the crop for nutrients, water, and light. But establishing cover crops in RRV is not without its challenges. There's a little growing season left after the harvest (Sept-Nov), it often limits the ability to get a good cover stand. As a solution, we hypothesized that inter-seeded cover crop will produce more biomass, and its root will protect the soil from erosion during fall and early spring. So this research is focused on identifying the effects of interseeding cover crop species and best time to plant these cover crops and how these interaction effect sugarbeet yield and quality. This will help growers to determine which cover crop species and planting date is most promising for incorporation into the sugarbeet cropping system. With this, RRV sugarbeet growers can find appropriate species and interseeding time for off-setting the extra time, effort, and expense involved in the work of planting and managing the crops.

METHODS

Field study was conducted at two sites, Ada, MN and Prosper, ND. The experiment was laid out in factorial RCBD which included four different cover crops inter-seeded at two planting date, check (no cover crop), winter rye (*Secale cereal* L.) cv. ND Dylan, winter camelina (*Camelina sativa* L.) cv. Joelle, winter Austrian pea (*Pisum Sativum* L.), mustard (*Sinapis alba* L.) cv. Kodiak, as main plot and two cover crops planting time (June and July) as sub plot with four replications.

Table 1. Seeding rates of inter-seeded cover crops in 2019 at Ada and Prosper

Cover Crop	Cultivar	Seeding Rate (lbs/acre)
Austrian Pea		20
Camelina	Joelle	6
Mustard	Kodiak	10
Rye	ND Dylan	20

Individual treatment plots measured 11 feet wide and 30 feet long. Standard Roundup Ready sugarbeet cultivar was planted. The sugarbeet seeds were planted 4.75" apart. Recommended NPK fertilizers were applied prior to planting based on soil test. Sugarbeet planting was done at May 13th and May 16th for Ada and Prosper respectively. For Ada,

first cover crop planting was done on 13th June and second on 24th June whereas for Prosper, first and second cover crop planting was done on 17th June and 2nd of July respectively. The cover crops were inter-seeded in between sugarbeet rows using a hoe. A 22 inches row spacing was used. Fungicide applications were done thrice, for the control of fungal diseases such as Cercospora in sugarbeet. Hand weeding was done to control other weeds in between the crops. The cover crop biomass was measured just before the harvest and 0-6" depth soil samples were analyzed for inorganic nitrogen concentration. Sugarbeet trials were harvested on September 16th and October 9th for Ada, MN and Prosper, ND respectively. The middle two rows of each plot were harvested and subsamples were analyzed to determine, crop yield, sugar percentage and recoverable sugar per acre. Yield determination were made, and quality analysis was performed at American Crystal Sugar Quality Tare Lab, East Grand Forks, MN.

The effect of cover crop inter-seeding on yield was analyzed using RCBD. The proc GLM procedure of the Statistical Analysis System (SAS Inc.) was used for analysis of variance of all data. Probabilities equal to or less than 0.05 were considered significant for main effects and interactions. The least significant difference (LSD) test was used to separate differences between treatment means if analysis of variance indicated the presence of such differences.

Table 2. Initial soil nutrient concentration and basic soil physical-chemical properties

Site	**Ada, MN**	**Prosper, ND**
Textural Class	Sandy Clay Loam	Silty Clay Loam
pH	7.6	6.7
NO_3-N 0-6" (lb ac^{-1})	14.4	16
Olsen P (ppm)	19.5	40
K (ppm)	171.6	280
OM (%)	3.07	3.3

RESULTS AND DISCUSSION

Precipitation was abnormally high in 2019. There was 25% and 59% more precipitation from May to October in 2019 than in 2018 at Ada and Prosper respectively. Rainfall in 2019 at Prosper was higher than at Ada.

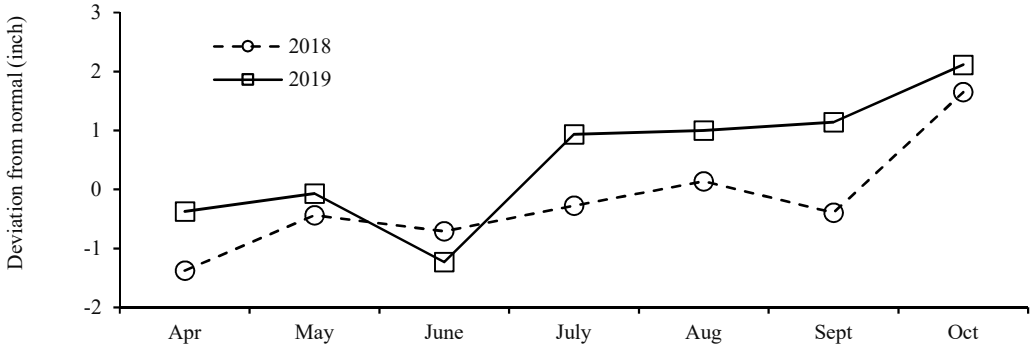

Figure 1: Deviation from normal precipitation for 2018 and 2019.

Sugarbeet root yield: The cover crop treatment and its planting time significantly affected the sugarbeet root yield and sugar quality at Ada (Table 3).

Table 3. Effect of different inter-seeded cover crops on sugarbeet root yield (tons acre^{-1}), sugar quality (%) and recoverable sugar/acre for Ada and Prosper during 2019 growing season.

Site	Planting Time	Treatment	Root Yield (ton acre^{-1})		Sugar %		RSA	
Ada, MN	13-Jun	No Cover Crop	30.87±4.04	AB	16.32±0.30	BCD	9219±1203	AB
		Rye	21.65±4.46	D	16.95±0.42	A	6716±1244	D
		Camelina	26.99±3.22	BC	16.82±0.46	AB	8315±774	BC
		Austrian pea	25.45±4.33	CD	16.31±0.25	BCD	7580±1201	CD
		Mustard	22.41±1.59	D	16.19±0.36	CD	6614±505	D
	24-Jun	Rye	30.77±0.84	AB	16.34±0.40	BCD	9186±84	AB
		Camelina	34.17±1.40	A	16.02±0.11	CD	9996±357	A
		Austrian pea	33.55±2.63	A	15.88±0.57	D	9714±368	A
		Mustard	32.08±1.53	A	16.54±0.30	ABC	9700±532	A
		$LSD_{0.05}$	4.33		0.54		1169	
Prosper, ND	17-Jun	No Cover Crop	35.79±3.51		14.87±0.63		9955±1024	
		Rye	34.30±5.40		14.84±0.24		9556±1543	
		Camelina	38.05±3.51		15.13±0.69		10772±745	
		Austrian pea	35.21±5.57		14.96±0.43		9803±1351	
		Mustard	33.61±4.24		14.83±0.78		9360±1102	
	2-Jul	Rye	37.42±4.52		14.41±0.84		10020±1215	
		Camelina	38.18±1.79		15.15±0.90		10560±963	
		Austrian pea	40.35±4.50		14.69±0.23		11071±1236	
		Mustard	38.30±2.99		14.65±0.58		10482±872	
		$LSD_{0.05}$	ns		ns		ns	

† Mean values for each soil followed by the standard deviation.
‡ Means within a column sharing a letter are not significantly (p=0.05) different from each other; ns= non-significant

Inter-seeding date and its interaction with cover crop species had significant effect on root yield. Sugarbeet root yield were significantly reduced if the planting date of inter-seeded cover crops were too early. Averaged across inter-seeding time at Ada site, root yield for 13-June inter-seeded cover crop treatments i.e. 24.13 tons acre^{-1}, were lower than that of control (30 tons acre^{-1}) and 24-June inter-seeding (32.65 tons acre^{-1}). Here, the rapid establishment of early inter-seeded cover crops caused severe competition with sugarbeet resulting in yield reduction for 1st planting. However, root yield for 2nd inter-seeding time have some potential advantages. Here, we can observe, late inter-seeded cover crop plot had consistently higher yield than any of the plots (Table 3). Among the treatments, 24-June inter-seeded camelina produced highest root yield of 34 tons acre^{-1} but was not significantly different from control.

For Prosper ND, root yield from inter-seeded plots were not significantly different from those of control in 2019. This shows no effect on root yield of sugarbeet due to inter-seeding of rye, camelina, pea and mustard at Prosper.

Sugar Content: In 2019, at Ada MN, there were no differences among treatments and control for sugar content, expect for early inter-seeded rye, where rye had significantly higher sugar concentration than of control with no cover. For Prosper, there were no differences among the treatments. Besides, due to the extreme wet growing conditions the cover crops at Prosper either was choked out due to canopy closure or drowned out due to excessive rainfall.

Recoverable sugar per acre: Recoverable sugar per acre is affected mainly by root yield and sugar quality. The cover crop treatment and its inter-seeding time did not affect recoverable sugar per acre at Prosper. However, at Ada, for 2nd inter-seeding the recoverable sugar per acre increased over 1st inter-seeding and control. Early

competition between cover crop and beet did decrease the amount of recoverable sugar per acre for 1st inter-seeding time, mainly due to reduced root yield in the cover crop treatments.

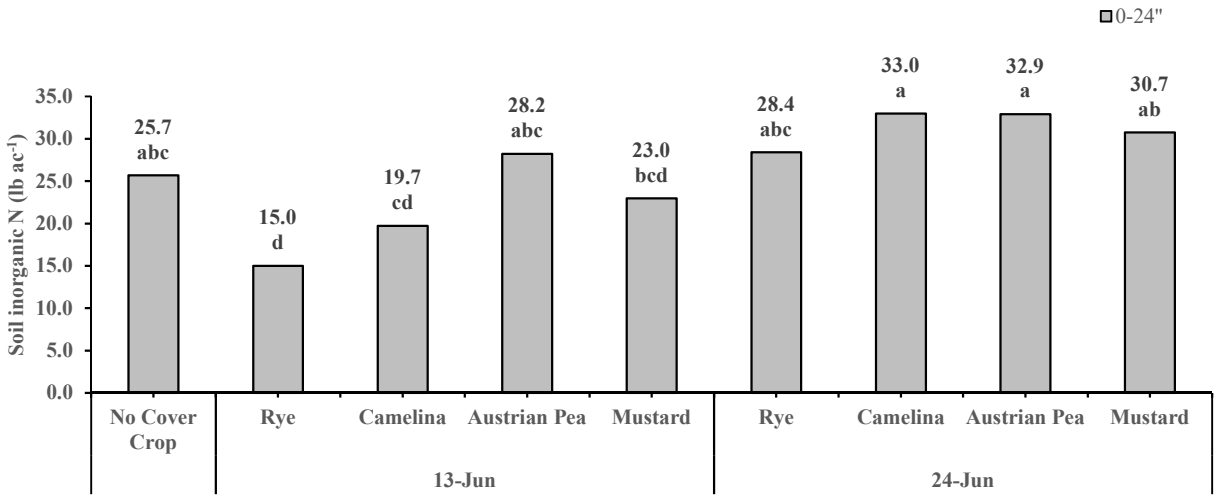

Figure 1: Effect of cover crop interseeding on residual soil inorganic N (lb ac^{-1}) after harvest at 0-24" depth during 2019 at Ada.

CONCLUSION

Under the conditions of this experiment, root yield and sugar quality were affected by time of cover crop seeding and species type at Ada, MN. Cover crop inter-seeding at least 40-45 days after beet emergence did not affect the sugarbeet root yield. The reduction in root yield for early inter-seeding was probably the result of competition between planted cover crops and beet. However, more research is needed to identify what environmental conditions and practices would reduce the risk of yield loss following inter-seeding.

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