EFFECT OF SEEDING TIME AND INTER-SEED COVER CROPS ON SUGARBEET YIELD AND QUALITY

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Red River Valley of North Dakota and Minnesota is a major sugar beet production region in the United States. After sugarbeet is harvested, soil is mostly exposed to wind and water erosion due to less residue is left over. Growers have reported significant soil loss from their field and deposition in ditches after harvest. Integrating covercrops in the sugarbeet cropping system will reduce the soil erosion. Benefits from cover crops also include erosion reduction, promoting pest-suppression, and improving soil and water quality, (Frye et al. 1985, Lal et al. 1991, Reicosky and Forcella. 1998, Snapp, et al., 2005, Weil, et al., 2009). Production practices allows only for a short window for cover crop establishment in the fall and this may not be enough time for some cover crop species to establish and provide agronomic benefits. Interseeding or sowing cover crop into a standing cash crop, is a way to get a jump on the traditional winter cover crop season. Interseeded cover crop may provide protection against wind and water erosion soon after sugar beet harvest. Under this management practice, the cover crop get established prior to canopy closure, and then survive to the end of the growing season without creating too much competition for resources for the sugarbeet crop. However, the adoption of cover crop inter seeding has been limited to only a few production regions (Bittman and Schmidt, 2004; Abdin et al., 1998). So, this field experiment was conducted to compare interseeding in June vs July and performance of four cover crops species on sugarbeet yield and quality at Ada and Downer of Minnesota.

OBJECTIVES

1. Effect of seeding time and different inter-seeded cover crops on sugar beet yield and quality and cover crop biomass production
2. Effect of cover crops on soil nitrate-nitrogen availability for 0-6" depth at the end of the season

MATERIALS AND METHODOLOGY

This study was conducted at two sites; Ada (N 47° 19' 39.8") and Downer (46° 51' 52.3"), MN. The experiment was laid out in split plot which included five cover crop treatments; 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 replication.. Individual treatment plots measured 11 feet wide and 30 feet long. The sugar beet seeds were planted 4.75" apart. Sugar beet planting was done at May 3 and 7 for Downer and Ada respectively. For Ada, first cover crop planting was done on June 21st and second on July 11th whereas for Downer; first and second cover crop planting was done on June 27th and July 16th respectively. Prior to planting, soil nutrient levels were measured and recommended NPK fertilizers were applied.

Standard sugar beet cultivar were planted and the cover crops were inter-seeded in between sugar beet 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 sugar beet. Hand weeding was done to control other weeds in between the crops. The cover crop biomass were measured just before the harvest and 0-6" depth soil samples were analyzed for inorganic nitrogen concentration. Sugar beet was harvested on September 17th and 26th for Downer and Ada respectively. The middle two rows of each plot was harvested and subsamples was analyzed for quality parameters. Crop yield, sugar percentage and recoverable sugar per acre were taken as above ground parameter. Yield determination were made and quality analysis was performed at American Crystal Sugar Quality Tare Lab, East Grand Forks, MN. The soil available nitrogen was determined for 0-6" depth at the end of the season. Soil available nitrogen at the time of harvest and at the end of the season was also considered as the soil health parameter.

Growth was closely observed for all treatments. The average air temperature was 60.67˚F and 54.48˚F for Downer and Ada respectively. The total rainfall received was 17.26 inches and 10.816 inches for Downer and Ada respectively (NDAWN, April-September 2018). The amount of the rainfall were below average during early growing season for both of the sites (Figure 1 and 2).

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Table 1. Initial soil nutrient concentration and basic soil physical-chemical properties

Project	Depth(inch)	NO_3-N (lb/ac)	Olsen-P (ppm)	K (ppm)	PH	OM%
Downer, MN	0-6"	8	5	74	8.1	2.6
	6-24"	15				
	0-24"	23				
Ada ,MN	0-6"	8	5	67	8.4	2.4
	6-24"	12			8.5	
	0-24"	20				

RESULTS

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Sugarbeet yield and quality in response to cover crop were presented in Table 2. Average stand count plant population at Downer was low compared to Ada. Average yield at Downer 17.7 tons/acre was lower than average yield at Ada 37.6 tons/ac due to the lack of moisture at early growing season and possible herbicide carryover from the previous growing season at Downer.

Table 2; Effect of different inter-seeded cover crops on sugar beet yield, sugar quality and recoverable sugar/acre and ANOVA results for effect of cover crop species, planting date and inter-seeding on sugar beet root yield and quality parameters

Site	**Planting time**	**Treatments**	**Yield (tons/ac)**	**Sugar %**	**RSA**
Downer		Control	18.42±3.27 AB	14.28±0.25 D	4910±929 AB
	June	Rye	18.94±5.29 AB	15.25±0.48 A	5445±1640 AB
		Camelina	21.12±3.84 A	14.80±0.08 ABC	5848±1011 A
		Austrian pea	16.08±5.33 AB	14.70±0.42 BCD	4433±1551 AB
		Mustard	14.51±6.69 B	14.80±0.22 ABC	4050±1882 B
	July	Rye	16.17±3.51 AB	15.08±0.40 AB	4553±1028 AB
		Camelina	17.52±3.23 AB	14.58±0.26 CD	4791±951 AB
		Austrian pea	16.87±2.99 AB	14.35±0.13 CD	4511±783 AB
		Mustard	19.31±1.27 AB	14.68±0.70 BCD	5301±512 AB
		LSD(p=0.05)	6.05	0.46	1723
Ada		Control	37.64±1.39 ABC	16.20±0.35 C	11562±500 BC
	June	Rye	36.12±2.28 C	16.55±0.17 AB	11386±667 C
		Camelina	37.03±2.27 BC	16.65±0.06 AB	11757±439 ABC
		Austrian pea	36.30±3.03 C	16.83±0.36 A	11657±990 BC
		Mustard	39.04±3.10 A	16.62±0.26 AB	12354±1066 A
	July	Rye	38.13±2.04 AB	16.62±0.33 AB	12062±824 AB
		Camelina	38.25±1.89 AB	16.45±0.33 BC	11957±795 ABC
		Austrian pea	38.42±1.03 AB	16.40±0.35 BC	11996±500 AB
		Mustard	37.08±2.47 BC	16.80±0.23 A	11860±891 ABC
		LSD(p=0.05)	1.72	0.34	605
Downer, MN					
Planting Time			NS	**	NS
Species			NS	**	NS
Planting Time*Species			NS	NS	NS
Ada, MN					
Planting Time			*	NS	NS
Species			NS	NS	NS
Planting Time*Species			**	**	*

Means within a column sharing a letter are not significantly (p=0.05) different from each other
*, ** and NS represent significance at 0.1, 0.05 and non-significant respectively

At both sites, yield and quality parameters had significant response to cover crop treatment. At Downer, the lowest sugarbeet yield was observed with mustard interseeded in June and the highest value was observed with camelina

interseeded in June. At Ada, mustard interseeded in June had the highest yield and the lowest yield was observed under with rye interseeded in June.

At Downer, the highest sugar content was observed with rye interseeded in June and the lowest under control (no cover crop) . At Ada, the highest sugar content was observed with Austrian pea interseeded in June and the lowest sugar content was observed with treatment with no cover crop. The result shows that sugar content was significantly influenced by the cover crop treatment. It can be hypothesized that cover crop nitrogen uptake might reduce the soil N availability and helped in more sugar accumulation at later growth stage.

At Downer, sugar content was significantly influenced by planting time and cover crop species. The sugar content were higher for the June compared to interseeding in July. Among the cover crop species, interseeding with rye treatment had the highest sugar content and the lowest sugar content was observed under interseeding with pea.

At Ada, planting date and its interaction with cover crop species had significant effect on yield. The average yield were higher for the July interseeded cover crops than for June planted cover crops. Interaction between planting time and species also had significant effect on sugar content and recoverable sugar per acre.

Table 3: Effect of seeding date and inter-seeded cover crop on soil nutrient availability for 0-6' depth at the time of harvest and ANOVA results for effect of cover crop species, planting date and inter-seeding on soil nutrient availability for 0-6' depth at the time of harvest

Site	Planting time	Treatments	NO_3-N	P (ppm in soil)	K (ppm in soil)
Downer	Control	No cover crop	2.32±0.20 b	14.97±1.76 ab	81.00±14.45 a
	June	Rye	2.06±0.28 b	14.20±0.47 ab	83.75±13.07 a
		Camelina	2.41±0.44 b	12.45±1.12 ab	108.50±42.25 a
		Austrian pea	2.68±0.73 ab	15.48±2.69 a	115.75±38.91 a
		Mustard	2.48±0.51 b	12.72±2.56 ab	111.50±40.64 a
	July	Rye	2.56±0.45 ab	12.95±3.02 ab	84.25±17.40 a
		Camelina	2.29±0.36 b	14.90±5.01 ab	103.00±31.37 a
		Austrian pea	2.00±0.13 b	13.02±1.29 ab	126.75±35.61 a
		Mustard	3.22±1.16 a	11.87±1.45 b	113.00±36.18 a
Ada	Control	No cover crop	3.12±0.74 abc	11.57±5.49 a	103.50±40.25 ab
	June	Rye	3.11±1.35 abc	5.99±0.59 b	83.00±8.37 ab
		Camelina	3.51±1.22 ab	9.96±2.11 ab	98.25±34.62 ab
		Austrian pea	2.17±0.38 c	7.97±2.87 ab	108±58.59 ab
		Mustard	3.89±1.63 a	10.02±8.17 ab	79.00±10.68 ab
	July	Rye	3.49±0.92 ab	5.28±1.64 b	121.25±24.50 a
		Camelina	2.98±0.78 abc	8.24±1.42 ab	77.50±15.72 b
		Austrian pea	3.10±1.09 abc	7.80±3.59 ab	86.50±18.21 ab
		Mustard	2.72±0.60 bc	8.21±4.53 ab	118.50±43.65 ab
Downer, MN					
Planting Time			NS	NS	NS
Species			NS	NS	NS
Planting Time*Species			**	NS	**
Ada, MN					
Planting Time			NS	NS	NS
Species			NS	NS	NS
Planting Time*Species			*	NS	NS

Means within a column sharing a letter are not significantly (p=0.05) different from each other
*, ** and NS represent significance at 0.1, 0.05 and non-significant respectively

Soil nutrient availability for 0-6' depth at the time of harvest, for the sites are summarized in the Table 3. In both sites soil nutrient availability had significant response to the cover crop treatment. But there was no significant interaction or differences among the planting time and cover crop species. At Downer soil nitrate and potassium was significantly influenced by the interaction between planting time and species. For Ada, only soil nitrate was influenced by the interaction between planting time and cover crop species.

CONCLUSION

Interseeding with cover crop had shown some interaction with sugar content. It would be interesting to conduct this trial for multiple site-year to ascertain the interaction among weather and site characteristics and cover crop interseeding.

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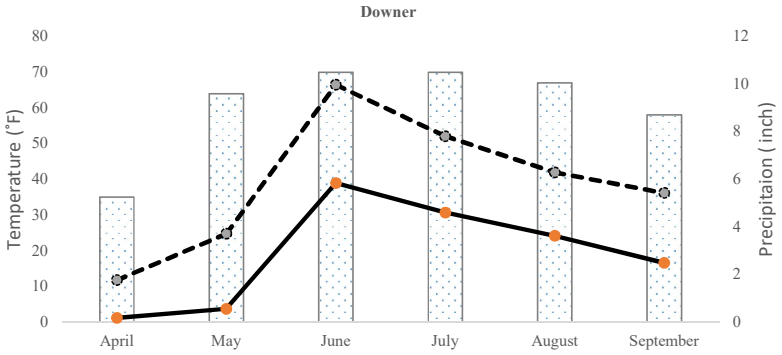

Figure1: Monthly average air temperature and total rainfall of experimental site Downer. April-September 2018, NDAWN

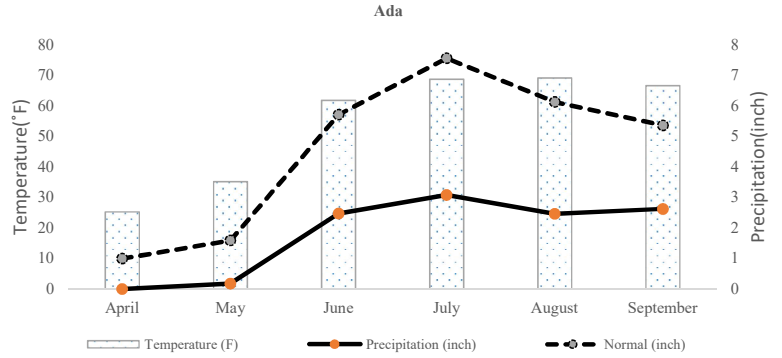

Figure 2: Monthly average air temperature and total rainfall of experimental site Ada. April-September 2018, NDAWN