TILLAGE EFFECTS ON RHIZOCTONIA DISEASES OF SUGARBEET

Amitava Chatterjee[1], Norm Cattanach[1], Carol E. Windels[2], Jason R. Brantner[2] and Laura F. Overstreet[3]

[1]Soil Science Dept., NDSU Fargo; [2]University of Minnesota, Northwest Research and Outreach Center, Crookston; [3]Formerly Soil Science Dept., NDSU, currently, Univ. of Illinois, Champaign-Urbana

Infection of sugarbeet seedlings, roots, and crowns by *Rhizoctonia solani* AG 2-2 (= *R. solani*) increases when soil is wet (Bolton et al., 2010). It has been observed in Red River Valley that Rhizoctonia crown and root rot (RCRR) is reduced on sugarbeet grown in strip-tillage systems compared to conventional tillage. It is assumed that reduced Rhizoctonia diseases are the result of improved drainage in the root zone in strip-tillage systems. It is unknown, however, if improved drainage in strip tillage is due to increased aggregate stability OR the result of more aggressive tillage in the root zone relative to conventional chisel plowing. There are no data in the literature to support these hypotheses, nor is there any information on the effect of no-till and other tillage systems on Rhizoctonia diseases of sugarbeet.

OBJECTIVES

Field trials were established to investigate the effect of no-till and several tillage systems used in sugarbeet production for effects on Rhizoctonia seedling diseases and RCRR.

MATERIALS AND METHODS

In the fall of 2010, trials were established in three grower fields near Fargo with a history of Rhizoctonia diseases (identified through American Crystal agricultural staff). In 2010, Field 1 (Eidem), Field 2 (Morken) and Field 3 (Radermacher) had all been cropped to soybean. Five tillage treatments were applied at each location including : 1) no tillage, 2) full-width conventional tillage (two passes with a chisel plow, 8-inches deep, in the fall and one pass with a field cultivator in the spring), 3) strip tillage, 4) deep ripping (12 to 14 inches deep) with a soil ripper, and 5) mold-board plow. Each treatment (6 rows wide and 20 ft long) was replicated four times in a randomized block design with an 11-ft buffer between each tillage treatment to reduce interactions that may affect drainage patterns and disease severity. The three trials were planted with a sugarbeet variety with a Rhizoctonia disease rating of 4.4 (moderately susceptible) at a 4.5-inch spacing with 3 gallons starter fertilizer A^{-1} in 22-inch rows. Trials were maintained following standard production practices. Data were collected for seedling emergence at 27 and 34 days after planting. At harvest, two middle rows from each plot were hand-harvested, weighed, and roots were analyzed for sucrose yield and quality by the American Crystal Tare Laboratory at East Grand Forks, MN. Twenty roots from each plot also were rated for RCRR using a 0 to 7 scale (0 = clean healthy root and 7 = root rotted and foliage dead).

Field 3 was abandoned in August because of severe Aphanomyces root rot. The other two fields also had severe root rot caused by both *Rhizoctonia* and *Aphanomyces* but were salvageable and taken to harvest in case any trends with tillage treatments could be detected. Although we intended to evaluate effects of tillage on Rhizoctonia diseases, the presence of Aphanomyces root rot at both locations allowed us to evaluate tillage effects on both pathogens.

The trials were repeated in 2012. Again in the fall of 2011, four fields were identified with a history of Rhizoctonia disease and tillage treatments were fall applied. All four fields had previously been planted to soybeans. Field 1 (Eidem North) and field 2 (Eidem South) were located near Glyndon, MN and were planted on April 23, 2012. Field 3 (Morken) and field 4 (Radermacher) were located near Amenia, ND and were planted to sugarbeet on April 24, 2012. As in 2012, the middle two rows from each plot were hand-harvested, weighed, and roots were analyzed for sucrose yield and quality by the American Crystal Tare Laboratory at East Grand Forks, MN on September 06, 2012. Twenty roots from each plot also were rated for RCRR using a 0 to 7 scale (0 = clean healthy root and 7 = root rotted and foliage dead).

Data were subjected to analysis of variance (ANOVA) and if significant ($P \geq 0.05$), means were separated by Fisher's least significant difference.

Table 1. Effect of different tillage practices on sugarbeet yield (tons ac^{-1}) of two sites in 2011 (EidemN_11 and EidemS_11) and four sites (Eidem N_12, Eidem S_12, Morkens_12, and Radermacher_12) in 2012.

Treatments	EidemN_11	EidemS_11	EidemN_12	EidemS_12	Morken_12	Radermacher_12
No Till	7.7	2.2	32.36	38.89	28.82^{B}	19.00
Strip Till	7.9	3.7	33.93	40.39	36.20^{AB}	17.84
Plow	4.5	4.5	41.41	41.67	38.80^{A}	16.04
Chisel	7.3	3.6	36.26	40.68	38.94^{A}	17.04
Deep Rip	7.9	4.2	32.22	40.80	36.74^{A}	17.88
LSD (P<0.05)	NS	NS	NS	NS	7.39	3.41

Table 2. Effect of different tillage practices on recoverable sugar per ton (lbs ton^{-1}) of two sites in 2011 (EidemN_11 and EidemS_11) and four sites (Eidem N_12, Eidem S_12, Morken_12, and Radermacher_12) in 2012.

Treatments	EidemN_11	EidemS_11	EidemN_12	EidemS_12	Morken_12	Radermacher_12
No Till	251	213	295^{A}	279	298	358
Strip Till	274	236	258^{B}	256	277	341
Plow	212	221	284^{AB}	252	286	355
Chisel	238	210	279^{AB}	271	273	356
Deep Rip	251	228	285^{AB}	262	270	344
LSD (P<0.05)	NS	NS	30.68	NS	NS	NS

Table 3. Effect of different tillage practices on sugarbeet yield profitability ($ ac^{-1}) of two sites in 2011 (EidemN_11 and EidemS_11) and four sites (Eidem N_12, Eidem S_12, Morken_12, and Radermacher) in 2012.

Treatments	EidemN_11	EidemS_11	EidemN_12	EidemS_12	Morken_12	Radermacher_12
No Till	281	38	1704.3	1836.9	1526.9	1349.9
Strip Till	312	94	1406.5	1642.7	1693.3	1175.1
Plow	83	101	2023.6	1689.2	1907.3	1126.1
Chisel	183	69	1713.7	1815.3	1760.0	1199.4
Deep Rip	241	97	1598.5	1733.3	1653.7	1195.3
LSD (P<0.05)	NS	NS	NS	NS	NS	NS

Table 4. Effect of different tillage practices on root rot rating of two sites in 2011 (EidemN_11 and EidemS_11) and four sites (Eidem N_12, Eidem S_12, Morken_12, and Radermacher) in 2012.

Treatments	EidemN_11	EidemS_11	EidemN_12	EidemS_12	Morken_12	Radermacher_12
No Till	4.4	5.9^{A}	0.3	0.3^{AB}	0.7	0.4^{A}
Strip Till	3.7	5.1^{AB}	0.2	0.4^{A}	0.5	0.3^{AB}
Plow	5.9	4.5^{B}	0.1	0.1^{BC}	0.9	0.2^{B}
Chisel	4.9	5.7^{A}	0.4	0.1^{C}	1.9	0.2^{B}
Deep Rip	4.5	5.3^{A}	0.3	0.2^{ABC}	1.2	0.2^{B}
LSD (P<0.05)	NS	0.77	NS	0.18	NS	0.17

RESULTS

Effect of different tillage treatments on sugarbeet yield during 2011 and 2012 growing seasons are presented in Table 1. Results revealed that tillage treatments had no effect on sugarbeet yield except at the Morken location in 2012. No tillage resulted in lowest yield as compared to moldboard and chisel plow and deep rip. Tillage had hardly any effect on sucrose content during both growing season besides Eidem North site in 2012 where no-tillage practice had higher recoverable sugar than strip till but same with other conventional tillage practices (table 2). Two-year data suggest that economic profitability did not respond to tillage practices and results varied widely with site and year (table 3).

During 2011, root rot was very severe across all tillage treatments (table 4). At the Eidem South site, moldboard plow had a significantly lower disease rating than chisel plow, no-till and subsoil ripping. During 2012, root rot was very low across all sites due to low rainfall and dry soil conditions. There were statistically significant differences at two sites, but root rot ratings were too low for differences to be biologically meaningful.

DISCUSSION

We conducted these trials during two extreme growing seasons, wet-2011 and dry-2012. In 2011, rainfall in May, June, and July totaled 4.3, 4, and 4.1 inches, respectively, compared to 5-year averages of 2.3, 3.5, and 2.9 inches, respectively. In addition, there was a 2.1 inch rainfall on August 1, 2011. The above normal rainfall, especially in Cass and Clay counties, resulted in resurgence of Aphanomyces root rot, and above normal incidence and severity of early-season Rhizoctonia root rot and chronic crown and root rot. In 2012, total monthly rainfall for April, May, June, July, August, and September was 1.18, 1.82, 2.65, 0.64, 0.90 and 0.58 inches, respectively.

At both extremes, tillage practices did not produce any consistent result across different sites. Yield, quality, economic profitability and disease incidence varied with sites and climatic variability. All types of conventional and conservation tillage options showed similar effect. Even within the same growing season, effect of tillage practice on yield and disease severity changed with sites. This incidence indicates extreme spatial variability of disease potential. Adoption of tile drainage may hold consistent moisture condition and control disease severity and increase sugarbeet yield and quality.

SUMMARY AND CONCLUSIONS

Tillage practice did not produce any consistent results mainly because of extreme weather conditions. Differences between conventional and conservation tillage practices require longer time to show the effect on disease severity and hard to get an immediate effect. Long-term crop rotation study in combination with tillage and tile drainage interactions on yield and disease severity will be essential for future research.

ACKNOWLEDGEMENTS

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for partial funding of this research; American Crystal for seed; Trent and Terry Eidem, Harvey and Joe Morken, and Ryan Radermacher for use of land, and American Crystal Sugar Co. Quality Laboratory, East Grand Forks, MN for sugarbeet yield and quality analyses.

LITERATURE CITED

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