TILLAGE EFFECTS ON RHIZOCTONIA DISEASES OF SUGARBEET

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

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

Infection of sugarbeet seedlings, roots, and crowns by *Rhizoctonia solani* AG 2-2 (= *R. solani*) increases when soil is wet (Bolton et al., 2010). In Red River Valley, it has been observed that Rhizoctonia crown and root rot (RCRR) is reduced when sugarbeet is 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 for effects on Rhizoctonia seedling diseases and RCRR and sugarbeet yield and quality.

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 had been cropped to soybean, Field 2 to corn, and Field 3 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 location included five treatments (6 rows wide and 30 feet long) replicated four times in a randomized block design with an 11-foot 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 10-34-0 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 (20 feet per row) 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).

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

RESULTS

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 to detect any trends/effects of tillage treatments. 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.

At Field 1 (Table 1), stand counts at 27 days after planting were excellent; stands were significantly lowest in no-till plots compared to the other tillage treatments, which were equal. By 33 days after planting, stand counts had decreased slightly for all treatments, except for no-till plots, which had increased. Plant populations were significantly highest in the subsoil ripping plots, lowest in no-till plots, and intermediate in chisel plow, moldboard plow and strip-till plots. Dying plants collected in early July were confirmed as infected by *Rhizoctonia* (data not

Table 1. Field 1: Effect of fall-applied tillage treatments on sugarbeet seedling stands, root rot, yield and quality; trial was planted on May 6 and harvested September 22, 2011.

Treatment	No. plants/100 ft row[z] 27 DAP	33 DAP	Harvest	Root rot (0-7)[y z]	Yield T/A[z]	Sucrose[z] %	lb/ton	lb recov./A	Revenue ($/A)[z]
Chisel plow	367 a	357 b	108	4.9	7.3	13.4	238	1716	183
Moldboard plow	383 a	358 ab	60	5.9	4.5	12.4	212	974	83
No-till	319 b	327 c	125	4.4	7.7	14.1	251	2079	281
Strip-till	363 a	345 bc	175	3.7	7.9	15.0	274	2195	312
Subsoil ripping	395 a	383 a	115	4.5	7.9	14.0	251	1990	241
ANOVA p-value	0.021	0.006	0.433	0.259	0.517	0.088	0.051	0.401	0.293
LSD (P = 0.05)[Z]	42	25	NS	NS	NS	NS	NS	NS	NS

[y] Roots rated simultaneously for Aphanomyces and Rhizoctonia root rot, 0 to 7 scale; 0 = root healthy, 7 = root completely rotted and foliage dead.

[z] For each column, numbers followed by the same letter are not significantly different according to Fisher's protected least significant difference (P = 0.05).

---

shown). Plots were not thinned because disease killed or injured many plants which resulted in reduced and highly variable plant populations and treatments. Consequently, by harvest, there were no significant differences in plant populations among treatments. Across all treatments, roots displayed symptoms (rotting of crown, lateral and root tips, and small roots) caused by *Rhizoctonia* and *Aphanomyces*. Some roots also appeared to be scarred, a symptom that occurs on *Aphanomyces*-infested roots when soil dries out. Foliage often was stunted, chlorotic, and upright – aboveground symptoms typical of Aphanomyces root rot. Foliage of some plants was yellow or dead and collapsed on the soil surface – aboveground symptoms typical of Rhizoctonia crown and root rot. The 0 to 7 disease rating scale is similar for *Rhizoctonia* and *Aphanomyces*, so roots were rated without separating pathogen symptoms (and some roots had symptoms of both pathogens). Root rot was very severe across all tillage treatments. A disease rating of 4 = 25-50% of root surface rotted or scarred; 5 = 51-75% root surface rotted; and 6 = more than 76% of root surface rotted. Severely diseased roots also were small because they were infected early in the season. The combination of low stands, severe disease, and small roots resulted in extremely low yields of roots and sucrose and thus, economic returns were exceedingly poor.

In Field 2 (Table 2), seedling stands at 27 days after planting were excellent and there were no significant differences among tillage treatments. By 34 days after planting, plant numbers had increased in all tillage treatments and were statistically the same. In early June, *R. solani* was isolated from 25% of dying seedlings and wind damage was observed that also reduced stands. In early July *R. solani* was isolated from 7 of 8 dying plants and in early August, from 4 of 10 dying plants (data not shown). In early August, we also noted scarred, stunted roots with symptoms typical of early-season infection by *Aphanomyces.* Both pathogens resulted in low stands at harvest; moldboard plow, strip-till, and subsoil ripping had significantly higher stands than no-till, and chisel plow was intermediate. Root rot was very severe in all tillage treatments although moldboard plow had a significantly lower disease rating than chisel plow, no-till and subsoil ripping, and strip-till was intermediate. Root and sucrose yields were very low across all tillage treatments and resulted in extremely low economic returns.

DISCUSSION

The trials did not identify a tillage system that effectively reduced root rot because excess moisture in May, June, and July resulted in prolonged, wet soil conditions favorable for infections by *Rhizoctonia* and *Aphanomyces.* Both pathogens commonly occur in sugarbeet fields but usually do not develop to epidemic proportions unless the growing season has an excessively wet period and population densities are relatively high. For instance, soil-moisture holding capacities of 75 to 100% are most conducive for infections by *Rhizoctonia* (Bolton et al, 2010) and *Aphanomyces* (Papavizas and Ayers, 1974). 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 (NDAWN, 2011). In addition, there was a 2.1 inch rainfall on August 1, 2011 compared to a 5-year average of 0.08 inches of rainfall on this date (NDAWN, 2011). The above normal rainfall, especially in Cass and Clay counties, resulted in a resurgence of Aphanomyces root rot and above normal incidence and severity of early-season Rhizoctonia root rot and chronic

Table 2. Field 2: Effect of tillage treatments on sugarbeet seedling stands, root rot, yield and quality; trial was planted on May 6 and harvested September 22, 2011.

	No. plants/100 ft row[z]			Root rot	Yield	Sucrose[z]			Revenue
Treatment	27 DAP	34 DAP	Harvest	(0-7)[y z]	T/A[z]	%	lb/ton	lb recov./A	($/A)[z]
Chisel plow	329	335	88 ab	5.7 a	3.6	12.0	210	789	69
Moldboard plow	345	352	125 a	4.5 b	4.5	12.5	221	1023	101
No-till	270	309	58 b	5.9 a	2.2	12.1	213	466	38
Strip-till	315	342	103 a	5.1 ab	3.7	13.2	236	886	94
Subsoil ripping	331	337	98 a	5.3 a	4.2	12.8	228	965	97
ANOVA p-value	0.366	0.642	0.036	0.019	0.107	0.243	0.258	0.181	0.340
LSD (P = 0.05)[Z]	NS	NS	39	0.77	NS	NS	NS	NS	NS

[y] Roots rated simultaneously for Aphanomyces and Rhizoctonia root rot, 0 to 7 scale; 0 = root healthy, 7 = root completely rotted and foliage dead.

[z] For each column, numbers followed by the same letter are not significantly different according to Fisher's protected least significant difference (P = 0.05).

---

crown and root rot. Good soil drainage is recommended to reduce root rot diseases. None of the tillage treatments, however, were effective in draining water sufficiently to reduce infection and disease. Since above normal rainfall occurred early in the season, many diseased plants died and those that survived did not develop normally. Under these circumstances, even best management practices, are insufficient to control *Rhizoctonia* and *Aphanomyces* because weather overwhelmingly favors the pathogens, thus resulting in a "pathogen-dominant" situation (Kommedahl and Windels, 1979). The final results of 2011 root rot epidemics were destruction of fields or disastrous economic returns at harvest.

The trials will be repeated in 2012. In the fall of 2011, four fields were identified and tillage treatments were applied. These fields will be planted to sugarbeet in 2012.

SUMMARY AND CONCLUSIONS

1. None of the tillage systems effectively reduced root rot because excessive moisture in May, June, and July resulted in prolonged, wet soil conditions favorable for infections by *Rhizoctonia* and *Aphanomyces.*

2. Good soil drainage is recommended to reduced root rot diseases, but in 2011, the tillage treatments were unable to sufficiently drain enough water to reduce infection and root rot caused by *Aphanomyces* and *Rhizoctonia*.

ACKNOWLEDGEMENTS

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for partial funding of this research; American Crystal for seed; and American Crystal Sugar Co. Quality Laboratory, East Grand Forks, MN for sugarbeet yield and quality analyses.

LITERATURE CITED

1. Bolton, M.D., L. Panella, L. Campbell, and M.F.R. Khan. 2010. Temperature, moisture, and fungicide effects in managing Rhizoctonia root and crown rot of sugar beet. Phytopathology 100:689-697.

2. Kommedahl, T. and C.E. Windels. 1979. Fungi: Pathogen or host dominance in disease. Pages 1-103 in: Ecology of Root Pathogens. S.V.Krupa and Y.R. Dommergues (Eds.), Elsevier Sci. Publ. Co., Amsterdam-Oxford-New York. 281 pp.

3. North Dakota Agricultural Weather Network. 2011. http://ndawn.ndsu.nodak.edu/.

4. Papavizas, G.C., and W.A. Ayers. 1974. *Aphanomyces* species and their root diseases in pea and sugar beet. U.S. Dept. Agric. Tech. Bull. 1485, 158 pp.