HARRIGAN, TIMOTHY M.[1], STEVE POINDEXTER[2]*, KURT EWALD[3] and TOM WENZEL[2], [1]Biosystems and Agricultural Engineering Dept., Michigan State University, East Lansing, MI 48824, [2]Michigan State University Extension, Saginaw Co. 1, Tuscola Street, Suite 100, Saginaw, MI 48607 and [3]Lakke-Ewald Farms Inc., 4949 N. Unionville Road, Unionville, MI 48767. **Reclaiming beet ground soil quality and productivity with low-intensity tillage, biosuppressive covers and organic inputs.**

ABSTRACT

Economic pressures have led to shorter rotations with more frequent planting of sugar beets. Intense tillage and trafficking has damaged soil structure, and many beet growers have seen yields stagnate or decline. Specific causes are often difficult to identify and may arise from multiple sources including diseases, insects and nematodes. Managing cropping systems with the goal of improving soil quality can improve stand establishment and crop growth, improve water infiltration, drainage and aeration, maintain a balance of pests and pathogens, and create a low-stress environment for the crop. The goal of this project is to develop an approach to soil quality management designed to reclaim the natural productivity of currently unproductive beet ground. Key objectives include a reduction in tillage intensity when practical; the use of biosuppressive cover crops for disease, insect and nematode control; and the use of livestock manure as an organic input to enhance microbial activity and add soil carbon and structure.

Oil seed radish (var. Colonel, 20 lb/ac; OSR) and oriental mustard (var. Pacific Gold, 12 lb/ac; OM) were sown in untilled wheat stubble on a sandy clay loam on 8 August 2006 and 8 August 2007 at the Lakke-Ewald farm in Unionville. Oil seed radish is suppressive of sugar beet cyst nematode, and oriental mustard has been shown to be suppressive of soil borne fungal diseases. Two seeding methods were used: 1) direct-drilling with a Deere 750 no-till drill (15 ft width, 7.5 inch spacing), and 2) slurry seeding with aeration tillage with seed-laden dairy manure (10° gang angle, 10,000 gal/ac). The plots (2000 ft x 15 ft in 2006, 1000 ft by 15 ft in 2007) were arranged in a randomized complete block with four replications. Cover crop biomass and plant population (plants yd^{-2}) were measured in November of each year prior to tillage incorporation.

Figure 1. On the left, OSR direct drilled in wheat stubble; center, OSR slurry-seeded; right, OM slurry-seeded. Photo taken November 9.

The slurry-seeded plant population was 40% to 50% of the direct-drilled stand, but the biomass yield of the slurry-seeded crop was equal to or greater than the direct-drilled crop (table 1). The slurry-seeded plants effectively scavenged the manure nitrogen and grew vigorously. Individual slurry-seeded plants were two to six time larger than drilled plants.

The 2008 sugar beet crop was planted on April 19 in 22-inch rows. The field had a history of poor sugar beet yields—sugar beet cyst nematode (SBCN) was suspected but not confirmed as the likely cause. The field was split east-to-west with a nematode resistant variety, B-5534N planted on the east-half and a susceptible variety, B-5833R on the west-half. Thirty-

day plant stands were excellent, 214 plants per 100 ft-row on the east-half and 194 plants on the west half (table 1). All plots were sampled in two transects (one east and one west) for plant available nitrogen (PSNT) and sugar beet cyst nematode on May 31. Based on the results of the pre-sidedress nitrate test (PSNT) there was little difference in plant available nitrate nitrogen between the manured and non-manured plots. Presumably, the nitrate N was lost through ammonia volatilization, leaching, or incorporated in microbial and plant biomass. Sugar beet cyst nematode was detectable--the greatest numbers followed the oriental mustard cover crops. The least SBCN followed the oil seed radish cover crop.

Figure 2. Slurry-seeded OSR and OM cover crops were seeded in direct contact with 10,000 gal. per acre of liquid dairy manure.

Table 1. Fall 2007 cover crop biomass, spring 2008 sugar beet crop nematode population and nitrogen credit based on PSNT.

	2007 East Cover Crops				2007 West Cover Crops					
Seeding Method	Biomass ton/ac *	Plants ft^2	30-day stand	Rhizoc	Biomass ton/ac	Plants ft^2	30-day Stand	Rhizoc	PSNT lb N	SBCN nematode
Check, no cover, no tillage	0.84 d	---	221 a	6 a	0.79 c	---	189 a	13 a	62 ab	203 abc
No cover crop, manure	0.92 d	---	216 a	3 a	0.68 c	---	187 a	4 a	86 ab	198 abc
Oil seed radish, slurry seed	2.08 ab	5.1 b	208 a	1 a	2.60 a	4.6 b	198 a	2 a	91 ab	50 a
Oil seed radish, direct drill	2.38 a	8.8 b	207 a	0 a	2.49 a	9.9 b	201 a	1 a	95 a	100 ab
Oriental mustard, slurry seed	2.12 a	8.6 b	211 a	2 a	2.36 a	7.4 b	192 a	1 a	58 b	2745 bc
Oriental mustard, direct drill	1.55 c	20.6 a	220 a	5 a	1.87 b	17.7 a	198 a	13 a	79 ab	5098 c

*abc letters within the same column represent significant differences ($p \leq 0.10$) by Tukey's HSD procedure. SBCN mean separation by Friedman's median aligned test ($p \leq 0.10$). Risk ratings based on SBCN eggs plus J2's: no risk = 0; low = 1-1,500; moderate = 1001-10,000; high = >10,000.

The beets were harvested on September 23 in the first days of the harvest campaign. Although the field was rated as low to moderate risk based on the results of nematode count, the average yield of the resistant variety was 11.6 t/ac and 3457 lb recoverable sugar greater than the susceptible variety (Table 2). The sugar content of the resistant variety averaged 1.8 percentage points greater than the susceptible variety. The greatest yields for each variety followed oil seed radish, or oriental mustard combined with manure. There was no difference in clear juice purity between treatments or varieties.

Table 2. Sugar beet harvest data, 2008.

	East Field 2008, B-5534N *					West Field 2008, B-5534R				
Seeding Method	ton/acre	CJP, %	% Sugar	RWST	RWSA	ton/ac.	CJP, %	% Sugar	RWST	RWSA
Check, no cover, no tillage	26.1 c	93.3 a	16.7 b	251 b	6551 c	13.8 c	96.0 a	14.7 c	218 b	3017 b
No cover crop, manure	27.3 bc	96.3 a	17.1 ab	255 b	6956 bc	14.0 bc	96.2 a	14.9 c	225 b	3157 b
Oil seed radish, slurry seed	28.9 ab	96.2 a	17.3 ab	267 a	7726 a	17.3 ab	95.6 a	15.7 ab	239 a	4128 a
Oil seed radish, direct drill	29.2 a	96.3 a	17.4 a	263 a	7675 ab	20.6 a	95.9 a	16.1 a	237 a	4893 a
Oriental mustard, slurry seed	29.1 ab	96.2 a	17.5 a	263 a	7646 ab	17.6 a	96.0 a	15.9 a	240 a	4207 a
Oriental mustard, direct drill	26.4 bc	96.4 a	17.1 ab	256 b	6759 c	14.0 bc	96.5 a	15.1 bc	226 b	3170 b
Treatment avg.	27.8	96.3	17.2	259	7219	16.2	96.0	15.4	233	3762

abc letters within the same column represent significant differences by Tukey's HSD procedure ($p \leq 0.10$).

Summary:

Based on the 2008 sugar beet harvest at the Ewald farm in Unionville:

- Slurry seeded plant populations were 40 to 50% of the direct drilled crops, but total biomass production was equal to or greater than direct drilling.
- Manure N was presumably lost to volatilization, leaching, or incorporated in microbial or plant biomass and not detectable with the PSNT. There was no difference in nitrate N due to manure application.
- The nematode resistant variety averaged 11.6 tons/ac beet yield, 26 lbs RWST and 3457 lbs. greater RWSA than the susceptible variety.
- The greatest beet and sugar yields for each variety followed oil seed radish, or oriental mustard when combined with manure.
- Although high SBCN counts at side-dress time followed oriental mustard, there was no corresponding drop in sugar production when the cover crop was combined with manure.