SLURRY ENRICHED MICRO-SITE SEEDING OF BIOSUPPRESSIVE COVER CROPS FOR SUGAR BEET PRODUCTION

Timothy M. Harrigan, Biosystems and Agricultural Engineering
Sieglinde Snapp, Department of Crop and Soil Sciences and Kellogg Biological Station
Dale R. Mutch, Kellogg Biological Station

Improving pest management strategies, soil quality, and stand establishment are top priorities of the sugar beet industry. The development of crop management alternatives that reduce tillage intensity and encourage the use of cover crops will improve soil quality by increasing soil organic matter. Manure has been shown to improve soil quality by increasing soil organic matter and hydraulic conductivity, and by decreasing soil bulk density. A lower bulk density allows more extensive root growth and a favorable pore size distribution which increases water infiltration, water holding capacity and soil aeration.

Cover crops are generally grown for soil conservation, but cover crops also improve soil quality by adding organic matter and increasing soil biological activity. In Michigan, growers often use winter cereals as cover crops to protect the soil from wind erosion, but stand establishment costs and the additional management requirements have limited their widespread use. Cover crops in the Brassica (mustard) family may offer benefits beyond soil conservation in sugar beet rotations. Forage radish crops have been used to alleviate compaction in coastal plain soils in Maryland. In Michigan, sugar beet yields increased two tons/acre following an oil seed radish cover crop (Poindexter and Van Sickle, 2004). And, oil seed radish has been shown to suppress the sugar beet cyst nematode. The incorporation of oriental mustard (*Brassica juncea* L., variety Pacific Gold) in the spring before planting potatoes suppressed *Rhizoctonia solani* by 73%, and the cover was highly suppressive of fungal activity by *Pythium ultimum,* and *Fusarium solani* (Snapp, 2004). There is a need to evaluate the potential for disease suppression in sugar beet from Brassica cover crops.

OBJECTIVES

The objectives of this work were to: 1) Evaluate a new and resource efficient seeding method - *slurry enriched micro-site seeding* - for establishing bio-suppressive cover crops in small grain stubble, and 2) quantify effects of treated soil/cover crop combinations on beet emergence, sugar production and the frequency of *Rhizoctonia.*

METHODS AND MATERIALS

Cover crop establishment

In 2005, a replicated trial comparing oil seed radish (*Colonel*, 16.8 kg ha PLS) and oriental mustard variety (*Pacific Gold*, 11.2 kg ha PLS) was established following wheat (August 8, 2005) in a Capac sandy loam soil at the University Farm in East Lansing. Three seedbed tillage were compared: 1) two passes with a Kongskilde Triple-K combination tillage tool in untilled wheat stubble at a depth of 7.5 cm, 2) direct-drilling into untilled wheat stubble with a Great Plains no-till drill (disk openers on 19 cm centers), and 3) slurry-enriched micro-site seeding in untilled wheat stubble. The plots were arranged in a randomized complete block with six treatments and four replications. The seedings were made on August 8 and harvested on October 20, 2005.

The slurry seeding treatments were established using a commercially available slurry tanker (3000 gallon capacity) equipped with a rear-mounted Aer-Way SSD low-disturbance soil aeration and slurry distribution system. Swine manure (1.7 % dry matter) was applied at 56,100 L ha^{-1}. The soil aerator gang angle was set at 10° for maximum soil disturbance. The seed was placed in the spreader tank where bypass flow provided tank agitation and seed mixing. Drop tubes delivered the seed-laden slurry from the chopper/distributor to the loosened soil behind each set of rolling tines. The 56,100 L ha^{-1} application of swine slurry provided 204 kg ha^{-1} total N (172 kg ha^{-1} as NH_4-N), 76 kg ha^{-1} P as P_2O_5, and 123 kg ha^{-1} K as K_2O. Because commercial fertilizer is not often used for cover crop establishment, no fertilizer was applied to the non-manure plots.

Sugarbeet seed emergence--greenhouse

The brassica cover crops were incorporated with tillage in late October, 2005. Two weeks after incorporation, representative soil samples from each manure/cover crop treatment were collected from the surface to six-inch soil layer. Untreated samples (experimental control) were gathered from adjacent areas at the north and south perimeters of the field site. The soil was placed in cylindrical PVC containers (6.4 cm x 2.54 cm) and compacted to an air-dry bulk density of 1.16 g/cc. Eight sugar beet seeds (EL0204; uncoated, untreated) were planted at a depth of 8 mm in each container. Three replications were evaluated for each of the four field replications of each the four field treatments (48 containers). Additionally, six untreated control containers were evaluated. The containers were incubated at 29º C and 90% RH for 28 days and seed emergence was recorded daily.

Sugar beet yield and quality

Sugar beets (5833R, fair *Rhizoctonia* resistance) were planted on May 12, 2006 with a row spacing of 76 cm and 10 cm seed spacing in the plots where the brassica cover crops were sown in 2005. The beets were hand-harvested from 13.3 m of row at the center of each plot on November 1 and each beet was visually inspected for the presence of *Rhizoctonia*. Beet quality was evaluated by Michigan Sugar Company, Bay City, MI.

RESULTS

Cover crop biomass

The above-ground plant mass, root mass, total biomass and plant stand density from the six cover crop treatments are listed in Table 1. There were no significant differences in top growth biomass between tillage and seeding methods. There were, however, significant effects on plant stand density. The direct-drilled OSR and OM plant stands were significantly greater than the slurry-seeded OSR and OM plant densities ($p \leq 0.01$).

Table 1. 2005 cover crop biomass yield and 2006 sugar beet yield, quality and frequency of *Rhizoctonia*.

2005 Cover crop				2006 Sugar beet crop					
Cover Crop	Seeding method	Aboveground biomass, kg ha^{-1} [a]	Root biomass, kg ha^{-1}	Beets, kg ha^{-1}	*Rhizoc,* beets/30.5 m	Sugar, %	Purity, %	RWST	RWSA
OSR	Till-drill	4376 a	741 a	26.5 a	9.2 ab	17.1 a	93.8 a	246 a	6511 a
OM	Till-drill	4054 a		26.7 a	2.9 b	17.0 a	93.5 a	243 a	6488 a
OSR	Slurry	3876 a	947 a	30.9 a	6.3 ab	16.0 a	92.8 a	224 a	6957 a
OM	Slurry	4715 a		27.3 a	13.3 ab	16.9 a	93.7 a	241 a	6565 a
OSR	No-till	4724 a	598 a	26.3 a	20.7 a	16.6 a	93.7 a	237 a	6249 a
OM	No-till	4081 a		28.3 a	9.8 ab	16.9 a	94.2 a	244 a	6919 a

[a] abc letters within columns indicate values not significantly different by Tukey's HSD procedure ($p \leq 0.05$).

Sugar beet seed emergence--greenhouse

There was a clear difference in the rate and final percentage of emergence between the treated (manure, OM, OSR) and untreated soils (Figs. 1 and 2). Emergence occurred more rapidly and continued for a few days longer in the treated soils. There was little increase in the rate of emergence in the control soil after day 9. Emergence continued at a nearly constant rate in the treated soil until day 15. Final emergence was about 50% in each of the treated soils, 33% in the untreated soil.

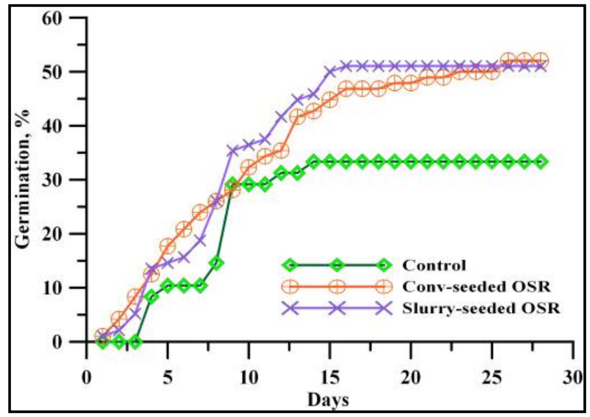

Figure 1. Sugar beet germination and emergence in soil previously treated with an oil seed radish cover crop with and without swine manure slurry.

Sugar beet yield and quality

The average beet stand was 133 beets per 30.5 m (100 ft). There was no significant difference in plant stand due to cover crop tillage and stand establishment method (p = 0.86). The occurrence of *Rhizoctonia* in the sugar beet crop following the no-till seeding of OM and OSR was significantly greater than in the tilled-and-drilled seedings (p = 0.07). *Rhizoctonia* was significantly greater in the no-till OSR than in the tilled-and-drilled OM (p = 0.045; Table 1).

There were no significant differences in sugar beet yield, percent sugar, percent clear juice purity, raw white sugar per ton (RWST), or raw white sugar (RWSA) due to the previous cover crop and seeding method ($p \leq 0.05$).

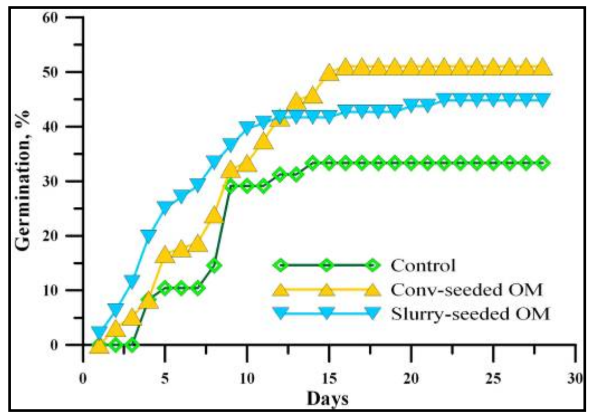

Figure 2. Sugar beet germination and emergence in soil treated with an oriental mustard cover crop, with and without swine manure slurry.

CONCLUSIONS

The 2005 biomass yield and stand density measurements showed that the manure slurry enriched micro-site seeding process can provide yields equivalent to conventional seeding methods. A manure application method that effectively incorporates cover crop seeding, manure application and low-disturbance aeration tillage provides considerable labor and machinery efficiencies that will encourage environmentally responsible manure and cover crop use in sugar beet rotations. Reducing tillage intensity and including manure and a biosuppressive cover crop such as oil seed radish in a sugar beet rotation will improve plant stand uniformity by improving soil quality, aid in managing such pests as the sugar beet cyst nematode, and may suppress fungal diseases. Additional work is needed to develop guidelines for this new slurry seeding process and to evaluate potential benefits of brassica cover crops in sugar beet rotations for pest and disease suppression, soil conservation, and improving soil quality.

Acknowledgements: The authors would like to acknowledge the contributions of research technicians **Tim Duckert, Kitty O'Nea**l, **Todd Martin** and **Tim Boring** in conducting this project. We extend our appreciation to the **Michigan Sugar Company** for contributing the beet quality analysis.