Manure Slurry-Enriched Seeding of Cover Crops

Protecting the Environment, Building Quality Soil

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Over the last several years many crop producers in the Great Lakes region have adopted no-till cropping and soil conservation practices, which protect water quality by preventing runoff, erosion, and sedimentation of streams and waterways. Many livestock producers have been slow to adopt no-till cropping practices because few manure management options are compatible with no-till. Because a vegetative cover is an effective barrier to overland flow of manure contaminants, interest in the use of cover crops is increasing. However, cover crops have not been used widely because establishment costs, competition for labor during harvest, and added management needs have discouraged their use.

A new land application process – manure slurry-enriched seeding – has been in development at Michigan State University since 2003. Manure slurry-enriched seeding combines low-disturbance aeration tillage, manure application, and the seeding of cover crops in one efficient operation. Low-disturbance aeration tillage creates an absorptive surface in untilled ground that inhibits overland flow by fracturing the soil, increasing surface roughness, improving infiltration, and conserving crop residues. In the same pass, cover crop seed, that has been mixed in the slurry tank, is delivered through drop-tubes to the fractured and loosened soil behind each set of aeration tines. The nutrient-rich, seed-laden slurry quickly infiltrates the soil matrix, thereby minimizing volatile nitrogen losses. The loose, absorptive soil surface prevents soil erosion and phosphorus runoff. A cover crop soon emerges, capturing nutrients and forming a vegetative barrier to overland flow. The aerated soil resettles and is generally suitable for no-till planting with no additional seedbed tillage. The manure is retained in the root zone for nutrient cycling and remediation of pathogens.

Biomass yields of oil seed radish, oriental mustard, annual ryegrass, cereal rye, oats, wheat, forage rape, and forage turnips sown in untilled wheat and corn silage stubble with swine, dairy, and beef slurries from 2004 through 2006 were equal to or greater than a conventional seeding.

Slurry seeding in wheat.

Slurry-seeding is done with a commercially available slurry tanker equipped with a rear-mounted rolling-tine aerator (3.7m [12 ft]; AerWay, Holland Equipment Ltd. Norwich, Ontario, Canada) and a SSD (sub-surface deposition) slurry distribution system. The rolling-tine aerator is ground-driven with sets of four 20-cm (8-in.) tines mounted helically on a rotating shaft with 19-cm (7.5-in.) spacing between each set of tines. The tines are angled slightly on the shaft to provide lateral movement and loosening of the soil. The angle of the rotating shaft is adjustable in 2.5º increments from 0º to 10º degrees from perpendicular relative to the direction of travel. The 0º gang angle provides little soil disturbance while the 10º gang angle provides the most soil loosening. A gang angle of 5º to 10º is generally used for most cover crop work. No additional seedbed tillage or soil firming is needed.

Slurry-seeding involves mixing cover crop seed with the manure in the slurry tank and passing the seed-laden slurry through a hydraulically driven, rotating chopper/distributor (300 rpm) with radially configured outlets, and then through drop tubes to the fractured and loosened soil behind each set of rolling tines. Excess pump capacity provides bypass flow for seed mixing and uniform distribution. The throughput of the pto-driven centrifugal pump on the slurry tank is about 6,056 l (1,600 gal) per minute, but only 1,514 to 2,650 l (400 to 700 gal) per minute is needed at normal travel speeds to apply agronomic rates of 22,712 to 30,283 l (6,000 to 8,000 gal) per acre through the 3.7-m (12 ft) applicator. The flow rate is monitored with an electromagnetic flow meter 13-cm (5-in.) diameter; Danfoss, Danfoss Inc., Milwaukee, Wis.) mounted on the SSD.

Unlike conventional planters and drills that open a seed furrow, place the seed at a uniform depth, and then firm the soil around the seed, manure slurry-enriched seeding mimics a natural seeding process. In nature, seed that drops to the ground from seed pods or in the feces of birds and animals is carried by wind or water to soil cracks or protected sites beneath crop residues where they germinate and take root. Manure slurry-enriched seeding uses aeration tillage to create cracks and fissures which are then inundated with nutrient-rich, seed-laden slurry. The manure slurry carries the seed to protected seeding micro-sites. No additional seedbed tillage is needed.

This seeding process is best suited for untilled ground. In our trials we have seen crop emergence through cracks and fissures from depths ranging from near the surface to three inches or more below the surface. Seed placement was deeper in untilled, consolidated soil that formed large clods and aggregates under aeration tillage; loose and flowable soils that backfilled the aeration tine opening before the seed-laden slurry was applied caused near-surface seed placement. We have not had good results in tilled or loose soils that do not fracture and create protected seeding micro-sites.

nitrogen in the spring. The wheat yielded 75 to 80 bu/acre and the cereal rye yielded 65 to 70 bu/acre. We have had similar results with oil seed radish and oriental mustard after wheat in sugar beet rotations.

The integration of soil conservation, manure application, nutrient cycling, and cover crop seeding in one efficient operation offers important operational efficiencies that will encourage environmentally sensitive manure use in no-till and other cropping systems. This new process will expand the land base and windows of opportunity for manure spreading, save two gallons per acre of diesel fuel compared to conventional cover crop seeding methods, and protect water quality. Work is ongoing in evaluating manure slurry-enriched seeding for pasture improvement and seeding late season grazing crops.

Aeration tines loosen and fracture the soil for slurry seeding.

SLURRY-SEEDING IS DONE WITH A REAR-MOUNTED ROLLING-TINE AERATOR … NO ADDITIONAL SEEDBED TILLAGE OR SOIL FIRMING IS NEEDED.

This new process builds soil quality by reducing tillage intensity and adding organic inputs – manure and cover crops. We generally see fewer plants per unit area – often only 30 to 70 percent of a conventional seeding – but we have three to six times more biomass per plant with slurry seeding. Although our primary interest has been in cover crops, we allowed some winter wheat and cereal rye test plots seeded after corn silage in 2004 to go to grain for yield measurements. There was no significant difference ($p \leq 0.05$) in grain yield between winter wheat slurry seeded with 18,927 kiloliters (5,000 gallons) per acre dairy slurry and drilled wheat with 50 lb/ac commercial

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