Overcoming Challenges of Reduced-Till Organic Corn

Gladis Zinati[1], *Ph.D.*, Jeff Moyer[1], and Guillaume Tant[2]
Associate Research Scientist, Executive Director, Visiting Intern
[1]Rodale Institute, 611 Siegfriedale Road, Kutztown, PA 19530
[2]ISARA-Lyon 23 rue Jean Baldassini, 69007, Lyon, France

Organic grain producers have been relying on mechanical cultivation to manage weeds, using row cultivators between rows and rotary hoes or harrows over the rows. However, frequent soil cultivation weakens soil health[1]; brings buried weed seeds to the soil surface where they are more likely to germinate and compete with crop plants; potentially reducing yields and growers' profits. Organic grain growers are becoming interested in improving soil health, by reducing tillage frequency, and covering the soil surface with cover crops over the winter season.

Using cover crops along with reduced or no-tillage improves soil health and profitability. This can be achieved by the integration cover crops and roller-crimper technology[2].

The role of the roller-crimper (**Photo 1**) is to roll and crimp the standing cover crop forming a soil covering mulch.

Photo 1. Rodale Institute's Roller-Crimper.

This approach has many advantages:

- reduces or eliminates cultivation,
- reduces soil temperature fluctuation,
- promotes weed suppression,
- builds soil organic matter content and soil structure; and
- conserves soil moisture.

Ecosystem services of cover crops

Cover crops play multiple roles in improving system performance through increased nitrogen fixation and nutrient cycling, soil biodiversity, water infiltration and storage, and soil organic matter content; reduced soil erosion, compaction, and pest and weed pressure; and improved soil structure[3-5].

Legume cover crops, such as hairy vetch (*Vicia villosa* Roth) and Austrian winter pea, provide nitrogen (N) to cash crops though rarely provide sufficient N for high N demanding crops such as corn. Cereal cover crop mulches such as rye (*Secale cereale* L.) can have the opposite effect by immobilizing N and have a longer impact on soil moisture and weed dynamics. Physical[6] rather than allelopathic[7] influences from cereal rye residue have been shown to inhibit weed

germination and growth processes of many plant species especially because the active phytotoxic compounds may not be present in soil more than 2 weeks after rye termination[8].

A dense uniform cover crop is needed to create a soil covering mulch that enhances suppression of weeds. For effective suppression of annual weeds, research has shown that there must be at least 8,000 kg ha^{-1} of rye aboveground dry biomass to create a mulch of at least 10 cm deep at time of rolling[9].

Cover crop management is a key

Successful weed suppression using cover crop mulches is highly dependent, not only on the amount of biomass but also on the rate of decomposition. Upon rolling the cover crops, decomposition starts. Decomposition rate of rolled cover crops may vary with the type of cover crop. Legume mulches decompose at a faster rate (50% dry matter can be lost in first three weeks) than those with cereal cover crops (50% dry matter can be lost in nine weeks)[10].

Photo 2. Cover crop biomass of cereal rye and hairy vetch mixture.

Photo 3. Rolled cover crop into mulch using roller-crimper.

Planting a mixture of legumes and grass cover crops (**Photo 2**) will provide a fast growing, dense ground cover and thicker residue mulch upon rolling (**Photo 3**). Cover crop biomass can be manipulated mainly with seeding rate and time of planting. Early planting of cover crops in September rather than later in October (in the Northeast) provides enough biomass to cover soil surface and establishment of good root biomass before soil freezes in the winter. In spring, cover crop mixtures such as cereal rye with hairy vetch continue to grow and increase in biomass. Residue of rolled cover crop mixtures that include hairy vetch and cereal rye supply N and decompose at a slower rate than when the biomass is tilled into the soil in a corn production system. Such a cover crop mixture can yield above ground biomass production of between 8,922 to 10,706 lb/acre (*10,000 to 12,000 kg/ha*).

Importance of proper equipment

Jeff Moyer modified a Monosem® corn planter and included the **Pequea turbo disc soil slicers** and **130 pounds of added weight per row unit** to cut through the rolled cover crop.

Photo 4. Thick cover crop mulch impedes seed-to-soil contact.

Despite many successes in rolling leguminous cover crops at Rodale Institute, planting no- or reduced-till corn into dense cover crop residue that includes cereal–legume cover crop mixtures can be challenging. A thick layer of plant residue on the soil surface may impede planter performance and seed-to-soil contact (**Photo 4**), reduce corn plant population and consequently yield.

To overcome this problem, Mr. Moyer included **residue slicers in the front** to ensure cutting through the dense cover crop residue before drilling in corn seeds (**Photo 5**).

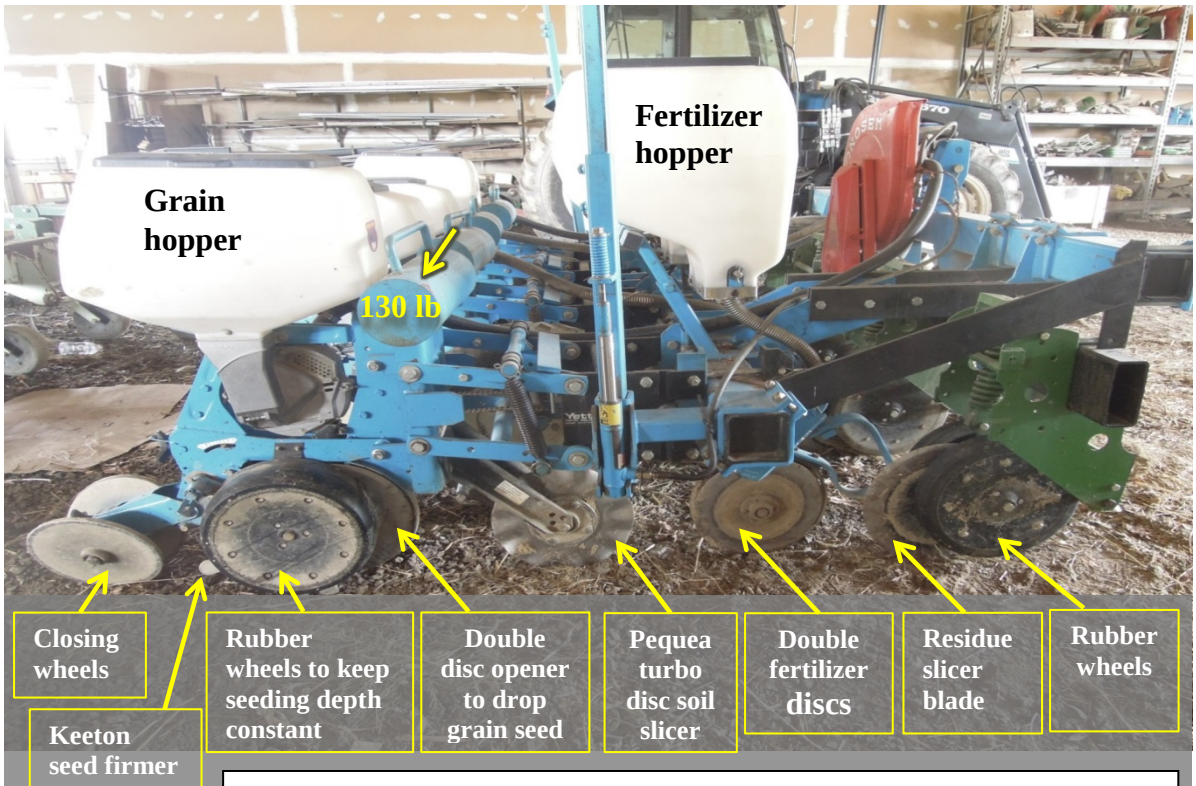

Photo 5. Monosem corn planter modified to improve slicing of the thick rolled-crimped cover crop mulch and seed-to-soil contact.

The residue slicer is compatible with John Deere 7000-7200-1750 planters. The combination of down spring pressure, a straight blade, and the rubber wheels to hold the thick residue will make a clean cut.

In addition, the Yetter shark-tooth residue managers (i.e., row cleaners) (Yetter Manufacturing Co Inc., IL), placed in front of each Pequea turbo soil slicer (**Photo 6**) can be used to improve plant establishment.

This modification enhanced slicing through the rolled cover crop, seed bed preparation, drilling of corn seeds without missing (**Photo 7**), seed germination and plant growth (**Photo 8**).

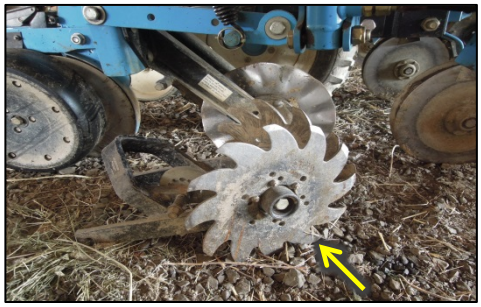

Photo 6. Yetter™ shark-tooth residue managers.

Photo 7. Enhanced slicing of cover crop mulch improved drilling of corn seeds.

Photo 8. Improved corn germination and growth in no-till cover crop mulch.

Summary

Frequent soil cultivation disrupts soil biota† and structure and eventually degrades soil health. The integration of using cover crops and roller crimper technology provided growers with alternative management system to reduce or eliminate tillage. This system provides extended ecosystem services of cover crops by increasing duration of the living cover crop during the winter time and rolling it into mulch in spring. In addition, it reduces tillage, improves soil health, suppresses weeds and increases profitability. In organic systems, grain growers are interested in adopting reduced- or no-till practices to improve crop and soil productivity. For successful weed suppression, a dense uniform cover crop biomass is needed. Planting corn grain

into thick cover crop mulch can be challenging. These challenges can be overcome by using proper equipment. In this article we highlighted the challenges and the modifications made to Monosem® corn planter. By integrating the **roller crimpe**r, **residue slicers, Pequea slicers, and Yetter™ shark-teeth** to the corn planter, we were successful in rolling-crimping and slicing through the dense layer of mulch and consequently increasing corn establishment and improving weed management throughout the growing season without tillage. This system also allowed us to plant corn and fertilize with pelleted chicken manure in one pass rather than running several passes with machinery over soil surface in order to conduct these operations. In the long-term, applying these practices would improve soil carbon sequestration, water and nutrient plant use efficiency, reduce fuel and labor costs, and consequently increase yields and profitability.

References

[1] Grandy, A. S., G. P. Robertson, and K. D. Thelen. 2006. Do productivity and environmental trade-offs justify periodically cultivating no-till cropping systems? Agron. J. 98:1377–1383.

[2] Davis, A.S. 2010. Cover-crop roller–crimper contributes to weed management in no-till soybean. Weed Sci. 58:300–309.

[3] Dabney, S.M., Delgado, J.A., and Reeves, D.W. (2001) Using winter cover crops to improve soil and water quality. Commun. Soil Sci. and Plant Anal. 32: 1221–1250.

[4] Torbert, H. A., D. W. Reeves, and R. L. Mulvaney. 1996. Winter legume cover crop benefits to corn: Rotation vs. fixed-nitrogen effects. Agron. J. 88:527–535.

[5] Vieira, F. C. B., C. Bayer, J. A. Zanatta, J. Mielniczuk, and J. Six. 2009. Building up organic matter in a subtropical Paleudult under legume cover-crop-based rotations. SSSAJ 73:1699–1706.

[6] Teasdale, J. R., C. P. Rice, G. Cai, and R. W. Magnum. 2012. Expression of allelopathy in the soil environment: soil concentration and activity of benzoxazinoid compounds released by rye cover crop residue. J. Plant Ecol. http://dx.doi.org/10.1007/s11258-012-0057-x.

[7] Barnes, J. P. and A. R. Putnam. 1987. Role of benzoxazinones in allelopathy by rye. J. Chem. Ecol. 13:889–906.

[8] Rice, C. P., G. Cai, and J. R. Teasdale. 2012. Fate of benzoxazinoids in soil treated with rye cover crop. J. Agric. Food Chem. 60:4471–4479.

[9] Teasdale, J. R. and C. L. Mohler. 2000. The quantitative relationship between weed emergence and the physical properties of mulches. Weed Sci. 48:385–392.

10] Herbert, S.J., Y. Liu, and G. Liu. 1997. Decomposition of Cover Crop Biomass and Nitrogen Release. http://ag.umass.edu/sites/ag.umass.edu/files/research-reports/1997-01-decomposition-of-cover-crops-biomass-and-nitrogen-release.pdf Accessed online October 10, 2015.

†Soil biota: It is the biologically active powerhouse of the soil. It includes a diverse range of micro-organisms (bacteria, fungi, and algae) and soil "animals" (nematodes, protozoa, spiders, earthworms and mites), interacting with plant roots.

"This material is based upon work supported *by the Natural Resources Conservation Service, U.S. Department of Agriculture, under Grant Agreement Number 69-3A75-11-193."*