Cover Crop Rollers for Northeastern Grain Production

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Background

Cover crop rollers have been used for decades in Brazil, Argentina, and Paraguay to successfully manage cover crops and their residues (Derpsch et al. 1991; Ashford and Reeves, 2003). Farmers adopted these tools to manage large amounts of cover crop residue for more successful cash crop establishment in no-till systems. This "high-residue conservation tillage" system involves producing large amounts of cover crop residue and using it to suppress weeds, protect the soil from erosion, and conserve soil moisture. In the last several years, farmers in the northeast and other regions of the US have shown interest in using cover crop rollers for high residue conservation tillage. Much of the interest in the Northeast comes from organic grain and vegetable farmers who would like to reduce frequency or intensity of tillage in their rotation.

Description and potential use

Cover crop rollers have come in various designs, but are generally made from a hollow steel drum or cylinder 1 to 2 ft in diameter. The roller/crimpers used today generally have blunt blades or knives arranged on the cylinder that crimp or crush the stems of the living cover crop, which then kills it. Rollers flatten and crimp susceptible cover crops leaving an intact mat of soil protective mulch oriented in the direction of planting. This unidirectional mulch can help facilitate planting and improve seed to soil contract and ultimately cash crop emergence. In contrast to mowing the cover crop, there is less risk of cover crop regrowth when it is rolled, the intact residue decomposes slower, and weed suppression is better from the uniform surface residue.

Several designs have been tested (long-straight blades vs. curved blades vs. other designs) for cover crop control and vibration reduction (Kornecki et al. 2006; Raper et al. 2004). A common design used today has metal blades welded onto a cylinder in a chevron pattern that allows for smooth operation (Ashford and Reeves, 2003). This design was further refined by The Rodale Institute (www.rodaleinstitute.org/no-till_revolution) and is now manufactured and sold by I & J Manufacturing of Gap, PA (http://www.croproller.com/).

The Rodale style roller in action with Jeff Moyer and Dave Wilson (at The Rodale Institute) and a commercial roller in tandem with seeding soybeans on the eastern shore of Maryland. (upper photo courtesy of M. Ryan and lower photo W. Curran)

Cover crop rollers vary in width but are generally between 5 and 30 feet wide weighing at least 1000 lbs or more. Larger units are used by some farmers that employ several cylinders linked together to cover large areas more quickly. Many designs allow more weight by filling the metal drum with water. The energy required to operate a roller/crimper is similar to that required for a cultipacker and tenfold less than the energy required for mowing (Anonymous 2002). The rolled cover crop system can save organic soybean farmers up to 5-gallons of fuel per acre by reducing tillage operations (Mutch 2004) and when averaged over a three year corn-soybean-wheat rotation, no-till planting with a roller uses 25% less energy than traditional organic management (Ryan et al. 2009).

Where they work

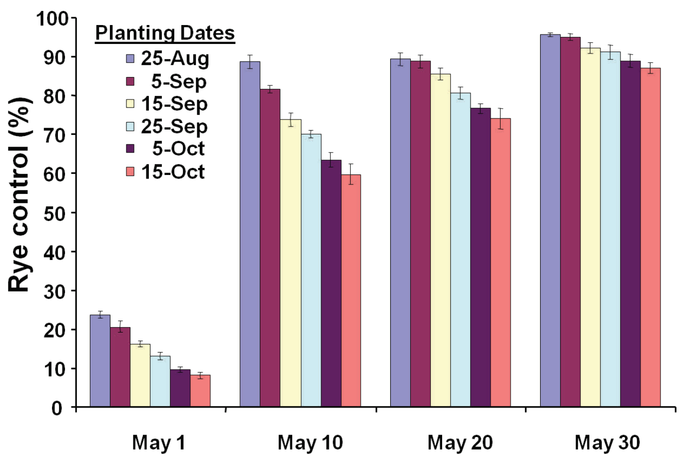
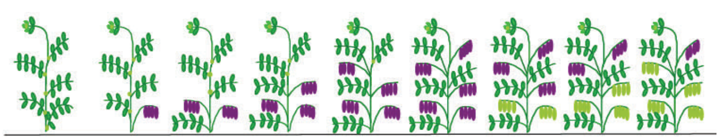


Figure 1. Percent control of cereal rye 6 weeks after rolling as influenced by planting date (Aug. 25-Oct. 15) and termination date (May 1-May 30). Bars represent standard error of the means. By the May 30 termination, fall planting date was not important—all dates were effectively controlled. Experiment was conducted in conducted in Central Pennsylvania in 2005 and 2006 (Mirsky et al. 2009).

Cover crop rollers can be effective for terminating annual crops including cereal grains; rye, wheat, oats, and barley as well as annual legumes and other forbs. Most of the research with roller/crimpers has been with cereal grain cover crops, although legume cover crops such as hairy vetch, winter pea, and crimson clover have also been evaluated (Wilson 2007, unpublished). Previous work showed that control of cereal cover crops improves with increasing plant maturity (Ashford and Reeves, 2004). The cereal grain generally needs to be well into flowering in order for the roller-crimper to provide acceptable control alone. Mirsky et al. (2009) reported that cereal rye was consistently controlled at Zadoks growth stage 61, when the anthers were clearly visible and shedding pollen. Rolling prior to this growth stage did not consistently prevent the rye cover crop from competing with the cash crop and producing viable seed. Cereal rye maturity and thus the time one must wait until it reaches the susceptible growth stage for control will depend on several factors including the fall seeding date and the temperature in the fall and spring (Figure 1). These dates will vary somewhat by year and can be delayed in the spring as we move north geographically.

Hairy vetch is another common cover crop that can be successfully terminated with a roller crimper. Research by Mischler et al. 2009 reported that consistent hairy vetch control was achieved when small pods were visible (early pod set) on the upper nodes of the plant counting down from the top (Figure 2). Although acceptable control was sometimes achieved prior to this growth stage, some regrowth occurred at some locations. Incomplete control of vetch increases the risk for vetch seed production, which can be a serious problem in subsequent winter annual crops such as wheat. The roller crimper can also work well on mixtures of cereals and legumes such as hairy vetch seeded with rye, wheat, or triticale. The timing of the operation should be based on the latest maturing species or multiple passes with a roller may be necessary. A number of cover crops are not controlled by the roller crimper including biennial or perennial legumes (alfalfa, red clover, etc.), canola, and annual ryegrass to name just a few. More cover crop species need to be tested for their suitability for using a roller-crimper.



Vege-tative 1	20% Flower 2	40% Flower 3	60% Flower 4	80% Flowe r 5	100% Flower 6	Early Pod 7	Mid Pod 8	Late Pod 9

Figure 2. Hairy vetch growth stages based on the upper five nodes of the vine. Growth stage depends on the number of buds that have begun to bloom or produce pods. Vegetative (1), no flower buds are visible; early pod set (7), when 1-2 pods are visible; and late pod set (9) when 4+ pods are visible. Consistent control with the roller-crimper was achieved at early pod set (7).

Combinations with herbicides

Although much of the interest in the roller-crimper in North America comes from organic farmers that do not use herbicides, there is some potential to combine herbicides with the roller and use an integrated approach. This has been the basis for their use in South America where burndown herbicides are generally used. Some research has shown that the roller-crimper in combination with a burndown herbicide like glyphosate can increase the effectiveness of cover crop control. In a study by Ashford and Reeves 2003, the roller in combination with a half rate of herbicide equaled the effectiveness of the herbicide alone at the full rate. In research by Curran et al. 2007, reduced rates of glyphosate in combination with the roller desiccated cereal rye more quickly than the herbicide alone. Several weeks after application, rye control was similar between rolled and unrolled treatments that included glyphosate. Although not tested in the previous study, the rolled cover crop mat potentially provides greater weed suppression than a more upright unrolled cover due to reductions in weed emergence and reduced competition. Finally, the combination of a burndown herbicide plus the roller alleviates the need to "wait" until the cover crop is susceptible to control by the roller alone and can provide an earlier window for cash crop establishment. Small grain cover crops should be in the late boot stage or in early heading to benefit from rolling. Rolling prior to this does not generally provide sufficient cover crop biomass nor the quality (higher fiber content) necessary to suppress weeds or persist long enough to impact weed emergence. In some soybean research by Mischler et al. 2010, a sprayed and rolled rye cover crop at the late boot stage or beyond provided weed control results similar to a postemergence glyphosate and no cover in 2 of 4 study locations.

Need for good no-till equipment

High-residue conservation tillage requires planting equipment that is capable of slicing through the rolled cover crop residue, accurately placing seeds in the soil, and then covering the seed with soil. In vegetable transplant systems, similar results with seedlings are desired. Although the no-till industry has made great strides in the past 15 years toward developing planters and drills that can handle large amounts of plant residue, there continues to be challenges when establishing cash crops in large amounts of residue. Too wet or too dry soil conditions, lodged cereal cover crops at the time of rolling, and extreme amounts (greater than 10,000 lb DM/acre) of cover crop biomass can make direct seeding particularly challenging. We have been more successful using no-till planters than no-till drills where depth of seed placement can be more problematic. **Be sure to test, adjust, and refine your planting equipment prior to adopting high-residue no-till management.** Establishment of the cash crop is critical to success for this no-till system.

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