

INTRODUCTION TO COVER CROP ROLLING & THE VA-USDA CRIMPER ROLLER DEMONSTRATION PROJECT

February 2007 Long Version - available at: http://www.va.nrcs.usda.gov/technical/crop_agronomy.html

1. Overview of VA Roller Demo Project

The goal of the Virginia-USDA Cover Crop Crimper Roller Demonstration Project is to evaluate the potential for increased use of cover crop rolling in Virginia. Our strategy is to provide two farm-scale cover crop crimper rollers for Virginia farmers and their advisors to try. Rollers and trailers to move them are available to borrow and use free-of-charge. Rollers are housed in Harrisonburg and Tappahannock. Scheduling is handled by the Soil & Water Conservation Districts in these localities. Read on or call the contacts below to learn more about rolling or borrowing our rollers.

2. What Is Cover Crop Rolling?

Cover crop rolling is an advanced no-till technique. It involves flattening a high-biomass cover crop to produce a thick, uniform mat of mulch. A cash crop is then no-tilled into the mulch. If the right kind of roller is used on the right cover crop at the right time, the rolling process itself will kill or partially kill the cover crop. This means burndown herbicides can be reduced or eliminated. Other potential advantages and disadvantages of cover crop rolling are listed later in this document.

Cover crop rolling has been used for decades on millions of cropland acres in South America. It has also been used successfully by individual farmers and researchers from Alabama to Pennsylvania, but has yet to see widespread adoption in the U.S.



Rolling down rye with our 15.5-foot unit in New Kent County



Our 10.5-foot roller at work in Shenandoah Valley

Contacts for VA-USDA Roller Demonstration Project

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Organic soybeans no-tilled into rolled rye, King & Queen Co.
No-herbicide no-till!



Pumpkins no-tilled into rolled rye, New Kent Co.



Our special trailers can lay flat on the ground if needed, so rollers can be loaded and unloaded without lifting.

3. Who Should Consider Rolling?

Cover crop rolling is *not* for everyone. To help you decide if it might work for you, we've provided the following profiles of Virginia growers who we think are most likely to benefit:

A. Traditional Field Crop Producers

If you are a traditional field crop producer (corn, soybeans, cotton, etc.), cover crop rolling may be for you if most or all of the following are true:

1. You are an experienced no-tiller or you plan to become one;
2. You grow later-planted crops such as full-season soybeans or cotton, or you might consider delaying the seeding of earlier-planted crops like corn;
3. You grow cover crops, you are willing to kill them late, and you are willing to manage them for high biomass production;
4. You have a strong interest in maximizing soil organic matter and soil quality on your land.

B. Vegetable and Specialty Crop Producers

Many vegetable and specialty crop producers should take a close look at cover crop rolling, whether or not they have ever no-tilled a crop before. For example, there is a special place for rolling ahead of crops like no-till pumpkins because of the clear production advantages of keeping fruit from touching soil all summer.

C. Organic Producers

Cover crop rolling should be of great interest to all organic (pesticide-free) producers, because it opens the door to herbicide-free no-till and the cost-savings and soil quality benefits associated with reduced soil disturbance.

4. Which Cover Crops Roll Best?

A. Many Species

Rolling is for killing annual cover crops. It is most often used on winter annual cereal cover crops like rye. In Virginia, tall cereal rye appears to be much better suited to rolling than barley and wheat. This is logical because most barley and wheat has been bred for standability and short straw. Winter annual grass/legume mixes like rye/hairy vetch or barley/crimson clover also work well.

B. High Yields

Rolling is for killing high-yield cover crops. Even if the right species is rolled with the right tool at the right growth stage, the full benefit of rolling will not be seen unless there is a lot of cover crop biomass. Therefore,

you may need to spend more time and money growing a cover crop for rolling than you would growing a typical cover crop. For example, if you are trying to grow a high-biomass rye cover crop for rolling on a sandy Virginia Coastal Plain soil with low nitrogen (N) carryover from the previous crop, a minimum spring application of 30 lb/ac of N will probably be needed to achieve the desired biomass. Remember, we expect this investment in your soil to pay you dividends in the long run, as further discussed below.

C. Uniform Stands

Rolling is for killing uniform stands of high-biomass cover crops. Uniform stands are important for uniform mulch thickness, which can have key planting and weed control implications.

5. Which Cash Crops Work Best with Rolling?

Cover crop rolling can be and has been used successfully ahead of almost any crop that can be no-tilled, either by direct-seeding or no-till transplanting. However, rolling fits best ahead of later-planted cash crops in Virginia such as full-season soybeans, cotton, and vegetables.

6. Short-Term Advantages of Rolling

1. **Maximum cover crop biomass:**
Rolling works best when a cover crop is killed late and when it is managed for high biomass. Therefore, the practice is associated with maximizing the amount of above- and below-ground organic matter returned to the soil by a cover crop. If the cover crop includes a legume, N carryover to the next crop will be also maximized.
2. **Burndown herbicide reduction:**
When done properly, rolling can allow for reduction or elimination of burndown herbicides (see Page 5).
3. **Drying out soil profile ahead of cash crop planting:**
Heavy water use by a cover crop can dry out the soil ahead of cash crop planting. On certain soils in certain years, this can be a production advantage.
4. **Positive mulch effects:**
The following benefits can be expected when a cash crop is no-tilled into a thick, uniform mat of mulch:
 - a. Better weed control, especially early in growing season;
 - b. Cooler soil and improved moisture retention in mid-summer;
 - c. Maximum soil protection from raindrop impact and erosion;

- d. Better environment for some beneficial insects and organisms such as earthworms;
- e. No bare soil for cleaner picking and products (e.g. pumpkins).

7. Short-Term Disadvantages of Rolling

1. **Higher cover crop production costs:**
To maximize the advantages of rolling, cover crop biomass should be maximized. This usually requires more management (timely seeding, etc.) and inputs (more seed, better seed, fertilization, etc.) than most farmers typically devote to cover crops.
2. **Late cover crop kill date**
Some examples of disadvantages of killing a cover crop late include:
 - a. Delayed cash crop planting date;
 - b. Risk of the cover crop setting and dropping viable seed.
3. **Drying out soil profile ahead of cash crop planting:**
Heavy water use by a cover crop can dry out the soil ahead of cash crop planting. On certain soils in certain years, this can be a clear disadvantage.
4. **Negative mulch effects:**
Some possible disadvantages of no-tilling into a very thick mat of mulch:
 - a. Problems getting seed-to-soil contact;
 - b. Slower soil warming, germination, and seedling growth in a cool spring;
 - c. Better environment for some pests organisms such as slugs, cutworms, etc.;
 - d. Possible early-season N tie-ups and deficiencies when a grass cash crop like corn is no-tilled into a mulch of very mature, high C:N ratio grass cover like rye.



Straight-bar crimper roller: a bumpy ride at 6+ mph!

Early boot-stage rye.
Good biomass but TOO EARLY to roll.
(11 April 2006, New Kent Co., VA)



Rye at pollination stage. Great biomass and ready to roll.
Note same shovel as in picture above.
(10 May 2005, Rockingham Co., VA)



Rye at grain-fill stage, perfect for herbicide-free rolling. Think there's enough biomass here?
(3 May 2005, Southampton Co., VA)



8. Long-Term Considerations

When evaluated on a single-year basis (in the absence of cost share), the economics of growing a cover crop are often break-even or worse. But when cover crops are consistently grown over a period of years, their cumulative soil organic matter and nutrient cycling benefits are much more likely to translate into increased profit. This is especially true if cover cropping is used in conjunction with continuous no-till and crop rotation. The many positive interactions between cover cropping, continuous no-till, and crop rotation can't be overemphasized. We are starting to understand that combining these practices over a period of five to 10 years offers a real opportunity to improve long-term profitability for Virginia farmers. This is in part due to no-till fuel and time savings and in part due to production efficiencies that accumulate as soil quality improves. Adopting these practices also means major environmental and conservation benefits.

Where does rolling fit in? Managing cover crops for high biomass production simply accelerates the long-term process of soil quality improvement described above. Once a farmer decides he wants to speed up the soil organic matter buildup that occurs with continuous no-till, then high biomass cover crops make sense. And once a farmer decides that he wants to grow high biomass cover crops, then rolling makes sense. This is why rolling is expected to have significant appeal among farmers who are committed to no-till and to increasing their soil organic matter levels and soil quality.

9. Crimping vs. Rolling

Crimping involves rolling down a cover crop with a special tool that not only flattens the crop, but also repeatedly crushes (but does not cut) cover crop stems. On our machines, the blunt edges of three-inch tall metal bars welded to the roller drum do the crimping (see picture on next page). Crimping further damages the cover crop and increases the likelihood it will stay down and die after rolling. Therefore, using a crimper becomes more important if you are trying to kill a cover crop with no herbicide.

If a standing cover crop is killed with a full rate of herbicide, then almost any device (roller without crimping bars, cultipacker, etc.) can be used to roll down the crop. Some farmers say they are able to cut herbicide rates on flattened mature cover crops even when a specially-designed crimper has not been used. But if your goal is to minimize or eliminate burndown herbicides, you should try a specially-designed crimper roller such as one of our demonstration units.



Curved crimping bars on our rollers make for a smooth ride.

10. Features of Our VA-USDA Crimper Rollers

Our two demonstration cover crop crimper rollers were custom built in Dayton, VA. Their design is based in large part on published specifications for a smooth rolling cover crop crimper roller developed by the USDA Agricultural Research Service (ARS) Soil Dynamics Lab in Auburn, AL. Their most important features are:

1. **Maximum crimping action:**
Our rollers are built heavy to maximize crimping and minimize need for burndown herbicides. They can also be filled with water for added weight.
2. **Smooth rolling action:**
Our crimping bars are curved around the roller cylinder in order to eliminate the excessive vibration that occurs at high operating speed with a traditional straight crimping bar design.

11. When Should I Roll?

Timing of cover crop rolling is a key issue. There are many general principles and tradeoffs for you to consider. As our understanding of rolling improves, we will update the guidelines offered below:

A. Timing: General

1. There is typically very little value in crimping/rolling annual cover crops until they have started the reproductive phase of their life cycle (bloom stage);
2. The more mature the cover crop is when it is crimped/rolled, the less supplemental burndown herbicide will be needed;
3. If you allow the cover crop to mature too much before crimping, it will produce and drop viable seed. Depending on your system, this may be a very important reason not to wait too long before crimping;
4. Our recommendation is to roll a few weeks prior to

- cash crop seeding, but some growers roll immediately before or even after no-tilling their cash crop;
5. If you crimp/roll with reduced or no burndown herbicide, it seems wise to allow some time to see if your cover crop dies before no-tilling your cash crop. The exception to this is if you have the option of cleaning up cover crop regrowth with selective herbicides once the cash crop is growing;
6. When rolling is used in conjunction with systemic (Roundup-type) herbicides, spraying has been successfully done before, during, and after rolling;
7. In 100% herbicide-free systems, be prepared to make additional passes with roller or flail mower in case the first crimping does not fully kill the cover crop.

B. Timing: Winter Cereal Cover Crops

Here are additional suggestions for rolling winter cereal cover crops with our VA-USDA crimper rollers. It may be possible to cut herbicide rates even lower than described below, but we'll need to evaluate results of on-farm tests before we can say more.

1. Do not consider rolling cereals with our units unless seedheads are visible across the entire field;
2. If a high-biomass cereal crop is crimped with our units around the time of flowering/pollination, it will likely stay flat and die if burndown herbicides are reduced ($\frac{3}{4}$ to $\frac{1}{4}$ of normal rates). Be ready to get covered in pollen if you roll at flowering.
3. If a high-biomass cereal crop is crimped with our units during the grain fill period, it will likely stay flat and die even if burndown herbicides are significantly reduced or eliminated ($\frac{1}{2}$ of normal rates to no herbicide). If carryover of viable cover crop seed is a problem for you, do not wait until later grain fill stages to roll.
4. If you delay crimping with our units until the soft dough stage, it is very likely the crop will stay flat and die without the use of herbicides.



Here the planter "hairpinned" rolled residue into the planting slot and the seed never touched soil. Sharpen your coulters!

12. How Should I Roll?

More advice for maximizing success with our rollers:

1. **Match roller and planter width:**
Many growers say that the best option is to roll down the cover crop in the same direction/pattern as you expect to plant the cash crop. For this reason, a roller width that exactly matches the width of your no-till planter or drill is best.
2. **Run parallel:**
If roller and planter widths don't match up, many growers find they are able to still plant effectively as long as their cash crop rows run more or less parallel to the direction of rolling. Some prefer to plant at a slight angle with respect to the direction of rolling. In both cases, no-till seed furrow openers and other ground- or residue-engaging hardware on the planting machine are typically moving aside most of the heavy residue rather than cutting through it.
3. **Don't run perpendicular (unless your planter is up to the task!):**
Most growers agree that planting perpendicular to the direction of rolling is not a good idea. This requires cutting through large quantities of residue and increases the likelihood of hairpinning, poor seed-to-soil contact, and bad stands.
4. **Look out for lodging:**
A real problem occurs when a high biomass grass cover crop like rye lodges or falls over on its own in a random pattern. The result is a "weave" of mulch giving you no clear direction to plant in and variable amounts of residue to cut through as you move through the field. For this reason, minimize the risk of lodging by not over-fertilizing rye or other susceptible cover crops with N. If you are concerned that a crop may lodge before the right stage for rolling, consider rolling early to establish a pattern, even though you expect it to stand back up. Then terminate the crop with another pass at the right time.
5. **Crimp, don't cut:**
Remember: the goal is to crush but not cut cover crop stems. Cut plants often regrow. If one of our crimpers is doing a lot of cutting, then most likely the crop is too immature/not stemmy enough or there is not enough total biomass.
6. **Manage for high biomass, uniform cover crops!**
A high biomass, uniform cover crop not only makes a better mulch mat — it is also much more likely to stay down and die when rolled! For this reason, we recommend that you seed, fertilize, and otherwise

manage your cover crop for maximum biomass and uniformity much as you would a cash crop.

13. Suggestions For On-Farm Tests With Our Rollers

1. We encourage farmers to try with our rollers on limited acreage. This is new technology and disasters can happen.
2. We encourage farmers to use our rollers to set up simple strip or split-field test plots rather than to roll down entire fields in a uniform manner. Both approaches are acceptable, but we will all probably learn more from side-by-side comparisons than from rolling entire fields.
3. On-farm tests need not be complicated. They can be as simple as splitting a field or rolling down one strip in a field and then taking a little extra time to keep track of crop progress. Hard data and yield measurements are ideal, but farmer observations alone are extremely valuable to us. For help with setting up or monitoring on-farm cover crop rolling tests, call the contacts listed on Page 1.
4. Some examples of good side-by-side comparisons:
 - a. Cover crop sprayed early vs. rolled down late;
 - b. Cover crop harvested for hay or silage vs. rolled down late;
 - c. Cover crop rolled down at different growth stages with the same amount of herbicide used;
 - d. Cover crop rolled down at the same growth stage with different amounts of herbicide used.

In all of the above plots, the cash crop could be no-tilled into both treatments on the same day and managed the same way throughout the season.

14. VA –USDA Roller Project Partners

Thanks to all of the following organizations for making this project possible:

1. Northern Neck Soil & Water Conservation District
2. Shenandoah Resource Conservation & Development (RC&D) Council
3. Shenandoah Valley Soil & Water Conservation District
4. Three Rivers Soil & Water Conservation District
5. Tidewater Resource Conservation & Development (RC&D) Council
6. USDA Natural Resources Conservation Service
7. Virginia Cooperative Extension