SARE Project FNC13-940: Evaluating the Roller-Crimper for Cover Crop Control in Corn and Soybeans on Terraced Ground - 2013 Annual Report

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Summary

This project evaluates the Rodale roller-crimper in hilly, terraced, and irregularly shaped fields. The questions this project aims to answer are:

1. How effectively does the roller-crimper control cover crops and weeds in these fields?
2. How does using the roller-crimper alter the way you plant a field? Should you plant on the contour? How sharp of a contour will the roller-crimper handle?
3. How well are cover crops controlled on a terrace? How many passes should be made on a terrace to get proper control?

Introduction

Cover crops prevent erosion and improve soil health (Hoorman, 2009). Usually cover crops are killed with herbicides or tillage. A front-mounted Rodale roller-crimper offers herbicide-free cover crop control while planting your cash crop, all in one pass. However, not much research has been done on how to use the roller-crimper in hilly, terraced, or irregularly shaped fields, all of which are common in northwest Missouri.

Figure 01 (above): This pin position lets the arms move up and down slightly in response to changes in the terrain. It also allows one arm to move up or down while the other stays in place, which helps on sloped terrain. Inserting the pin in the other opening firmly locks the arms in place.

Figure 02 (left): An opening in the center of the roller-crimper allows you to add water. I found it was easiest to remove the screw-in plug with a socket wrench with an extension, which kept my hands above the chevron-shaped edges of the roller-crimper.

Setting Up the Roller-Crimper

I purchased the roller-crimper from I&J Manufacturing in Gap, PA. It's 15.5' wide and hooks onto a LaForge front-mounted three-point hitch, which is controlled by a joystick that runs the mid-mount hydraulics on the side of my tractor, which is a New Holland TM140. The joystick has a float option that allows the roller-crimper to remain constantly pressed against the ground. When installing the front three-point hitch, you can feed the hydraulic hoses to the rear hydraulic connectors on your tractor and use your normal hydraulic levers for operating the hitch as well. It's crucial that whatever hydraulic setup you use has a "float" option. This lets gravity pull the roller-crimper downward, pressing it against the ground at all times and allowing it to adjust to the terrain. Constantly running the hydraulics to push the roller-crimper downward would put too much strain on your tractor and the front-mounted three-point hitch.

The pins that lock the three-point hitch arms into place can be adjusted two ways: One locks the arms firmly in place, and the other lets the arms move up and down slightly (*See Figure 01*). I chose the second option because this let the arms adjust for small variations in the terrain that might be too quick for the hydraulic float to respond to. The roller-crimper has a plug where a hose can be fed into it to add water for extra weight (*See Figure 02*). A few test runs showed it didn't have enough weight to sufficiently flatten the cover crops, so I added about 60 gallons of water, though the roller-crimper could hold more.

Planting Setup

Corn was planted while rolling and crimping in two different fields. The first field was 10 acres with a mix of hairy vetch (7 lbs./ac.), Austrian winter peas (5 lbs./ac.), crimson clover (3 lbs./ac.), canola (1 lb./ac.), purple top turnips (1 lb./ac.), and cereal rye (16 lbs./ac.). This mix was planted August 16, 2012, following wheat. This field was fertilized in the fall at a rate of 12.5-75-55-15S-5Zn. The second field was 6 acres with cereal rye (50 lbs./ac.) planted October 11, 2012, following soybeans. It was fertilized with 80 lbs. nitrogen March 31, 2013. Corn was planted at a rate of about 25,000 seeds/ac. in both fields using a John Deere 7000 6-row planter. The planter had heavy-duty no-till down-pressure springs, 13-wave coulters, cast iron closing wheels, and Keeton seed firmers. No weights were added to the planter. The planting date was May 23, 2013. Spring started out cooler than normal in 2013, delaying cover crop maturity and pushing planting into late May. I decided to plant these fields on May 23 because rain was expected for the next several days and the forecast indicated it would be over a week before I'd be able to get back in the field.

Soybeans were planted into 15 acres of cereal rye (60 lbs./ac.). The rye was planted October 12, 2012, following soybeans. The field was fertilized at a rate of 10-50-80 on April 8, 2013. Soybeans were planted at a rate of about 160,000 seeds/ac. using a John Deere 1590 15' no-till grain drill. No suitcase weights were added to the back of the drill. The planting date was June 13, 2013.

Operating the Roller-Crimper in Irregularly Shaped Fields While Planting

A couple months before I used the roller-crimper while planting, I did a test run in a stalk field with just the roller-crimper. My father stood at the edge of the field and observed how the roller-crimper performed while I drove the tractor. When I turned too sharply while rolling, he noticed the front three-point hitch arms bent slightly. When I lifted the roller-crimper, they sprang back into place. Keeping this in mind, I decided to take caution when approaching curves. Even though the stress didn't permanently bend the arms, I didn't want to possibly break them by stressing them too much. I kept my speed at about 4 to 4.5 mph, using the same gear and range I normally would for planting.

I started rolling and planting a field like I would normally plant a field. I made four to six passes around the perimeter of the field to provide ample room to turn around when planting the inner part of the field. Berms or terrace ends at the edge of a field made it harder to adequately flatten cover crops while rolling a boundary around the field. The roller-crimper flattened cover crops while approaching the berm or terrace, but when I drove up and over it, the roller-crimper took a few seconds to touch back to the ground and didn't flatten the cover crops on the opposite side of the berm or terrace (*See Figure 03*). To flatten these areas, I drove toward the berm or terrace when making successive passes inside the field. When I reached the end of a pass that positioned me near the berm or terrace, I drove parallel along the berm or terrace, raising the planter once I entered the rolled area around the edge of the field (*See Figure 04*).

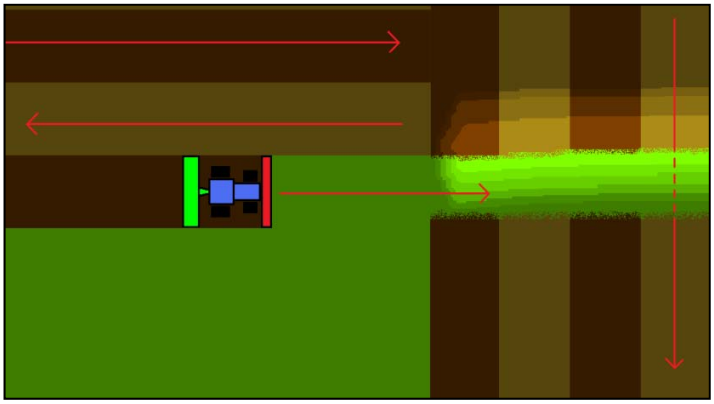

Figure 03 (left): This is an example of cover crops that didn't get flattened when driving up and over a small berm near the edge of the field. The roller-crimper flattened cover crops on the side of the berm facing it, but failed to make contact with the ground soon enough to flatten cover crops on the opposite side.

Figure 04 (right): This drawing shows how I tried to rectify areas like the example in the left image. After rolling and planting a boundary around the field, I planted going back and forth in the center of the field. When I reached the end of a pass near an area behind a berm or terrace where the cover crops weren't sufficiently flattened, I continued driving into the unflattened area with the roller-crimper pressed against the ground. As I entered this area, I lifted the planter so I didn't overlap my previously planted rows, continuing to keep the roller-crimper pressed to the ground until I reached the edge of the field.

Once the field boundary was rolled and planted, I found it was easier *not* to plant on the contour. Instead, I planted straight back and forth through the field as long as there were no obstructions to prevent me from doing so. The roller-crimper could handle very gentle contours, but I avoided anything that seemed too sharp since it would strain the front-mounted three-point hitch. For these sharper curves, I had to plant them the same way I would plant a corner. I planted going straight toward the curve and stopped driving once the planter reached the edge of the field. Then I raised both the planter and roller-crimper, backed up, and planted driving away from the curve. If you're rolling and planting and try to turn to match the contour of the field but the roller-crimper keeps rolling in the same direction even though your tractor tires are turned, then the curve is definitely too sharp.

While driving along steeper slopes, the roller-crimper caused the tractor to pull sideways and downhill; the tractor tires left skid marks in the field where this happened (*See Figure 05*). I noticed this while driving where the edge of the field slopes into a grassed waterway and while on steeper terraces. When I felt the tractor begin to drag sideways downhill, I found it was easiest to let the roller-crimper guide the tractor rather than steer the wheel to correct. Steering to correct made no difference in the tractor's trajectory and would likely put too much stress on the arms of the front-mounted three-point hitch, possibly bending or damaging them.

Figure 05: Skid marks where the roller-crimper pulled the tractor sideways downhill.

Straight terraces were pretty easy to roll and crimp. First, I rolled the top of the terrace. Then I rolled on both sides of my first pass. I then rolled to the sides of those two subsequent passes. In all, it took five passes to get good control on a terrace (*See Figures 06 & 07*). The roller-crimper wouldn't flatten its full 15.5' width while on a terrace because the edges of the roller-crimper wouldn't make contact with the ground when driving on a rounded surface, particularly when making a pass at the crest of the terrace. This meant I had to overlap my passes, which wasn't a major concern since I was drilling soybeans.

Figure 06 (left): After rolling at the crest and along the edges of a straight terrace, the cereal rye forms a smooth mat of flattened vegetation.

Figure 07 (right): Most of the rye is brown and dead six days later. Some cereal rye still remained upright, but looked like it was drying out and dying. The brown, standing rye on the right-hand side of this picture was in a low spot and could not be rolled and crimped because it was in a low spot that was too wet to plant.

Curved terraces were more difficult. First, I rolled the top of the terrace at one end, driving straight into the terrace channel once I reached the point where the terrace makes a curve. I did the same thing for the other end of the terrace. I then rolled on each side of my pass at the top of the terrace, driving up and over the terrace once I reached the curve. I continued this pattern until all sides of the terrace were rolled. This equaled six passes for a smaller curved terrace (*See Figure 08, next page*), though larger curved terraces would require more passes.

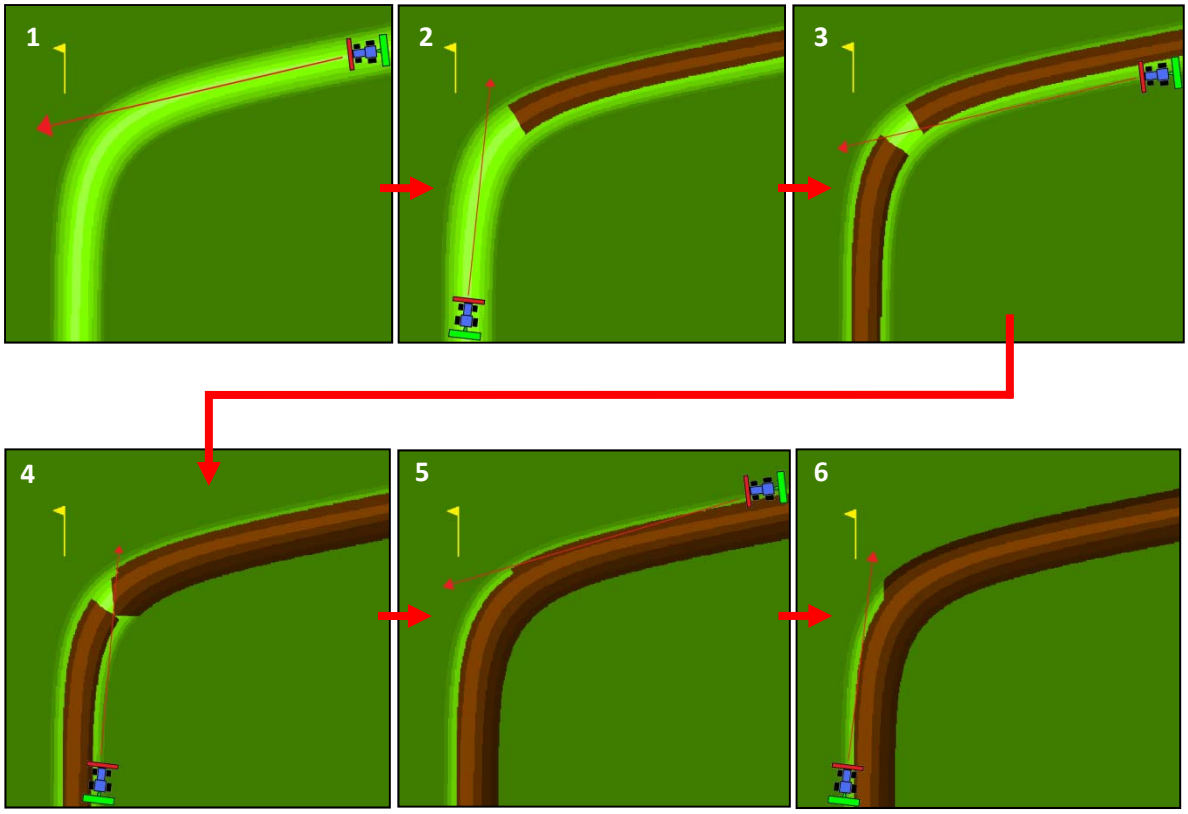

Figure 08: This diagram outlines how I approached a curved terrace. I started my first pass by driving straight on the crest at one end of the terrace, driving down into the terrace channel once I reached the curve. I drove straight into the channel because the roller-crimper couldn't handle such a sharp curve. I repeated this process at the other end of the terrace. After finishing the terrace crest, I made successive passes to each side, going up and over the terrace rather than following the contour. I repeated this process until the terrace was complete. If any cereal rye remained standing, I'd run the roller over it while making other passes through the field.

Figure 09: Cereal rye near a riser.

It was difficult to roll and crimp near the riser in the terrace channel. I didn't want to risk hitting the riser, so I left about a foot on each side (*See Figure 09*). When rolling and crimping, you'll need to either mow or spray the cover crops near the riser to control them, or accept that they'll likely go to seed. Since weeds are typical around risers in terrace channels anyway, it wouldn't be that worrisome if the cover crops were left uncontrolled around a riser.

As long as the terrain was level, the roller-crimper worked very well. However, it didn't flatten cover crops where there were small ditches, divots, or irregularities (such as tire tracks) in the terrain. When rolling over a divot, it flattened cover crops at ground level, but cover crops growing in the divot bent over and sprang back into place since the roller-crimper didn't make contact with the base of the stem (*See Figures 10 & 11*). Having an even, level field should eliminate these problems.

Figure 10 (left): Cereal rye on the left and right sides of the pass flattened successfully, but rye in a small ditch in the center of the pass remained upright.

Figure 11 (right): This illustrates how cereal rye growing in a divot doesn't make full contact with the roller-crimper, resulting in poor control.

Roller-Crimper's Effectiveness at Cover Crop Termination and Weed Control

Corn:

Despite planting in late May, the cover crops in the mixed field weren't mature enough to get good control from rolling and crimping (*See Figure 12*), so I had to spray herbicides to terminate the cover crops. Cereal rye can be rolled and crimped after reaching the pollination/anthesis stage (Seidel, 2008, p. 2). Control improves even more at dough stage (Lawrence, 2006, p. 5). Much of this field hadn't yet reached pollination stage. Canola in the mix wasn't controlled well; its flexible stem either bent after rolling and sprang back up, or broke off at the ground. This is consistent with information from the Penn State Extension (Curran, 2010, p. 2).

Figure 12: Poor cover crop control.

The second field, which consisted entirely of cereal rye, had better control. Most of the rye was at the pollination stage (*See Figure 13*). Once the field was finished, enough rye remained standing to warrant herbicides. I noticed this more in areas of the field where thinner soil resulted in a thinner, shorter stand of rye. Even though the rye in this field was planted later in the fall, it flattened much better than the rye in the cover crop mix. This field received about 80 lbs. N in the spring, whereas the mix received a smaller amount of fertilizer in the fall. This is consistent with findings from the USDA/NRCS and Virginia Cooperative Extension that fertilizer helps develop lush cover crop growth, making it easier to roll and crimp (Lawrence, 2006).

Figure 13: Cereal rye at anthesis/pollination. When rolled, pollen scatters into the air, coating the hood and windshield of the tractor in a fine, yellow dust.

After both fields of corn were planted on May 23, we received heavy rains and cool temperatures. Crop emergence was poor. Since the corn didn't form a good canopy, weeds took hold, particularly tall waterhemp (*See Figures 14 & 15*).

Figure 14 (left): The corn in the cover crop mix had only reached about the V3 stage by June 21, the date this photo was taken. I spread 100 lbs N/ac. as ammonium nitrate on this field June 14 since the cover crop mix didn't have enough legumes to supply the corn with nitrogen, but the corn remained stunted. The allelopathic effect of the cereal rye in the mix and nitrogen tie-up of the carbon-rich rye residue both may have hindered the corn, but the wet, cold conditions following planting seemed to be the dominant factor affecting the corn. Since it struggled with emergence at the very start, it struggled throughout the season.

Figure 15 (right): The corn planted into a pure stand of cereal rye had even poorer emergence. The corn was around the V8 growth stage when this picture was taken July 20. The poor canopy provided ample room for weeds to take hold.

Figure 16 (above): This picture was taken June 22, nine days after planting and rolling this field. Overall, I was pleased with how well the roller-crimper controlled the rye. You can see some standing stalks dotting the field, but they looked sufficiently crimped and weakened. I think wind and rainfall would have laid them down over the course of the summer. Several areas had a thick rye mulch to cover weeds, but thinner areas didn't block out weeds.

Figure 17 (above): There were enough weeds in the field to warrant a postemergence spraying. There were some small, emerging grasses that weren't controlled, but marestail (*Conyza canadensis*) was the most notable weed to survive the rolling and crimping process. This weed seen here actually has a visible bend in its stalk where it was crimped, but that did not prevent it from continuing its growth.

Figure 18 (above): This field of soybeans planted while rolling and crimping cereal rye was free of weeds when this picture was taken September 10. It had received two sprayings of Liberty herbicide. The brown strip in the center was a wet spot that couldn't be planted, so I used a sickle-bar mower to trim the cereal rye in that area.

Soybeans:

The weather was wet and cool following May 25, 2013. June 13 was the first date where soil conditions were decent enough to plant. Despite being able to plant, soil conditions weren't ideal. It was moist enough in some spots that the closing wheels of the drill didn't close the furrow very well. Despite less-than-ideal conditions, the soybeans emerged surprisingly well. The mulch kept the soil from drying out nearly as fast after planting, which possibly prevented it from crusting over. If the soybeans were planted into a field without rye, I question if they would have emerged as well.

The cereal rye was at the dough stage, meaning it was mature enough to get good control from rolling and crimping. Most of the rye flattened easily, and few plants remained standing. I couldn't roll and plant in some low spots in the field because they were too wet. In excessively wet spots, the rye was brown and dead. This provided a good visual indicator if a spot in the field was too wet to plant into.

The rolled mulch was dying within a week of rolling (*See Figure 16*), but there were some weed escapes, most notably marestail (*See Figure 17*). Since these soybeans were being raised for a local seed dealer, I sprayed Liberty (glufosinate) at the recommended rate post-emergence on June 22. A few weeds came back by mid-July, so I sprayed a second application of Liberty on July 21. Through the rest of the summer, the rolled and crimped field of soybeans was very clean (*See Figure 18*).

By mid-August, I noticed the seed heads on the rolled rye were germinating (*See Figures 19 & 20*). Though the seed felt like it was at the dough stage when I rolled it in June, it must have been mature enough to dry out and germinate after it was rolled and crimped. The volunteer rye didn't pose any problems for the combine when I harvested the soybeans October 25. The volunteer rye covered most of the field, providing ample cover throughout the winter (*See Figure 21*).

Figure 19 (far left): Volunteer cereal rye was starting to grow beneath the soybean canopy August 13.
Figure 20 (left): This is one of the seed heads that had started to germinate.
Figure 21 (above): After soybeans were harvested October 25, the volunteer cereal rye left a dense cover on the soil.

Crop Performance and Yield

Corn:

After planting corn, the weather turned wet and cold, and the crop's emergence was severely stunted. Even after two months, corn had only reached the V8 stage. This was most apparent in the second field that consisted mostly of cereal rye. The allelopathic effect of the rye might have stunted the corn, but the waterlogged conditions following planting seem like the dominant factor affecting the crop. Many farmers in my area who planted at the end of May had emergence problems and had to replant. However, the thick mat of cover crop residue kept the soil moist, making a timely replant unfeasible. Corn planted in the cover crop mix had slightly better emergence than the field of cereal rye. The average yield was 48.99 bu./ac. for the corn in the cover crop mix and 21.14 bu./ac. for the corn in the cereal rye.

Soybeans:

Soybeans emerged well, but didn't yield as well as the other portion of the field that had soybeans planted on May 17, 2013, into herbicide-killed rye. When comparing to the previous year's yield map, the rolled areas didn't perform as well. In 2012, they yielded above average compared to the rest of the field. In 2013 when they were rolled and crimped, they yielded at or below average (*See Figure 22*). This is only the second year I've farmed this field, and two years' worth of yield data isn't enough to gauge how an area of the field performs on average, but the information I have at least gives an indication that the lower yield in the rolled areas was due to either planting date, conditions at planting, or the rolling-crimping process and not due to inherently low fertility in those areas. Soybeans planted while rolling and crimping had an average yield of 29.26 bu./ac. Soybeans planted into cereal rye terminated with herbicides in the same field had an average yield of 36.51 bu./ac., while a nearby field with a different variety of soybeans planted into cereal rye terminated with herbicides had an average yield of 50.28 bu./ac.

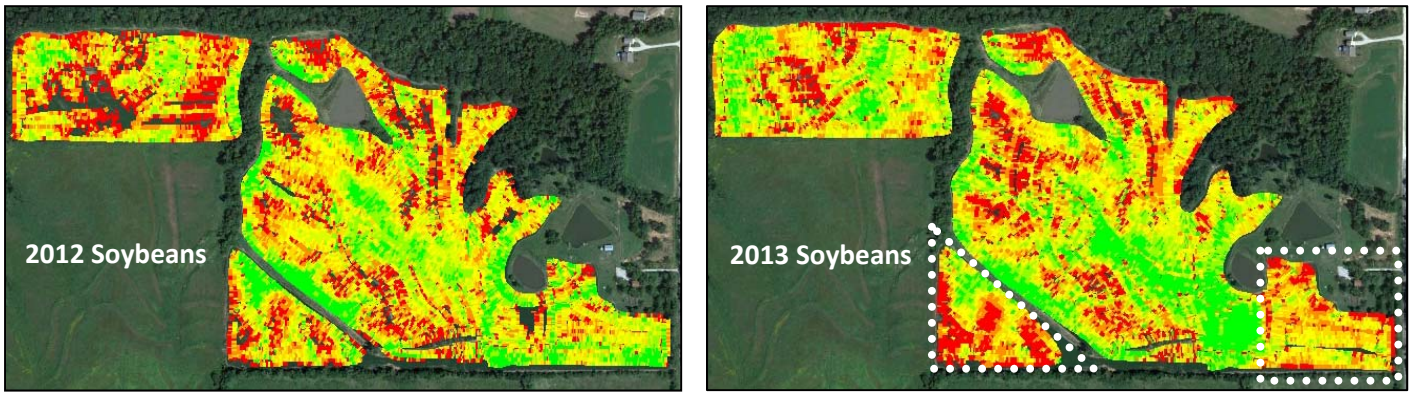

Figure 22: This picture compares the yield maps from soybeans planted in 2012 and 2013. The areas in the field that were rolled and crimped are surrounded with a dotted white outline in the map on the right. When these two areas were planted at the same time under the same conditions in 2012, they yielded at or above average compared to the rest of the field, as shown by their higher number of green and yellow data points. When these areas where planted at a later date using the roller-crimper in 2013, they yielded below average compared to the rest of the field, as shown by their higher number of orange and red data points. Since the soybeans in the rest of the field were planted into a cereal rye cover crop that produced a dense layer of mulch, it seems unlikely that the thick mulch from the rolling and crimping process led to lower yields. The soybeans planted while rolling and crimping were planted almost a month after the other soybeans in the field, which would be a likely cause of a yield drop. In years with a warmer spring, it may be possible that rolled and crimped soybeans could be planted around the same time as soybeans planted into a chemically killed cereal rye cover, providing a better yield comparison.

Conclusions and Suggestions

- **DON'T TURN TOO SHARPLY**. The roller-crimper can handle gentle curves, but if it looks like a curve will be too sharp, it's best to be safe and treat it like a corner. Turning too sharply bends the arms of the front-mounted three-point hitch, though they spring back into place once the roller-crimper is lifted. However, doing this too much could break them or leave them permanently bent.
- Start small and pick your easiest-laying fields when first trying out the roller-crimper to help you get used to the feel of using it while planting.
- I found planting soybeans while rolling and crimping cereal rye to be the easiest way to get used to using the roller-crimper. You don't have to worry about rows overlapping like you would with corn, and the rye posed no problem of nitrogen tie-up for soybeans like it would for corn. Soybeans also seemed to do a better job of poking up through the residue.
- Keep weather delays in mind. Cover crops may not be ready to roll and crimp when you'd like to plant, but the weather may turn wet once the time is right for rolling and crimping, keeping you out of the field until the cover crop is too mature and has set on seed.
- Cover crop mixes made rolling and crimping more difficult. When certain species of cover crops would be ready to crimp, others might still need time to mature. Having a pure stand of one cover crop made it much easier to manage. Planting soybeans into cereal rye was the easiest to manage.
- Irregularly shaped fields can be planted while rolling and crimping, but sharper curves need to be treated like corners. Wide grass borders around the field would make these areas easier to maneuver around, giving ample room to turn around for another pass.
- Rolling and crimping while planting on terraces was easiest on straight terraces. Cover crops near the terrace riser are harder to reach due to the concern of hitting the riser with the roller-crimper.
- Though cereal rye was controlled by the roller-crimper, the mat of residue it created when flattened wasn't enough to control weeds. Drilling rye at a heavier rate in the fall and applying some nitrogen in the spring both might have improved the amount of cover to make a thicker layer of mulch.
- If cereal rye is well into the later part of the dough stage when rolled, be prepared for volunteer rye to come up in the late summer or early fall. Volunteer rye didn't pose any problem when harvesting soybeans, but it would make rotating to wheat difficult because of the risk of volunteer rye in your wheat stand. The volunteer rye could be used for grazing or possibly be harvested the following year for cover crop seed.

Other Questions for Further Research

- What effect does crop rotation have on weed control using the roller-crimper? As with the marestail mentioned earlier, I found other weeds that grew horizontally under the mat of residue until they found an opening where they could access sunlight (*See Figure 23*). Would a different crop rotation break certain weed cycles and help control these weeds? For example, would rolling and crimping a cereal rye cover crop planted after a cool-season grain like wheat offer better weed control than a cereal rye cover crop planted after a warm-season crop like soybeans or corn?
- If cereal rye that was rolled and crimped ends up going to seed, how well does it work as a crop for the following year? Should it be grazed, or would it yield enough to provide cover crop seed for future use?

Figure 23: This picture was taken from cereal rye I had rolled and crimped for a summer squash patch. Like marestail, this prickly lettuce (*Lactuca serriola*) developed a bend in its stalk, but continued to grow through a gap in the cereal rye mulch.

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