18-1 NO-TILL SOYBEAN TRIAL 2017

Introduction

This organic no-till soybean trial is part of a larger organic no-till cropping system trial initiated in 2017 at the Arlington Agricultural Research Station. The trial is a four-year rotation including corn, soybean and a small grain. In the soybean phase of the rotation, reduced tillage is accomplished by using a fall planted small grain, with the soybeans direct planted before or after termination of the cover crop with a roller crimper.

In this fact sheet we compare the performance of different small grains as cover crops, as well as different soybean planting dates and crimping timing. If you are already using organic no-till our results can help you fine-tune your system. If you're interested in implementing organic no-till in the future these results will help you be aware of critical points in the system.

Cover crops used, planting and crimping strategies

4 cover crops, one control

- Two varieties of winter cereal rye: 'Aroostook', 'Spooner'
- Two varieties of winter triticale: 'NE426GT', '815'
- Control: no cover crop, relying on cultivation for weed management

2 planting strategies for soybeans

- Early planting: the soybeans are "planted green" in the standing cover crop when it reaches boot stage
- Late planting: the soybeans are planted in the rolled cover crop, at the same time as rolling (optimal) or a few days later if soil and weather condition are not favorable

2 crimping strategies (only applies to early soybean planting)

- "Typical" crimping: when the cover crop reaches full anthesis, soybeans are newly emerged - about VE stage
- Late crimping: past anthesis for the cover crop, soybeans are putting out true leaves - about VC/V1 stage

To allow space for this comparison, we split our 450 x 30ft plots into two 220 x 30ft sub-plots separated by a driveway (Figure 1).

Description of the trial

Prior to the inception of our trial, the 6-acre field was the site of an organic soil-balance (Ca/Mg) fertility trial from 2006 until 2014. The rotation was corn – soybeans - alfalfa/ oats - alfalfa. In 2014, the trial ended, and the field was under alfalfa between fall 2014-2016. It has been certified organic since 2009. We divided the field into 20 plots, upon which 5 different treatments were applied, repeated 4 times. Every plot is 450ft long by 30ft wide, allowing us to use 15ft wide farming implements.

Figure 1 - Drone view of soybean plot, May 26, 2017 showing rolling Aroostook-rye. Late planted treatments at the top, early planted treatments on the bottom, a driveway in the middle. There are 4 repetitions of the 5 different treatments.

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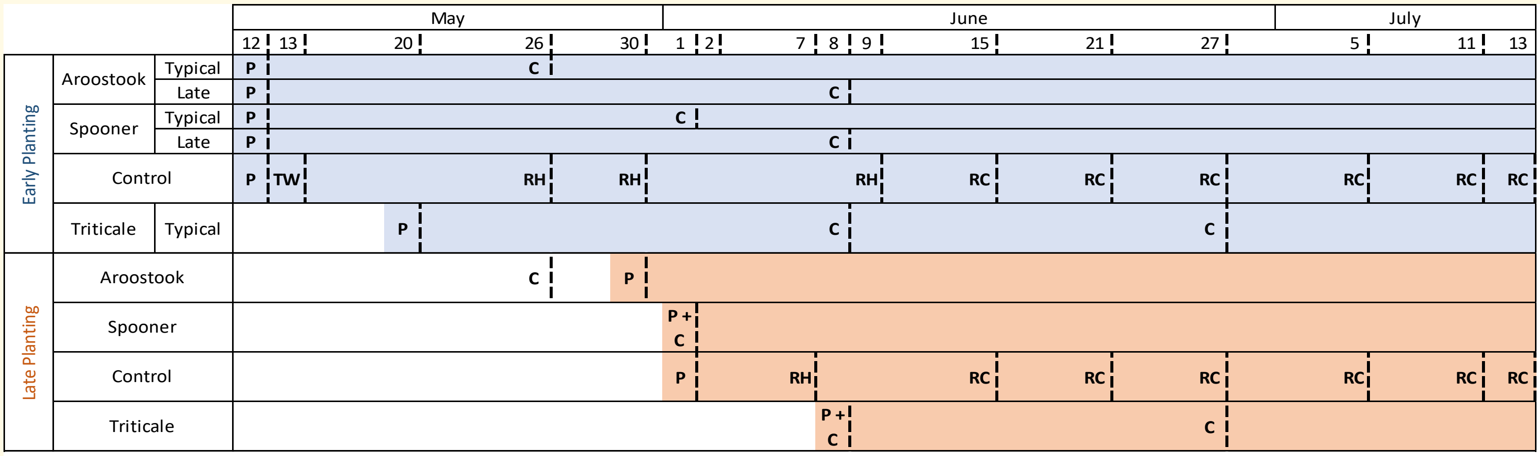

Figure 2 - 2017 Soybean planting, crimping and cultivation calendar
P-Planting   C-Crimping   TW-Tine Weeding   RH-Rotary Hoe   RC - Row Cultivator

In 2016, after terminating the previous alfalfa crop, we planted both varieties of triticale on September 19th and both varieties of rye on September 26th. The delay between the two species was due to a rain event. We planted 3bu/ac of each variety, a heavy seeding rate needed to generate the right amount of biomass at soybean planting. The triticale was planted slightly deeper than the rye, 1.75″ and 1.25″ respectively. Triticale is less winter hardy than rye, so by drilling it deeper, we were attempting to enhance its potential to survive the winter.

In 2017, 'Aroostook' and 'Spooner' reached boot stage[1] approximately on May 12 (see Figure 3). On that day, we planted soybeans in the early planted treatments of both rye cover crop treatments as well as in the control treatment. Eight days later, on May 20, both triticale treatments reached boot stage, and soybeans were planted in the early treatments. For every treatment, we planted the soybeans (Viking O.1706) on 30'' rows, at 1'' deep and with a rate of 225,000 seed/ac.

The first cover crop to reach anthesis[2] was 'Aroostook', on May 26 (see Figure 3). We crimped the rye in both the early and late planted treatments on this date. However, due to weather conditions, soybeans were not planted until 4 days later, on May 30, with another planter (see equipment used). The following day, 'Spooner' reached anthesis, we crimped the early planted treatment and both crimped and planted the late planted treatment. We also planted the late planted control. Both varieties of triticale reached anthesis 7 days later than the later maturing rye variety, 'Spooner'. We planted and crimped the late planted triticale, crimped the early planted triticale and finished crimping the early planted rye on June 8. Nineteen days later, we crimped all the triticale treatments a second time because the termination was insufficient.

The control treatment was tine weeded the day after planting on the early planted treatment. On that same treatment, we used the rotary hoe three times between May 26 and June 9, then switched to the row cultivator. On the late planted treatment, we did not use the tine weeder, but used the rotary hoe once, on June 8th before using the row cultivator. The row cultivator was used six times on both sides, between June 15 and July 13. The last row

1. Boot stage occurs prior to head emergence, the flag leaf sheath extends and the boot is swollen. Watching for first head emergence is a good way to identify boot stage.
2. Anthesis is reached when the anthers are out and pollen scattered

Figure 3

Left- Triticale at boot stage

Right- 'Aroostook' Rye at anthesis

cultivation, on July 13, was a bit of a stretch for the early planted half, with some beans pulled because they were too developed.

The temperature in 2017 compared to 1981-2010 was cooler than average in the 2nd half of May and warmer than average through June. The rest of the summer had temperatures within the ten year average, with temperatures cooling down at end of August/beginning of September and warming again at the end of September/beginning of October. Precipitation was above average in May and mostly below average through the summer with episodes of intense rainfall over short periods of time. The early fall had average rainfall.

Equipment used

The cereal grains were planted with a John Deere 1590 no-till drill. We used the roller crimper designed by the Rodale institute and manufactured by I&J Manufacturing. It was front mounted, with the planter in the back.

Two different planters were used. For the early planted soybeans, we used the John Deere 1750 Max Emerge Plus planter. For the late planted soybeans we used a modified AGCO planter. We used this modified planter to obtain greater down-pressure on the planting units and achieve better slicing through the rye to place the soybean seeds deep enough in the ground. In addition to applying 200 pounds per row unit, the modified AGCO planter has 12 000 pounds of weight and AGCO heavy duty down pressure springs adding 600lbs pressure per row unit. It also features front mounted no-till coulters and double disc openers.

On the control treatment, we used four different pieces of equipment for cultivation: the Hatzenbacher tine weeder (1"), a John Deere rotary hoe (1"), the Will-Rich row cultivator (2") and the Yetter row cultivator (2").

The soybean yield checks were done by harvesting every subplot with a 15-foot gleaner combine. The harvested soybeans were weighed, and the yield in bu/ac was standardized at 13% moisture.

Data collected

- Cover crop cover, early spring (April 14)
- Number of weeds, early spring (April 14)
- Cover crop biomass, prior to bean planting (May 24 – June 7)
- Biomass of cover crop regrowth 1 month after rolling (June 26)
- Soybean stand count (July 13)
- Mid-summer weed count and biomass between /in rows (Aug 1)
- Mid-summer soil (pH, P, K and OM) and soybean leaf (N, P, K, Ca, Mg, S, Zn, Mn, B, Fe, Cu) sampling and analysis (Aug 4)
- Mid/late summer development stage assessment, nodule count and biomass, soybean plant height and biomass, first pod height (Aug 10 – 15)
- Early fall weed count and biomass between/in rows (Sept 21)
- Yield (Oct 18-19)

Figure 4

(1) John Deere 1590 no-till drill

(2)Front mounted Rodale roller crimper

(3) Modified AGCO planter

(4) John Deere 1750 Max Emerge Plus planter

(5) Gleaner combine

Date	Observation	Aroostook	Spooner	NE426GT	815
Apr 14	Cover crop cover (%)	71	69	58	62
May 24 – June 7	Cover crop biomass (lbs dry matter/ac)	11,212	11,315	12,721	15,137
June 26	Biomass of cover crop regrowth (lbs dry matter/ac)	300	161	14	28

Table 1 - Cover crop related observations

Observations

Comparison of different cover crops

Cover crop development
In early spring (April 14th) 'Aroostook' rye cover crop offered the densest cover, while 'NE426GT' triticale offered the weakest (see Table 1). However, just before rolling, in late May/early June, '815' triticale cover crop had the highest biomass, followed by 'NE426GT' triticale. Both rye varieties had lower biomass.

Regarding termination, about a month after rolling, 'Aroostook' rye had the highest amount of regrowth – about twice as much as 'Spooner' rye. We did not observe a lot of regrowth in the triticale, but this data is not exactly comparable since both triticale treatments were rolled twice.

Weed suppression capacity
Through all the growing season, the control had the lowest number and biomass of weeds. Comparing the different cover crops, 'Spooner' rye was the most consistent cover crop in terms of weed suppression – it had the lowest number and biomass of weeds every time we checked. 'Aroostook' rye and 'NE426GT' triticale performed similarly, and '815' triticale showed the worst performance.

Soybean development and yield
In the middle of August, the soybeans planted in the rolled rye were slightly less mature than those planted in bare ground, even with the same planting date. This difference in development might be startling for a beginner to the technique, but it is common and does not necessarily impact the yields at the end of the season.

As we could expect with delayed planting date (+7 days), the soybeans planted in the triticale cover were almost one stage behind the ones planted in the rye cover crop. At that time of the year, this difference in development was reflected in the plant height and plant biomass. The height of the first pod was similar across treatments, which is predictable since it is mostly related to the variety.

In terms of nodulation, the soybeans in the control treatment had almost twice as many nodules compared to the ones in both rye cover crop treatments and in the '815' triticale treatment. The soybeans planted in the 'NE426GT' triticale had an intermediate number of nodules. The nodule biomass was similar across the treatments, which indicates that even though there were more nodules in the control and the 'NE426GT' triticale treatments, they were smaller.

Within the three main yield components – plants per acre, pod per plant and seed per pod – we only measured the number of plants per acre this past growing season. There were more plants per acre in the control treatment compared to all the cover crop treatments (See Table 2). We had heavy army worm pressure in the spring and decided to spray the field, once with Entrust® and once with XenTari®. Army worms lay eggs in grassy plants; thus, the cover crop is a favorable host. This pest pressure combined with the wet and cool conditions at planting and planter issues may have impacted the stand count.

Yields were much lower in the '815' triticale treatment and moderately lower in both 'Spooner' rye and 'NE426GT' triticale treatments as compared to the controls; however, yields of soybeans in the 'Aroostock' rye treatment were

Soybean stand count (ppa)		
Cover crop / Planting	Early	Late
Aroostook	82,958	116,000
Spooner	82,708	107,167
NE426GT	80,667	94,000
815	49,500	86,917
Control	152,833	148,000

Soybean Yields (bu/ac 13% moisture)		
Cover crop / Planting	Early	Late
Aroostook	34	42
Spooner	27	44
NE426GT	25	39
815	18	34
Control	45	46

Table 2 - Yield and soybean stand count

similar to that of the controls (See Table 2). The difference in stand count had an impact on yield but was not directly correlated to the degree of yield loss. In addition, we found that the taller the soybeans were mid-August, the higher was the resulting yield.

In-depth chemical analysis of soil and soybean leaves

The soil chemical analysis ran in the middle of the summer (August 4th) revealed differences in the soil potassium content. The potassium content was on the higher end in both 'Aroostook' and 'Spooner' rye treatments (appr. 130ppm), on the lower end in the control (under 100ppm) treatment, and intermediate in both triticale treatments (appr. 110ppm). The other soil properties did not differ between the different treatments.

Some variations were observed in several nutrient compounds in the soybean leaves (N, P, K, Mg, Zn). The soybean leaves had higher nitrogen and phosphorus content in the control treatment compared to each of the cover crop treatments. Conversely, the potassium content was lower in the soybean leaves of the control treatment compared to all the cover crop treatments.

Figure 5 - Bean sprouting in an opened furrow (Left) planted in cover crop / closed seedbed (Right) planted in bare ground

Comparison of the different planting dates

The early planted treatments of the trial was weedier than the other through the entire growing season and contained more rye regrowth. Both in August and September, both in row and between row the weed biomass as well as weed counts were two to four times higher in the early planted plots compared to the late planted ones.

Even if planted 20 days apart, the soybean development stage mid-August was about the same in the early and the late planted plots. Thus, the cover crop variety had a stronger influence on the soybean development than the planting date at that time. This means that the cover crop choice may allow some flexibility in the planting date. The late planted soybeans were taller (26 and 22 inches respectively) and had more nodules (56 nodules per plant vs. 38 respectively) than the early planted soybeans.

At the end of the season, the late planted soybeans yielded greater than the early planted soybeans for all treatments except the control (See Table 2). The '815' triticale had the weakest stand count and the lowest yield in the early planted treatment. When looking at the late planted results only, 'Spooner' rye and 'Aroostock' rye treatments offered competitive yields compared to the control.

Most of the difference can certainly be attributed to the lower number of overall plants recorded in the early planted treatment. This difference may be explained by a combination of the conditions at planting and equipment issues. With a wet spring and the dense cover, the soil was not dry enough to plant the soybeans early and the planting furrow was left open in most cases (See Figure 5). For the late planted treatment, the use of a planter modified specifically for no-till offered a better seed placement and furrow closure. This highlights the lack of flexibility of the no-till system, which requires monitoring, wise decision-making processes at sensitive times such as planting and/ or crimping and adapted equipment.

Figure 6 - Rolled triticale

Comparison of different crimping dates

The reason we tried two different crimping dates in the early planted rye is that we were worried about damaging the beans if rolling them too early. Thus, we decided to roll half the plot at the rye anthesis and waited about a week to roll the second half. Unfortunately, we didn't take note of the exact bean stage at these two different times.

We observed no difference in stand count or yield between the earlier and the later crimping dates, indicating that we have some flexibility here. As this year was not favorable for the early planted beans, we hope next year's results will help us better understand optimal conditions for this technique.

Figure 7 - Dr. Erin Silva and Léa Vereecke presenting the no-till soybean trial to visitors during the organic field day at the Arlington Agricultural Research Station, August 2017

Conclusions and plans for next growing season

This year, the soybeans planted early in the standing cover crop suffered from the cool, wet spring conditions. Winter rye remained the best cover crop choice, with triticale more difficult to manage and achieve good soybean stands.

With poor performances of '815' triticale, we decided to abandon that cover crop and try a variety of wheat instead. For the 2017-2018 growing seasons we planted 'Aroostook' rye, 'Spooner' rye, 'NE426GT' triticale as well as Emerson-wheat. We will collect the same data as in 2017 and probably add some more.

In terms of crimping timing, we may try to time the crimping of the cover crop with the V2/V3 stage of the early planted beans, as it can have a positive impact on yields through increased branching of the soybeans.

We are still making decisions about practices for the 2018 season, and welcome any suggestions in term of practices to try or data to collect. Please use the contact information at the end of this paper to send us your ideas or requests.

We invite you to join us for the next organic field day at the Arlington Agricultural Research Station, which will most likely take place in late August 2018. As organic extension specialists we are here to work with you for the success of organic farming.

OGRAIN is an educational framework to support the development of organic grain production in the upper Midwest. We host a variety of field days during the growing season, winter and summer seminars, support a producer listserv (join by emailing join-ograin@lists.wisc.edu) and have educational materials available on the OGRAIN website at https://ograin.triforce.cals.wisc.edu, including educational videos.

OGRAIN is housed in the Organic and Sustainable Agriculture Research and Extension Program within the UW-Madison Department of Plant Pathology under the leadership of Assistant Professor Dr. Erin Silva. Léa Vereecke is a research associate working with the program. To contact us, email Erin at emsilva@wisc.edu, Léa at vereecke@wisc.edu or call the lab at (608) 890-1503.