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Field Crops Research

Cereal Rye Cover Crop Termination Date Ahead of Soybeans, 2016 Update

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In a Nutshell

- Delaying cover crop termination until near soybean planting would allow for more biomass production by the cover crop in the spring presenting the opportunity for more environmental benefit.
- Two farmer-cooperators continued work they began in 2015 that compares terminating a cereal rye cover crop 2-3 weeks prior to seeding soybeans (early termination) with terminating the cover crop within 5 days of seeding soybeans (late termination).

Key findings

- Jeremy Gustafson saw a 2 bu/ac increase and improved weed control with the late termination treatment in 2016. This amounted to a $49.97/ac economic benefit compared to the early termination treatment. In 2015, soybean yields were equivalent between the two termination date treatments.
- Jack Boyer saw no difference in soybean yields between the two cover crop termination treatments in either year. In 2015, he was able to skip a post-emergence herbicide application which saved him approx. $40/ac.

Project Timline:
2015-2016

Replicated and randomized strips of the early (brown) and late (green) termination date treatments at Jeremy Gustafson's on May 6, 2016. Photo courtesy of Dean Houghton, The Furrow.

Background

Cover crops have been identified by the Iowa Nutrient Reduction Strategy as an effective in-field practice for reducing soil erosion and reducing nutrient leaching (IDALS et al., 2012). Long-term cover crop on-farm research has also stressed the importance of proper cover crop management to avoid any potential for cash crop yield drag (Gailans and Juchems, 2014; Gailans and Juchems, 2016). To be eligible for crop insurance coverage, farmers in western Iowa (Zone 3) must terminate a cover crop before or at the time of cash crop planting; in the rest of the state (Zone 4) farmers must terminate a cover crop within five days after planting the cash crop but before cash crop emergence (USDA-NRCS, 2014). Farmers in no-till systems are afforded seven more days to terminate a cover crop. Recent on-farm research by Practical Farmers of Iowa cooperators Bob Lynch, Jeremy Gustafson and Jack Boyer has explored delaying cover crop termination to within one day of seeding soybeans. In Iowa, cover crops, such as cereal rye, are typically terminated 7-14 days prior to planting a cash crop of corn or soybeans. These cooperators observed increased cover crop growth compared to where they terminated 7-14 days earlier and generally observed no reduction in soybean yield (Gailans et al., 2015). Gustafson and Boyer also observed reduced weed pressure where they terminated the cover crop within one day of seeding soybeans. Research at Iowa State University has also shown no negative effect on soybean yield by terminating a cover crop the day before seeding soybeans (Castellano and Mueller, 2016). With these recent results in mind, Gustafson and Boyer wanted to conduct the study once more to gain further knowledge and experience with the practice.

The objective of this research project was to quantify the agronomic performance of soybeans when delaying cover crop termination to within five days of seeding the soybeans. Gustafson hopes that more people will be comfortable planting soybeans into a thick stand of recently terminated cereal rye. In doing the trial

for the second time, Boyer wonders if he can reap the same weed control benefits he observed in 2015.

Methods

This research project was conducted by Jeremy Gustafson near Boone in Boone County and Jack Boyer near Reinbeck in Tama County in 2016. Gustafson and Boyer also conducted the study in 2015; Bob Lynch conducted the study near Gilmore City in Humboldt County in 2014 (Gailans et al., 2015).

Cereal rye cover crop and soybean management are presented in **Table 1**. Both cooperators followed corn (Boyer followed seed corn in 2015). By farm, soybeans were seeded on the same date following two cereal rye cover crop termination dates: approx. 2 weeks prior to soybean seeding (early termination) and within 5 days of soybean seeding (late termination). The design of these trials was a randomized complete block with each of the two treatments in strips running the length of the field at each farm.

Gustafson used glyphosate to terminate the cover crop in both treatments in both years. Boyer used gramoxone in both treatments in 2016; he used Roundup in the early termination treatment and Gramaxone+Zidua in the late treatment in 2015.

Gustafson and Boyer assessed spring cereal rye aboveground biomass at both termination dates by clipping shoot material from quadrats (one ft x one ft) placed in each strip. At both farms, replicate samples were combined, air dried for three weeks and weighed.

In 2016 only, volumetric soil water content and soil temperature were assessed by Boyer at two dates: late termination date and mid-season. Soil water content was assessed to a depth of 5 in. with the use of a soil moisture probe provided by local NRCS. Soil temperature was assessed to a depth of 4 in. with a thermometer.

Soybeans were harvested from strips individually and corrected for 13% moisture.

Data were analyzed using JMP Pro 12 (SAS Institute Inc., Cary, NC). Statistical significance is determined at $P \leq 0.05$ level with tendencies noted at the $0.05 < P \leq 0.10$. Means separations are reported using the Least Significant Difference (LSD) generated from a t-test.

Table 1

Dates of cereal rye cover crop and soybean management at Jeremy Gustafson's and Jack Boyer's in 2016 and 2015.

	2016		2015	
	Gustafson, Boone	**Boyer, Reinbeck**	**Gustafson, Boone**	**Boyer, Reinbeck**
Cereal rye cover crop seeding date	Mid-Sept. 2015	Aug. 31, 2015	Nov. 2, 2014	Sept 25 , 2014
Cover crop seeding rate	56 lb/ac	56 lb/ac	56 lb/ac	56 lb/ac
Cover crop seeding method	Aerial	Drilled, 10 in.	Planted, 15 in.	Drilled, 10 in.
No. replications	5	4	3	2
Early cover crop termination date	Apr. 15	Apr. 24	April 14	May 9
Late cover crop termination date	May 5	May 13	May 8	May 19
Soybean seeding date	May 7	May 8	May 9	May 18
Soybean row spacing	30 in.	10 in.	30 in.	10 in.
Soybean planting population	140,000 seeds/ac	150,000 seeds/ac	140,000 seeds/ac	150,000 seeds/ac
Soybean harvest date	Oct. 18	Sept. 30	Oct. 1	Oct. 8

Jeremy Gustafson planting soybeans into a late termination treatment strip on May 7, 2016.

Table 2

Mean monthly temperature and total monthly rainfall and the long-term averages near the Gustafson and Boyer farms for 2015-2016 and 2014-2015.

Month[a]	Gustafson, Boone[a]						Boyer, Reinbeck[b]					
	Temperature (˚F)			Rainfall (in.)			Temperature (˚F)			Rainfall (in.)		
	2015-16	2014-15	Avg.	2015-16	2014-15	Avg.	2015-16	2014-15	Avg.	2015-16	2014-15	Avg.
Sept	70	64	64	5.05	5.50	3.59	68	61	62	2.82	3.07	3.00
Oct	54	53	52	1.27	3.74	2.40	52	50	50	1.84	3.22	2.41
Nov	43	31	37	2.73	1.02	1.54	41	28	35	2.85	0.44	1.76
Dec	32	29	24	5.40	1.18	1.02	33	27	22	5.86	1.26	1.14
Jan	19	25	19	1.00	0.28	0.80	18	20	16	1.41	0.68	0.81
Feb	27	15	23	1.86	0.80	0.93	26	11	21	1.37	1.54	1.03
Mar	42	40	36	1.95	0.24	1.78	40	34	33	2.95	0.39	2.09
Apr	50	53	50	2.69	3.43	3.24	50	50	47	1.73	3.02	3.55
May	59	59	61	4.41	5.05	4.41	59	59	59	2.67	4.32	4.42
June	73	69	70	1.34	9.01	4.82	72	69	69	9.30	4.31	4.99
July	73	72	74	7.90	4.93	3.66	73	71	72	3.96	3.92	4.42
Aug	72	69	72	4.12	8.97	3.92	72	68	70	6.28	8.29	4.04
Sept	67	68	64	7.42	7.14	3.59	67	68	62	5.87	2.73	3.00
Oct	55	54	53	0.66	1.27	2.38	55	52	50	1.53	1.84	2.39

[a] Data from the Ames weather station (120 years, approx. 5 mi. from Gustafson's) (Iowa Environmental Mesonet, 2016).
[b] Data from the Grundy Center weather station (60 years, approx. 10 mi. from Boyer's) (Iowa Environmental Mesonet, 2016).

Results and Discussion

Mean monthly temperature and total monthly rainfall near Gustafson's and Boyer's farms compared to the long-term averages is presented in **Table 2**. The fall of 2015 and 2014 was warm and wet at both farms. December was particularly warmer and wetter than average at both locations in both years. These made for very favorable conditions for cover crop establishment and winter survival. June 2016 was dry near Gustafson's but wetter than normal at Boyer's. At both farms, July and August saw more rainfall than the long-term averages.

Cover crop growth

Prior to both cover crop termination dates on both farms, Gustafson and Boyer collected samples of aboveground cereal rye biomass. At Gustafson's in 2016, the cereal rye in the early termination treatment (Apr. 15) produced 1,825 lb/ac of biomass while in the late termination treatment (May 5) produced 7,811 lb/ac. "The cover was 10 in. tall on Apr. 15 and 41 in. tall on May 5," Gustafson reports. At Boyer's in 2016, the cereal rye in the early termination treatment (Apr. 24) produced 3,777 lb/ac of biomass while in the late termination treatment (May 13) produced 7,010 lb/ac.

In 2015 at Gustafson's, the cereal rye in the early termination treatment (Apr. 14) produced 178 lb/ac of biomass while the late termination treatment (May 8) produced 2,684 lb/ac. Recall that Gustafson seeded his cover crop in 15-in. rows with a no-till planter (**Table 1**). At Boyer's in 2015, the cereal rye in the early termination treatment (May 3) produced 2,394 lb/ac of biomass. Even though biomass samples were not taken at late termination (May 19), it was obvious that there was considerably more growth. "I would estimate two times the amount observed at the early termination," Boyer noted.

Table 3

Soil temperature (4 in.) and volumetric soil water content (5 in.) at the late termination date (May 8) and mid-season (July 15) at Jack Boyer's farm in 2016.

Treatment	Soil temperature (˚F)		Volumetric soil water content (%)[a]	
	May 8	July 15	May 8	July 15
Early termination (4/24)	66	69	31	36
Late termination (5/8)	64	69	22	35
Diff.	2	0	9	1
LSD	--	--	3	2

[a]For soil water content, the least significant difference (LSD) is indicated at the $P \leq 0.05$ level. By date, if the difference between the two treatments is greater than the LSD, the treatments are considered significantly different.

Soil temperature and moisture conditions

In 2016 only, Boyer collected soil temperature and water content data on two dates: May 8 (late termination date) and July 15 (mid-season) (**Table 3**). Soil temperatures did not differ between the early and late termination treatments on either date. Soil water content was significantly lower on May 8 in the late termination treatment compared to the early termination treatment. The early termination of the cover crop had already occurred by this time (**Table 1**). By mid-season, however, soil water content between the two treatments was equivalent. These soil water findings align with similar results from previous research in central Iowa (Daigh et al., 2014; Basche et al., 2016). These researchers found cover crops reduce soil water content in April and May compared to where there was no cover crop but found the opposite during the summer—plots with cover crops had greater soil water content

than those without cover crops. They attribute a mulching effect of the cover crop residue conserving soil water following late spring and early summer rain events. At Boyer's in 2016 in the present study, the greater amount of cover crop biomass (mulch) in the late termination treatment, as well as ample rainfall in June and July (**Table 2**), is the likely reason for the recovery of soil water content between May 8 and July 15 (**Table 3**).

Soybean yields

By location, soybeans were seeded and harvested on the same dates regardless of treatment (**Table 1**). Mean soybean yields in 2016 and 2015 at both Gustafson's and Boyer's farms are presented in **Figure 1**.

At Gustafson's in 2016, mean soybean yield in the late termination treatment was significantly greater than mean yield in the early termination treatment by 2 bu/ac. This despite 5,986 more pounds of cereal rye biomass per acre ahead of the soybeans in the late termination treatment. "The beans in the late termination treatment were noticeably shorter at harvest, but the plants were 'podded-out' top to bottom," Gustafson recalls.

At Boyer's in 2016, mean soybean yields were statistically equivalent between the two cover crop termination dates. The greater amount of cover crop biomass at soybean seeding (3,777 vs. 7,010 lb/ac) and reduced soil water content at soybean seeding (31 vs. 22%; **Table 3**) with the late termination did not detrimentally affect soybean yield at Boyer's. Boyer observed that the soybeans in the early termination treatment were six to eight inches taller in mid-July but this did not affect yields in the end. "As a side observation," Boyer notes, "the sudden death syndrome pressure on the soybeans was noticeably less in the strips where the cereal rye cover crop was terminated later." Suppression of some soybean diseases, like sudden death syndrome, has been recently documented in Illinois (Eastburn, 2014).

In 2015, mean soybean yields for both treatments were statistically equivalent at both farms.

Mean yields for both treatments at both farms in both years exceeded the 5-year soybean yield averages for Boone (49 bu/ac) and Tama (54 bu/ac) counties (USDA-NASS, 2016).

Weed control and economic considerations

In 2016, Gustafson was able to reduce the amount of herbicide and weed control passes through the field with

Figure 1

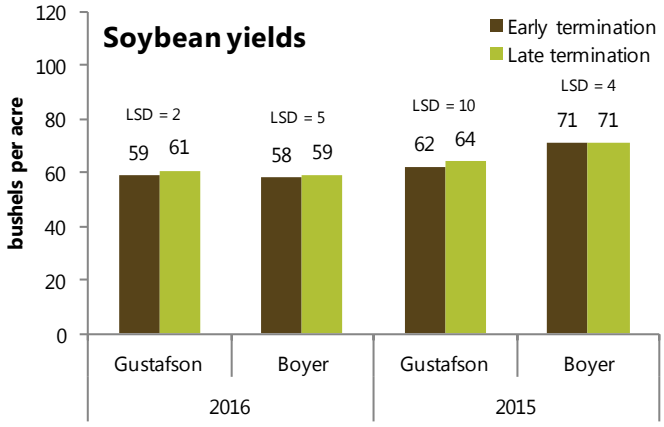

Figure 1. Soybean yields for the early and late cover crop termination treatments at Jeremy Gustafson's and Jack Boyer's in 2016 and 2015. The least significant difference (LSD) at the $P \leq 0.05$ level is indicated above each pair of mean columns for both years. By year and farm, if the difference between the treatment means is equal to or greater than the LSD, the treatments are considered significantly different.

Soybeans and interrow "mulch" provided by cereal rye cover crop in the late termination date treatment at Jeremy Gustafson's on Aug. 6, 2016.

the late termination treatment. As such, a partial budget was constructed to compare the costs and returns of the two cover crop termination treatments (**Table 4**). The partial budget only considers the differences between the two treatments: number of herbicide and weed control passes as well as soybean yields. The costs of planting the cover crop and planting and harvesting the soybeans are equivalent between the two scenarios and are thus not considered in the partial budget.

Terminating the cover crop on Apr. 15 (early termination treatment) resulted in the need for two additional passes compared to when the cover crop was terminated on May 5 (late termination). One of those additional passes was an interrow mechanical cultivation in late July. Delaying cover crop termination until May 5 (two days prior to seeding the soybeans) resulted in more cover crop biomass (1,825 vs. 7,811 lb/ac) that in turn acted as mulch through the rest of the growing season and reduced the amount of herbicide and weed control passes necessary. This amounted to savings in costs of $29.77/ac with the late termination treatment. The increase in yield with the late termination treatment at Gustafson's in 2016 (**Figure 1**) further improves the financial outcome of that treatment. Returns less costs were roughly $50/ac greater with the late termination treatment. Considering the typical cover crop cost of approximately $25-$30/ac (seed + application), delaying cover crop termination until the time of soybean planting (late termination) more than overcame that cost by reducing weed pressure and increasing yields compared with terminating three weeks before soybean planting (early termination).

At Boyer's in 2016, both treatments received postemergence applications of Outlook + Verdict on May 13, Liberty on June 7 and Liberty on June 30 to control weeds. As such, no partial budget is provided: weed control and soybean yields (**Figure 1**) were equivalent between the early and late termination treatments. Even so, Boyer does think that the cover crops saved him some expense in postemergence weed management: "I didn't have to apply Cobra. I am certain that if I didn't have the cover I would have needed that application. All the farms around me did."

In 2015, however, Boyer noticed that the strips with cover crops (early and late termination) had far less weeds than those areas on his farm without cover crops. As a result, he decided to not only spray his cover strips with a post-emergence herbicide. By Aug. 26 Boyer noticed: "The cover crop areas have continued to be as clean or cleaner than the no-cover areas [that received post-emergence herbicide]. They have not had a late flush to make them worse than the sprayed no-cover." The cover crop areas remained mostly free of weeds through the end of the season. Boyer also realized an effect on his pocketbook from not having to spray the cover crop strips: "That's about $40/ac of herbicide savings to pay for seeding the covers."

Table 4

Partial budget comparing costs and returns between the two treatments at Jeremy Gustafson's in 2016.

Early termination		**Late termination**	
Costs	*$/ac*	*Costs*	*$/ac*
Apr. 15: glyphosate (40 oz/ac; cover termination)	$5.16	**May 5:** glyphosate (32 oz/ac; cover termination)	$4.13
Class Act adjuvant	$3.76	Class Act adjuvant	$3.76
Application	$7.35	Application	$7.35
May 5: glyphosate (32 oz/ac)	$4.13	**June 28:** Flexstar GT (3.5 pt/ac)	$13.76
Class Act adjuvant	$3.76	AMS	$0.60
Application	$7.35	Destiny adjuvant	$0.80
June 28: Flexstar GT (3.5 pt/ac)	$13.76	Application	$7.35
AMS	$0.60		
Destiny adjuvant	$0.80		
Application	$7.35		
July 28: mechanical cultivation	$13.50		
TOTAL COSTS	$67.52	TOTAL COSTS	$37.75
Returns	*$/ac*	*Returns*	*$/ac*
59 bu/ac @ $10.10/bu	$595.90	61 bu/ac @ $10.10/bu	$616.10
RETURNS - COSTS	$595.90 - $67.52 = **$528.38**	RETURNS – COSTS	$616.10 - $37.75 = **$578.35**

Herbicide and product costs provided by Gustafson and application costs were accessed from ISU Extension's "2016 Iowa Farm Custom Rate Survey" (Plastina et al., 2016). Soybean price was accessed from the CME Group on Nov. 8, 2016.

The observations at Gustafson's in 2016 and Boyer's in 2015 align with previous findings by researchers in central Iowa who found reduced and delayed weed germination in soybeans from a cereal rye cover crop producing 3,200 lb biomass/ac (Anderson and Hartzler, 2014). The cereal rye cover crop in the late termination treatment in 2016 at Gustafson's and in both treatments at Boyer's in 2015 reached biomass levels well above this mark and had no adverse affect on soybean yield.

Conclusions and Next Steps

The trials conducted by farmer-cooperators Jeremy Gustafson and Jack Boyer compared soybeans seeded on the same date following two cover crop termination dates: 2-3 weeks prior to seeding soybeans or within 5 days of seeding soybeans. This was the second time these two farmer-cooperators conducted this trial (Gailans et al., 2015). They wanted to further investigate whether narrowing the time between cover crop termination and soybean planting (and thus increasing the amount of residue they were planting into) would have any detriment to soybean yield.

At Gustafson's in 2016, he saw soybean yield increased by 2 bu/ac with the late termination treatment (terminated 2 days prior to planting soybeans) (**Figure 1**). Planting soybeans on May 5 into 41-in. tall cereal rye (7,811 lb/ac biomass) after terminating on May 3 also helped to manage weeds (**Table 4**). The yield increase paired with fewer weed control passes with the late termination treatment resulted in an economic benefit of $49.97/ac (**Table 4**).

Boyer saw no difference in soybean yield between the early and late termination treatments in 2016. The late termination occurred 5 days after seeding soybeans. This resulted in seeding soybeans into 7,010 lb/ac of cover crop biomass with no ill effect on yield.

In 2015, both farmer-cooperators saw no difference in soybean yield between the early and late cover crop termination treatments (**Figure 1**). That year, Boyer was able to reduce herbicide use thanks to the late termination treatment (Gailans et al., 2015). He did not, however, reap that same economic benefit in 2016.

"Cereal rye cover crop termination at or within a few days of planting soybeans does not have a negative effect on soybean yield," Boyer concludes. "It was the second year of this study for me and provided additional confirmation of the benefits of additional cover in soybean fields. In the future, I will plant more of my soybeans into 'green' cereal rye and terminate at or within 5 days after planting."

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