Soybean Growth and Development Following Corn Stover Removal for Biofuel in a Corn Soybean Rotation

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Introduction

The Energy Independence and Security Act of 2007 mandates the use of 36 billion gallons of biofuel within the USA by 2022, 21 billion gallons of which must be made from cellulose. Corn stover is a readily available and easily obtained source of cellulose. Removing corn stover will change soil properties and other parameters of the field environment for crops planted after corn. Soybean is the most common rotation partner of corn in the Midwest. Understanding how corn stover removal affects soybean plants is essential for developing appropriate recommendations for energy crop management.

Objectives

- Determine the effects of corn stover removal on soybean emergence, development, yield, and grain composition.
- Determine the effects of rye cover crop on soybean emergence, development, yield, and grain composition.

Materials and Methods

- Experimental design for this study was a Randomized Complete Block with four replications. Treatments were arranged in a split plot. Whole plots were two residue treatments (baled and not baled) and subplots were two cover crop treatments (rye and none).
- For the baled treatment, corn stover was mowed, raked, baled and removed in fall 2009 shortly after corn harvest. The baled treatment removed approximately 70% of corn stover.
- Rye cover crop was planted immediately following corn stover removal. Row spacing was 0.19 m and seeding rate was 78.4 kg/ha.
- Soybean cultivar Asgrow brand AG4005 was planted in spring 2010. Plot length was 7.6 m and plot width was 8 rows spaced 0.76 m apart. Seeding rate was 434,720 seeds/hectare.
- Rows 2 and 3 were used to measure stand density and grain yield:
  - Stand density was calculated using the total number of plants in 6.1 m sections of rows 2 and 3.
  - Rows 2 and 3 were end-trimmed to 6.1 m and grain was harvested with a plot combine. Yields were corrected to 13% moisture.
- Rows 6 and 7 were used to follow plant development, determine yield components, and measure grain composition for two emergence classes (early and late). Prior to plant emergence, one 0.91 m section of each row was delineated.
  - All soybean plants within each of the 0.91 m sections were marked with a skewer that was color-coded to emergence date.
  - For each plot, five of the earliest emerging soybean plants comprised the “early” emergence class. Five of the latest emerging soybean plants comprised the “late” emergence class. All subsequent data were collected from these 10 plants.
  - Dates that each soybean plant reached VE, R1, R3, R5 and R7 were recorded.
  - At maturity, the five plants within each emergence class were cut and threshed. Grain weight was recorded and number of seeds were counted. Seed size was calculated by dividing grain weight by seed number.

Results and Discussion

Figure 1. Effect of corn stover removal and cover crop on soybean emergence

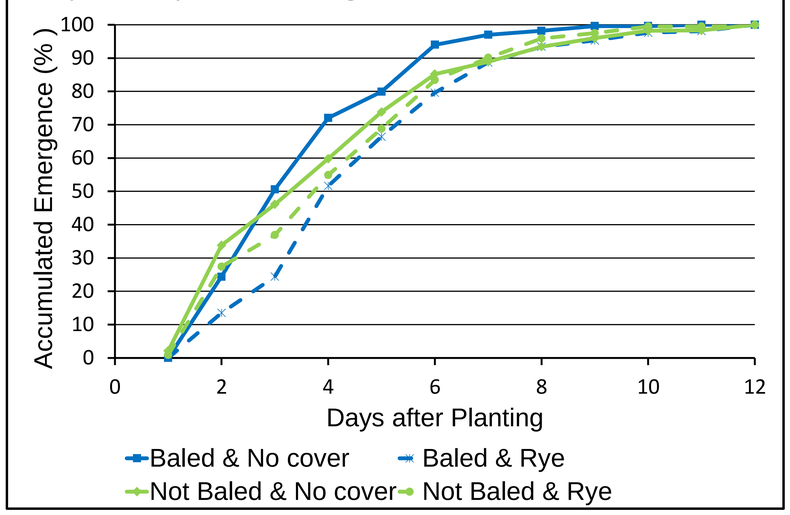
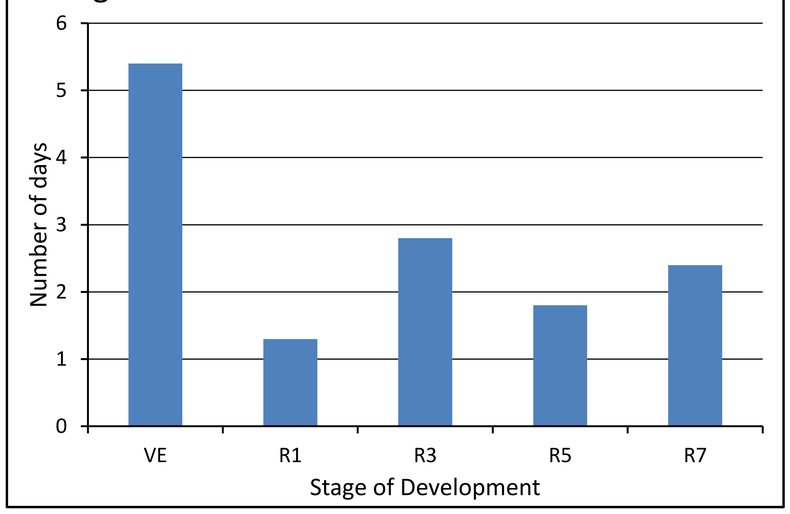


Table 1. Stand densities and yields for soybean planted in four treatment combinations.

Residue	Cover crop	Stand density	Yield
		no. plants/ha	kg/ha
Not baled	None	333 951b	3 850a
Not baled	Rye	344 445b	3 796a
Baled	None	412 258a	3 978a
Baled	Rye	382 119ab	3 810a

- Removal of corn stover increased soybean emergence from 78% to 92%.
- Neither the residue treatments nor the cover crop treatments affected grain yield.

Figure 2. Effect of corn stover removal and cover crop on number of days between early and late emergence classes.



- Neither the residue treatments nor the cover crop treatments affected the dates on which any of the stages of development were reached.
- The number of days between the early and late emergence classes at all reproductive stages of development were less than the number of days between the two classes at emergence.

Table 2. Yield and yield components for early and late emergence classes for soybean planted with or without corn stover removed.

Stover	Emergence class	Grain weight	Seed number	Seed size
		g/plant	no./plant	g/seed
Not baled	Early	18.8c	131c	0.144a
Not baled	Late	6.9a	45a	0.154a
Baled	Early	13.6b	99b	0.138a
Baled	Late	8.2a	57a	0.144a

- Averaged over emergence classes, removing corn stover decreased grain weight per plant and number of seeds per plant
- None of the four treatment combinations differed for seed size.
- Although the length of the seed filling period was similar for both emergence classes (41.8 and 42.3 days), the late emergence class yielded 54% less than the early emergence class.

Table 3. Grain composition for soybean planted in four treatment combinations.

Cover crop	Emergence class	Oil	Protein
		%	%
None	Early	19.5a	37.5a
None	Late	19.7a	38.2a
Rye	Early	19.5a	37.9a
Rye	Late	19.3a	38.1a

- Seed oil and protein concentrations were not affected by residue treatments, cover crop treatments, or emergence classes.
- Although emergence classes produced highly different grain weight per plant, seed oil and protein concentrations were similar.

Conclusions

- Averaged over the two cover crop treatments, removal of corn stover increased soybean stand density (397 189 vs. 339 198 plants/ha).
- Averaged over the two cover crop treatments, removal of corn stover had no affect on grain yield when yield was calculated on an area basis (3 894 vs. 3 823 kg/ha).
- Although removal of corn stover decreased grain weight and seed number per plant, the effect was not direct, but rather due to corn stover removal effects on stand density.
- The late emergence class yielded much less than the early emergence class. Lower yield was associated with fewer seeds rather than changes in seed size.
- Oil and protein concentrations in seeds were not affected by the residue treatments, the cover crop treatments, or emergence classes.
- Few impacts were found on soybean development, growth, and yield due to corn stover removal.