Effect of cover crop types on cash crop yields in no-till

Kraig Roozeboom, Peter Tomlinson, Megan Brown, Bryson Haverkamp, Joshua Jennings
Department of Agronomy, Kansas State University, Manhattan, KS, USA

Introduction

Using cover crops as a fallow period replacement may have short and long-term benefits in cropping systems. Cover crops effectively increase the intensity of cropping systems, providing opportunities to enhance system water use efficiency, crop diversity, carbon fixation, and associated benefits. It is important that cover crop selection and management be optimized to have either a neutral or positive short and medium-term influence of grain crop yields.

Objective

Evaluate the effects of cover crops on yields of cash crops in a three-year, no-till rotation

Materials and Methods

- Three-year, no-till cropping system of with all crops present each year

- Six cover crop treatments in the fallow period following wheat
  - Chemical fallow (check)
  - Double-crop soybeans (cash crop alternative)
  - Summer non-legume (sorghum-sudangrass)
  - Summer legume (late-maturing soybean)
  - Winter non-legume (canola or tillage radish)
  - Winter legume (winter pea, red clover, or crimson clover)
- Five nitrogen (N) treatments within each cover crop plot applied soon after grain sorghum emerged
  - 0, 45, 90, 135, and 180 kg ha^{-1}
  - Applied as urea ammonium nitrate (UAN)
  - Placed in bands 25 cm from sorghum rows and 2 cm below residue
- Randomized complete block with four replications, crop phase blocked within replications, cover crops as whole plots, and N rates as subplots
- Herbicide applications were made as needed to manage weed populations in all crop phases
- Winter wheat management:
  - Seeded immediately after soybean harvest, late October or early November
  - Seeded at 115 kg ha^{-1} in 19-cm rows using a John Deere 1590 no-till drill (Deere & Co., Moline, IL)
  - Monoammonium phosphate (11-52-00) applied with wheat seed at 65 kg ha^{-1}
  - Topdressed with 67 kg ha^{-1} nitrogen soon after spring greenup using 28% UAN applied in streams spaced every 10 cm
- Grain sorghum management (Figure 1):
  - Medium-full season hybrid seeded in late May or early June
  - Seeded at 190,000 seeds ha^{-1} in 76-cm rows using a White 6700 planter (AGCO Corp., Duluth, GA)
- Soybean management:
  - Maturity group 3.6 to 3.8 variety planted in late May or early June
  - Seeded at 432,000 seeds ha^{-1} in 76-cm rows

Figure 1. Delayed sorghum heading (right) associated with planting after summer non-legume cover crop Manhattan, KS.

Results and Discussion

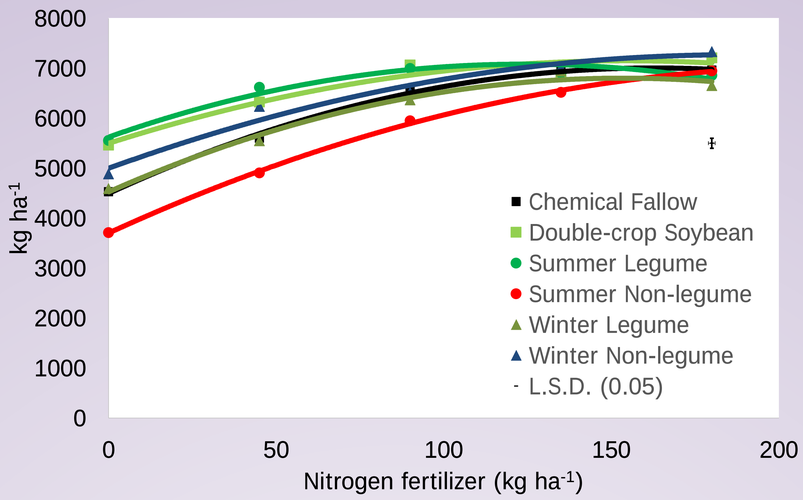

Figure 2. Sorghum yield response to nitrogen fertilizer after six cover crop treatments at Manhattan, KS, 2009 to 2014.

- **Sorghum yield response** to N depended on preceding cover crop treatments (Figure 2):
  - Summer non-legume reduced yield at N rates < 180 kg ha^{-1} , perhaps related to slower growth and delayed heading (Figure 1).
  - Sorghum yields after the summer legume cover crop or double-crop soybeans were greater than after chemical fallow at N rates < 135 kg ha^{-1}.
  - Sorghum yields after the winter non-legume were greater than after chemical fallow at N rates < 90 kg ha^{-1}.
  - Sorghum yields after the winter legume were nearly equal to those after chemical fallow at all N rates.

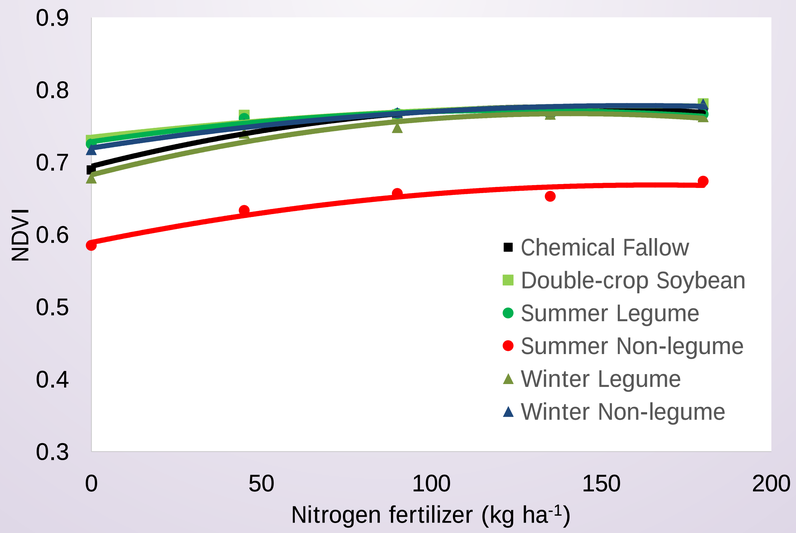

Figure 3. Sorghum NDVI response to nitrogen fertilizer after six cover crop treatments at Manhattan, KS, 2009 to 2014.

- **Sorghum NDVI response** to N was similar after all preceding cover crop treatments (cover crop x N NS, α = 0.05, Figure 3):
  - NDVI values following most cover crop treatments and double-crop soybeans were similar to those after chemical fallow at all N rates.
  - NDVI values after the summer non-legume cover crop were 0.1 less than after all other cover crop treatments at all N rates.

- **Soybean yield and seed protein content** were not affected by cover crop treatment imposed before the sorghum crop that preceded the soybean crop or by N rate applied to the sorghum crop for the years 2009 to 2014 (α = 0.05, data not shown).
  - Yield average = 2691 kg ha^{-1}
  - Seed protein content average = 364 g kg^{-1}
- **Double-crop soybean yields** varied with year, but were not affected by N application to the sorghum crop (α = 0.05). For 2007 to 2013:
  - Range was 202 to 2822 kg ha^{-1}
  - Average = 1411 kg ha^{-1}

Results and Discussion

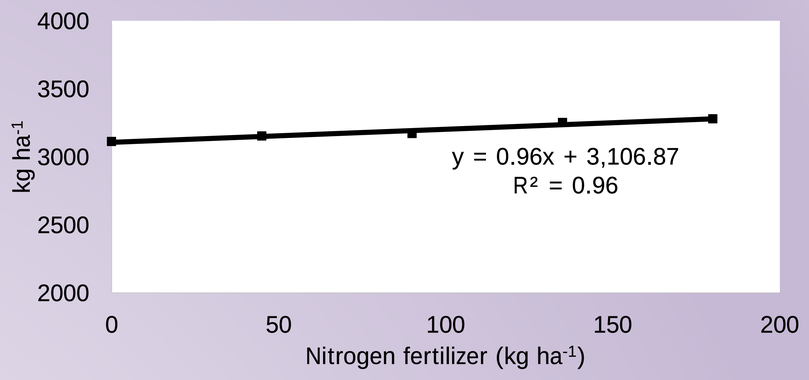

Figure 4. Wheat yield response to nitrogen fertilizer applied to sorghum crop in rotation at Manhattan, KS, 2009 to 2014.

- **Wheat yield and grain protein content** in the year after the soybean crop were not affected by cover crop treatment imposed before the sorghum crop for the years 2009 to 2014 (α = 0.05).
  - Wheat yield increased by 1 kg ha^{-1} for each additional kg ha^{-1} applied to the sorghum crop (Figure 4).
  - Wheat yield was reduced in two of the six years by wheat streak mosaic infestation that resulted from incomplete control of volunteer wheat in some cover crop treatments. Volunteer likely could be better controlled in a commercial setting where herbicide drift would be less of a constraint.
  - Wheat grain protein content and was not affected by nitrogen applied to the sorghum (α = 0.05, mean = 119 g kg^{-1}).

Table 1. Grain crop yield response to cover crop in the rotation at Manhattan, KS in drought year of 2012.

Cover Crop Treatment	Sorghum		Soybean		Wheat	
	kg ha^{-1}					
Chemical Fallow	2856	bc	1310	b	2882	c
Double-crop soybean	4213	a	1297	b	3151	ab
Summer legume	3971	a	1357	b	3165	ab
Summer non-legume	3225	b	1512	a	3138	ab
Winter legume	2345	c	1471	a	2936	bc
Winter non-legume	2708	bc	1404	b	3259	a

- In the **drought year of 2012**, summer crop yields were influenced by cover crop treatments in the rotation but not by N applications to sorghum (α = 0.05, Table 1).
  - Sorghum yields were greater with either double-crop soybean or a summer legume cover crop in the rotation.
  - Soybean yields were greater with either a summer non-legume or a winter legume cover crop in the rotation.
  - Wheat yield was least in rotations with chemical fallow or a winter legume cover crop present between the wheat and sorghum crops.

Conclusions

- Grain sorghum yields after all but one of the cover crop treatments were equal to or greater than after fallow .
  - Sorghum yields were less after the summer non-legume , a species closely related to sorghum that produced residue with a high C:N relative to the other cover crop treatments.
  - The yield response depended on amount of N fertilizer applied to the sorghum crop and indicated that fertilizer N applications to sorghum could be reduced after most cover crop treatments, including double-crop soybean.

- Yields of soybean and wheat crops grown in a 3-year rotation with sorghum were not affected by the presence of cover crops averaged over six growing seasons.
  - The exception was during an extreme drought year (2012) when alternatives to chemical fallow between wheat and sorghum resulted in yields equal to or greater than those achieved with chemical fallow.