Kansas Soybean Commission Final Report

Cover Crop Effects on Soybean in a Soybean/Corn Rotation

D.E. Shoup, I.A. Ciampitti, J. Kimball, DeAnn Presley, and G.F. Sassenrath

Summary

A research study was established in 2011 in a soybean and corn rotation with cover crops planted soon after each crop harvest in the fall. A variety of complex cover crop mixtures were evaluated ranging from single specie to 7 specie mixtures. Cover crops were terminated in the spring soon after anthesis of the cool season cereal in the cover crop. Soybean yield responded differently among the four years of the study. In an extreme drought year of 2012 the unplanted check yielded 29.4 bu/a. Soybean yield was significantly reduced by 4.2 and 3.4 bu/a in treatments with wheat or turnip cover crop, respectively. In 2014, the unplanted check yielded 33.9 bu/a and cover crop treatments rye, rye + radish, and >6-species mix had significantly greater soybean yield at 3.7, 3.4, and 3.3 bu/a, respectively. In 2015, only the rye cover crop treatment significantly reduced soybean yield compared to the unplanted check at a 4.2 bu/a yield loss. No significant yield differences were observed in any cover crop treatment in 2016.

Introduction

Cover crops are being utilized by more producers throughout Kansas. Reasons for the adoption of cover crops include reduced soil erosion, nutrient cycling, weed suppression, compaction alleviation, increased soil organic matter and biological activity. Kansas State University has evaluated cover crops extensively for the last two decades in various crop rotations, however, few studies have evaluated the effect of cover crops in a soybean/corn rotation.

Kansas has a diverse geography with much of the soybean/corn crop rotations occurring in the eastern third of the state. There can be quite a range in growing season from south to north with an average of 25 days difference from the last freeze in the spring to the first frost in the fall. These 25 days can impact the amount of fall growth a cover crop can establish before winter sets in. While it is a challenge to establish cover crops after soybean harvest, it is more likely to be successful following corn harvest prior to soybean planting the following spring. Regardless of the planting challenges, soybean's response to cover crops established immediately after corn harvest in a soybean/corn rotation need to be evaluated.

Procedures

The trial was initiated in 2011 after corn harvest at the K-State East Central experiment field near Ottawa and in 2015 at the K-State Ashland Bottoms research farm near Manhattan. Fall plantings were established on September 13, 2011; September 27, 2013; September 23, 2014; September 11, 2015; and October 20, 2016.

Five cover crop mixtures and one unplanted check were established, ranging in species complexity (Table 1). In the first year of the study, mostly single species were utilized but in subsequent years, more complex mixtures replaced the original treatment structure. In general, rye and/or radish were the base species for each treatment, but other species were interchanged depending on seed availability in that given year. Seeding rates of individual species were adjusted as the number of species in the mixture increases to avoid extremely high plant populations. Plots were 10-ft wide by 90-ft long and drilled on 7-inch spacings with a cone drill for uniform seed distribution throughout the plot.

Cover crops were terminated just after anthesis of the cool season cereal in late April with glyphosate plus additional soybean burndown herbicides. Soybean was no-tilled into the standing residue on May 29, 2012; May 22, 2014; June 10, 2015; June 6, 2016; and May 5, 2017. Prior to cover crop termination in the first week of May at both locations, soil samples were taken to a 6-in depth in each plot. Samples were kept cool until shipment to Ward Labs in Kearney, NE where samples were analyzed for traditional soil analysis, Haney analysis, Solvita analysis, and PFLA microbial analysis.

Experiments were arranged in a randomized complete block design with 4 replications. Plots were harvested and plot weights, moisture, and test weights were determined. Bartlett's homogeneity of variance was tested and data were analyzed using ANOVA. Means were separated by using a P value of 0.10.

Results

2012 Yields

During the first year of the study, soybean yields were below average due to extremely dry conditions in June, July, and August; only 1.78 inches of rain fell across those three months (Table 2). The unplanted check yielded the highest across all cover crop treatments with an average of 29.4 bu/a (Table 3). The two cover crop treatments that had significantly lower yield than the check, were the wheat and the turnip treatments which reduced yield by 4.2 and 3.4 bu/a, respectively. Reduction in yield was likely due to the cover crop utilizing soil moisture that could have maintain the soybean plant later in the growing season.

2014 Yields

Opposite to the previous year, several cover crop treatments significantly increased yield when compared to the unplanted check. The highest soybean yields were observed after rye, rye + radish, and the >6-specie mix treatment, with 37.6, 37.3, and 37.2 bu/a, respectively (Table 3). Two treatments that yielded significantly lower than the top yielding cover crop treatments were the unplanted check and the radish at 33.9 and 31.7 bu/a, respectively.

2015 Yields

Excellent yields were observed in 2015 with 2.3 to 4.4 inches of precipitation falling each month from June to September (Table 2). Only one cover crop treatment significantly reduced yield with the soybean planted after rye yielding 49.4 bu/a compared to the unplanted check at 53.6 bu/a (Table 3).

2016 Yields

Record soybean yields were achieved in Kansas in 2016. The unplanted check yielded 60.2 bu/a (Table 3). No significant differences among all cover crop treatments were observed. At the Ashland Bottoms research farm no significant differences were observed either with the check plot yielding 67.3 bu/ac.

Soil Characteristics

In general there were no microbial or Solvita differences among cover crop treatments in 2017 at either location with the exception of the Fungicide:Bacteria ratio at Ottawa (Table 4). Even though there was a statistical difference, there likely is no biological significance trends in changed didn't correlate with cover crop complexity.

Soil nutrients were evaluated at both locations with some statistical differences in pH, Total Nitrogen, and plant-available Potassium. While statistical differences occurred, differences were not great enough to explain any biological differences that could potentially impact crop performance. Organic matter at both locations did however significantly increase with increase in triticale presence in the cover crop mix. At both locations the lowest levels of soil organic matter were seen in the check plots while the greatest organic matter occurred in the triticale only plot. This might be because triticale was sown at the greatest seeding rate and had the greatest biomass of any cover crop species in the spring (data not shown). There was a 0.3% and 0.2% increase in organic matter in the triticale only cover crop at Ottawa and Ashland Bottoms, respectively.

Table 1. Cover crop treatments and seeding rate at the K-State experiment fields near Ottawa and Ashland Bottoms.

Cover crop	Seeding rate (lb/a)
Unplanted check	-
Wheat (2012) Cereal rye (2014-2016) Triticale was substituted for all rye treatments (2017)	100 75 75
Radish (2012, 2014-2017)	6
Turnip (2012) Rye + radish (2014-2016, triticale for rye in 2017)	4 60 + 4
Canola (2012) Rye + radish + buckwheat (2014) Rye + radish + alfalfa (2015) Rye + radish + winter pea (2016, triticale for rye in 2017)	5 50 + 3 + 3 50 + 3 + 3 50 + 3 + 20
Wheat + radish + winter pea (2012) Rye + radish + turnip + buckwheat + rapeseed + sorghum (2014) Rye + radish + turnip + alfalfa + rapeseed + wheat + sorghum (2015) Rye + radish + turnip + winter pea + oat + crimson clover + sorghum (2016, triticale for rye in 2017)	20 + 1 + 20 50 + 3 + 3 + 1 + 1 + 1 50 + 3 + 1 + 3 + 1 + 20 + 1 50 + 3 + 1 + 20 + 20 + 3 + 1

Table 2. Total monthly rainfall at the K-State experiment fields near Ottawa and Ashland Bottoms from 2012 and 2014-2017

Year	March	April	May	June	July	August	September
	———	———	———	precipitation (in.)	———	———	———
30-year average	2.67	3.84	5.41	5.63	4.09	4.04	4.12
2012	4.7	1.6	3.8	0.0	1.2	0.6	3.4
2014	0.6	3.5	1.2	7.1	0.9	2.9	3.4
2015	0.6	3.5	10.7	4.4	3.3	2.3	2.8
2016	2.0	3.9	6.1	1.9	5.6	6.5	5.8
2017 Ottawa	2.6	6.2	-	-	-	-	-
2017 Ashland	4.2	5.0	-	-	-	-	-

Table 3. Soybean yield as affected by cover crop treatment at the K-State experiment fields near Ottawa and Ashland Bottoms

	Soybean yield (bu/a)									
Cover crop	2012*		2014		2015		2016 Ottawa		2016 Ashland	
Check	29.4	a	33.9	b	53.6	a	60.2	a	67.3	a
Radish	-	-	31.7	b	54.3	a	59.4	a	69.9	a
Rye	25.2	b	37.6	a	49.4	b	60.3	a	71.3	a
Rye + radish	26.0	b	37.3	a	52.3	a	59.6	a	72.1	a
3-specie mix	27.6	ab	35.7	ab	51.8	ab	59.3	a	64.2	a
>6-specie mix	27.4	ab	37.2	a	51.6	ab	59.0	a	69.8	a

*Means followed by the same letter are not significantly different at $P = 0.10$.

Table 4. Biological soil analysis (PFLA) and Solvita analysis on soil in 2017 as effected by cover crop treatments after 6 years of cover crop at the K-State Experiment Field in Ottawa and a 2 years of cover crop at Ashland Bottoms near Manhattan. Soil samples were taken in the first week of May 2017 prior to cover crop termination ahead of soybean planting.

Location	Treatment	Total Microb Biomass		Microb Diversity Index		Total Bacteria		Total Fungi		Total Mycorrhizal		Fungi:Bacteria		Solvita	
		ng/g				——% of total——								CO_2 ppm	
Ottawa	Check	2787	a	1.6	a	45	a	10	a	2	a	0.22	ab	136	a
Ottawa	Radish	2675	a	1.6	a	49	a	11	a	3	a	0.22	ab	146	a
Ottawa	Triticale	2423	a	1.6	a	54	a	13	a	4	a	0.23	a	148	a
Ottawa	Triticale and radish	2964	a	1.4	a	52	a	8	a	2	a	0.15	c	162	a
Ottawa	Triticale, radish, winter pea	4076	a	1.6	a	51	a	12	a	3	a	0.24	a	142	a
Ottawa	Triticale, oat, radish, turnip, winter pea, crimson clover, sorghum	2200	a	1.5	a	55	a	10	a	3	a	0.18	bc	136	a
Manhattan	Check	1490	a	1.5	a	51	a	9	a	2	a	0.18	a	58	a
Manhattan	Radish	2549	a	1.5	a	43	a	12	a	1	a	0.27	a	64	a
Manhattan	Triticale	3087	a	1.5	a	46	a	9	a	2	a	0.21	a	83	a
Manhattan	Triticale and radish	2207	a	1.5	a	49	a	11	a	2	a	0.22	a	69	a
Manhattan	Triticale, radish, winter pea	1999	a	1.5	a	47	a	9	a	2	a	0.19	a	86	a
Manhattan	Triticale, oat, radish, turnip, winter pea, crimson clover, sorghum	1937	a	1.5	a	55	a	10	a	2	a	0.18	a	55	a

Table 5. Soil characteristics as effected by cover crop treatments at K-State experiment fields near Ottawa and Ashland Bottoms. Soil samples to a 6-inch depth were taken the first week of May, 2017 prior to cover crop termination.

Location	Treatment	Soil pH	Organic Matter	Phosphorus	Potassium	Traditional Nitrogen	Haney Test Nitrogen	Organic C:N	Soil Health Calculation
			%	ppm		Lb/ac			
Ottawa	Check	6.4 b	3.1 c	34 a	120 b	5 bc	44 a	12 a	15 a
Ottawa	Radish	6.6 a	3.2 c	32 a	129 a	6 a	45 a	11 a	17 a
Ottawa	Triticale	6.6 a	3.4 a	33 a	123 ab	4 c	47 a	12 a	17 a
Ottawa	Triticale and radish	6.5 ab	3.4 a	28 a	117 b	5 ab	46 a	12 a	18 a
Ottawa	Triticale, radish, winter pea	6.6 a	3.2 bc	28 a	118 b	6 ab	44 a	12 a	16 a
Ottawa	Triticale, oat, radish, turnip, winter pea, crimson clover, sorghum	6.6 a	3.3 ab	28 a	127 a	5 bc	44 a	11 a	16 a
Manhattan	Check	6.1 a	2.7 c	11 a	290 a	6 a	22 a	16 a	6 a
Manhattan	Radish	6.2 a	2.8 b	10 a	279 a	3 a	15 a	18 a	6 a
Manhattan	Triticale	6.1 a	2.9 a	11 a	270 a	6 a	19 a	18 a	7 a
Manhattan	Triticale and radish	6.2 a	2.8 b	7 a	249 a	4 a	17 a	18 a	6 a
Manhattan	Triticale, radish, winter pea	6.2 a	2.8 ab	9 a	283 a	7 a	22 a	18 a	7 a
Manhattan	Triticale, oat, radish, turnip, winter pea, crimson clover, sorghum	6.2 a	2.8 ab	8 a	266 a	5 a	16 a	18 a	6 a