





COVER CROPS

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Non-Irrigated Soybeans following Winter Terminated and Winter Hardy Cover Crop, NRCS Demo Farm

Study ID: 0656127202001

County: Nemaha

Soil Type: Judson silt loam 0-2% slope

Planting Date: 5/7/20

Harvest Date: 9/23/20

Population: 145,000

Row Spacing (in): 15

Hybrid: Pioneer® P27A17X

Reps: 7

Previous Crop: Corn

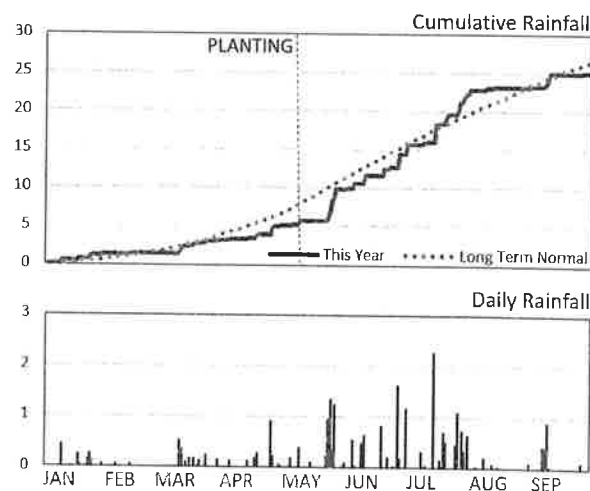
Tillage: No-Till

Herbicides: **Pre:** 6 oz/ac Authority® First, 16 oz/ac Me-Too-Lachlor™, 16 oz/ac dicamba HD, and 6.4 oz/ac Absorb 100® **Post:** 32 to 40 oz/ac Buccaneer® 5 Extra, 16 oz/ac BattleStar®, 7 oz/ac clethodim, 1 qt/100 gal Absorb 100®, and 1 qt/100 gal N-TENSE™

Fertilizer: NPSZ starter fertilizer (10 lb N/ac, 40 lb N/ac, 40 lb N/ac, 6 lb S/ac, and 2 lb Zn/ac)

Irrigation: None:

Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The two treatments, the use of winter terminated cover crops and the use of winter hardy cover crops, will be used in this five-year study (2016-2021). This is the fourth year of this study. The cover crops were drilled September 27, 2019. The winter terminated treatment was a mix of 30 lb/ac oats and 3 lb/ac turnips and radishes. The winter hardy treatment consisted of 30 lb/ac cereal rye and 3 lb/ac turnips and radishes. This study did not have a no-cover-crop control. Cattle were put out on the cover crop on November 17, 2019, and removed December 12, 2019. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 23, 2020. Baseline and soil health measures were collected in 2016, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for winter hardy and winter terminated treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm ³)	Soil temp. (F)	Soil respiration ¹	Total soil health score ²
2016 (1 composite sample collected for all replications of a treatment; samples collected on Oct. 19, 2016)						
Winter hardy	1.30	-	1.22	59	-	19.5
Winter terminated	1.12	-	1.32	59	-	20.8
2018 (2 composite samples collected for all replications of a treatment, n=4 per treatment; samples collected on Oct. 31, 2018)						
Winter hardy	0.86 A	29.4 A	1.20 A	49.0 A	-	18.5 A
Winter terminated	1.71 A	26.5 A	1.38 A	49.5 A	-	18.0 A
P-Value	0.350	0.777	0.113	0.500		0.5
2019 (1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 24, 2019)						
Winter hardy	0.72 A	22.6 A	1.19 A	48.83 A	2.88 A	19.5 A
Winter terminated	0.62 A	26.4 A	1.26 A	48.98 A	2.38 A	19.5 A
P-Value	0.599	0.195	0.284	0.638	0.308	1.000

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm ³)	Soil temp. (F)	Soil respiration ¹	Total soil health score ²
2020 (1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 15, 2020)						
Winter hardy	10.87 A	13.3 A	1.29 A	58 A	2.62 B	18.5 A
Winter terminated	7.59 A	15.2 A	1.29 A	58 A	3.00 A	17.6 A
P-Value	0.2560	0.605	0.928	1.000	0.0577	0.628

¹Soil respiration (Solvita® burst).

²Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.

³No test was completed in 2016 for soil moisture and 2016 and 2018 for soil respiration.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for winter hardy and winter terminated cover crop treatments. Cover crop biomass measured on April 2, 2020.

	Biomass (lbs./acre)	Green cover (%)
Winter hardy Cover Crop	796.27	26.23 A
Winter terminated Cover Crop	-	0.24 B
P-Value	-	<.0001

- Biomass not measured on winter terminated cover crop strips, only weeds were present.

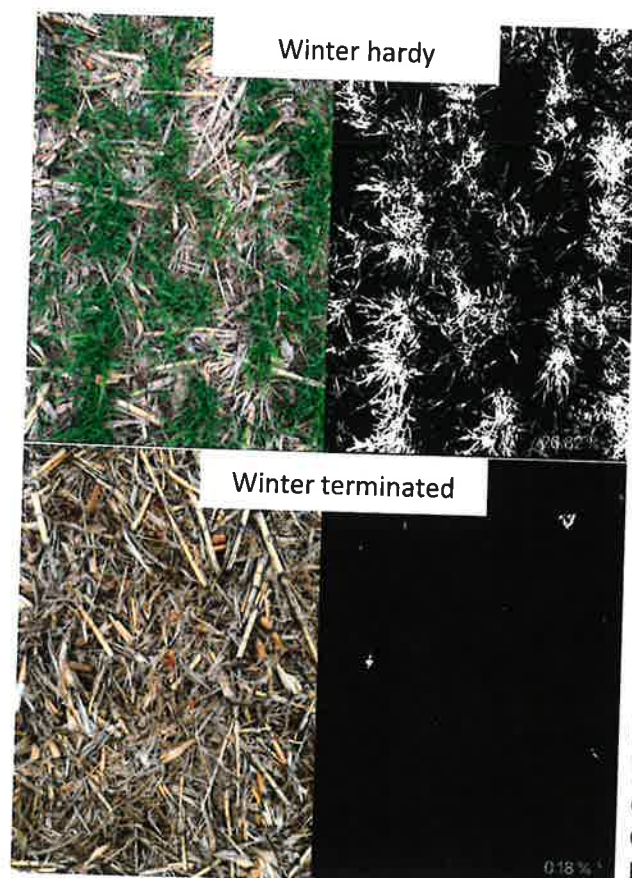


Figure 1. Cover crop green cover of winter hardy (top) and winter terminated (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on April 2, 2020.

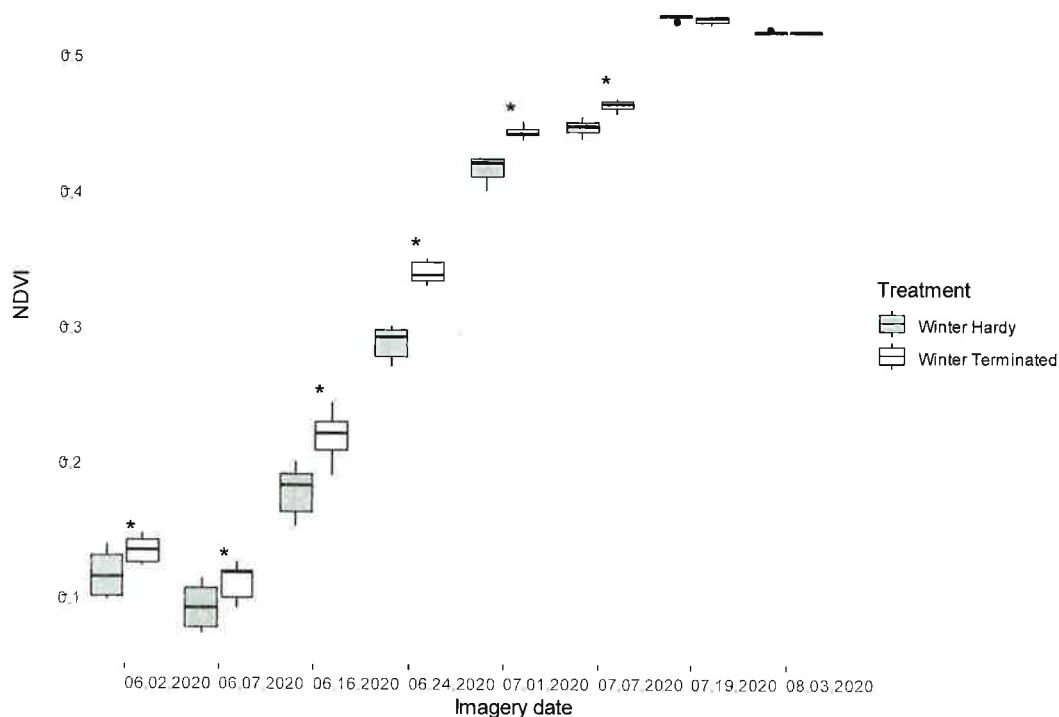


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the soybean crop following winter hardy and winter terminated cover crops. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between treatments at a 90% confidence level.

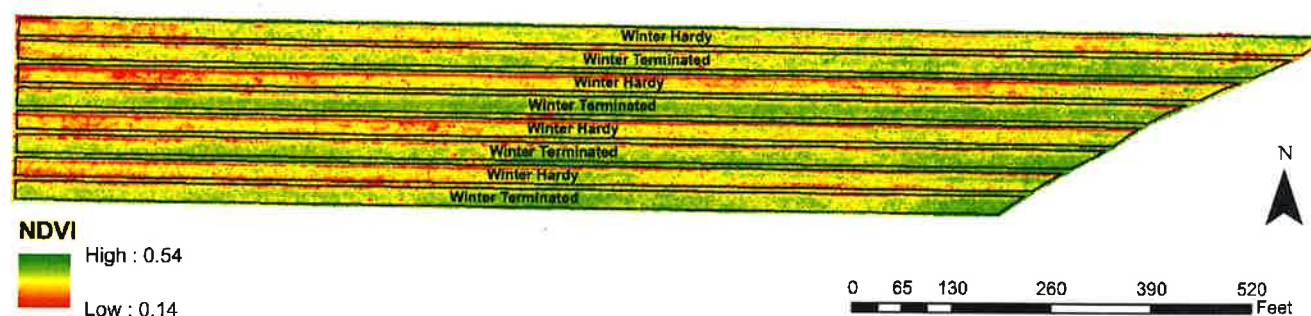


Figure 3. Aerial imagery from July 1 displayed as soybean normalized difference vegetation index (NDVI). Strips with winter hardy and winter terminated cover crop are indicated.

Table 3: 2020 soybean stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield (bu/ac) [†]	Marginal Net Return [‡] (\$/ac)
Winter Terminated Cover Crop	127,187 A*	56 A	12.6 A	76 A	694.02 A
Winter Hardy Cover Crop	117,338 A	56 A	12.8 A	73 A	669.34 A
P-Value	0.179	0.527	0.268	0.452	0.419

*Values with the same letter are not significantly different at a 90% confidence level.

[†]Bushels per acre corrected to 13% moisture.

[‡]Marginal net return based on \$9.50/bu soybean, \$12.48/ac winter terminated cover crop seed mix, \$12.45/ac winter hardy cover crop seed mix, and \$14.40/ac drilling cost.

Summary:

- There were no differences in soil health parameters between the treatments in 2018, 2019, and 2020 (Table 1).
- Aerial imagery normalized difference vegetation index (NDVI) analysis showed higher values for soybeans in the winter terminated strips (Figures 2 and 3). Soybeans following winter hardy cover crops were not as large or canopied as soybeans following winter terminated cover crop.
- In 2020, there were no differences in soybean stand counts, yield, moisture, test weight, or net return between the winter terminated and winter hardy cover crop. Results from this portion of the field in previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled on September 29, 2016. The winter terminated treatment was a mix of oats, turnips, and common rapeseed, whereas the winter hardy treatment consisted of cereal rye, turnips, and common rapeseed. For uniformity, both cover crop mixes were sprayed with glyphosate on April 12, 2017. This terminated the winter hardy treatment and controlled weeds and brassicas, which had overwintered in the winter terminated cover crop treatment. In 2017, soybeans had no difference in yield, test weight, moisture, or net return following the winter terminated and winter hardy cover crops.

Table 4. 2017 soybean stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield (bu/acre)†	Marginal Net Return‡ (\$/ac)
Winter Terminated Cover Crop	102,178 A*	56 A	10.6 A	62 A	518.84 A
Winter Hardy Cover Crop	102,178 A	56 A	10.6 A	61 A	516.42 A
P-Value	1	0.4886	1	0.7345	0.735

*Values with the same letter are not significantly different at a 90% confidence level.

†Bushels per acre corrected to 13% moisture.

‡Marginal net return based on \$8.90/bu soybean and \$30.07 cost for cover crops.

YEAR TWO | In year two, following soybean harvest in 2017, wheat was planted in this area. No yield measurements were made for the winter terminated and winter hardy cover crop strips.

YEAR THREE | In year three, following wheat harvest, cover crops were drilled August 1, 2018. The winter terminated treatment was a mix of 30 lb/ac oats and 1 lb/ac turnip. The winter hardy treatment consisted of 30 lb/ac cereal rye and 1 lb/ac turnip. This study had no cover crop control. Cattle were put out on the cover crop on November 1 and taken off on November 26. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 2, 2019. In 2019, there were no differences in corn population, moisture, test weight, yield, or net return.

Table 5. 2019 corn stand counts, test weight, moisture, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/acre)†	Marginal Net Return‡ (\$/ac)
Winter Terminated Cover Crop	29,952 A*	57 A	17.7 A	217 A	805.04 A
Winter Hardy Cover Crop	29,429 A	57 A	17.8 A	214 A	792.55 A
P-Value	0.207	0.552	0.891	0.277	0.216

*Values with the same letter are not significantly different at a 90% confidence level.

†Bushels per acre corrected to 15.5% moisture.

‡Marginal net return based on \$3.83/bu corn, \$12/ac winter terminated cover crop seed mix, \$13.80/ac winter hardy cover crop seed mix, and \$14.40/ac drilling cost.

Non-Irrigated Corn Following Winter Terminated and Winter Hardy Cover Crop, NRCS Demo Farm

Study ID: 0656127202002

County: Nemaha

Soil Type: Judson silt loam 2-6% slopes

Planting Date: 4/8/20

Harvest Date: 9/15/20

Population: 33,000

Row Spacing (in): 30

Hybrid: Pioneer® P0589AM

Reps: 7

Previous Crop: Wheat

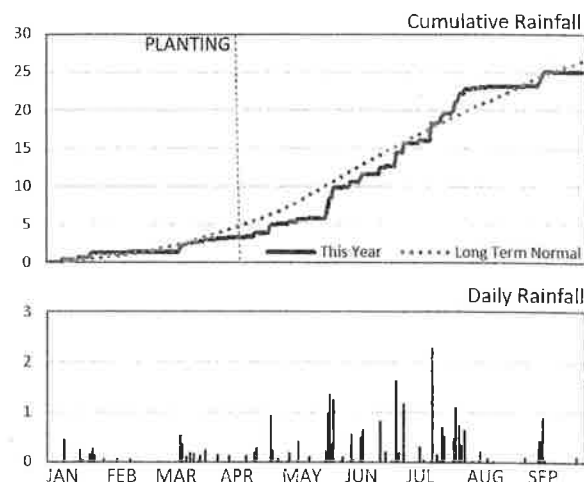
Tillage: No-Till

Herbicides: **Pre:** 1 lb/ac atrazine, 40 oz/ac Resicore®, 32 oz/ac glyphosate, 1 qt/100 gal N-TENSE™ on 4/2/20 **Post:** 40 oz/ac Resicore®, 32 oz/ac glyphosate, and 1 qt/100 gal N-TENSE™

Fertilizer: NPSZ starter fertilizer (10 lb N/ac, 40 lb N/ac, 40 lb N/ac, 6 lb S/ac, and 2 lb Zn/ac); 150 lb N/ac as 32% UAN, 46 lb N/ac as urea sidedress

Irrigation: None

Rainfall (in):



Introduction: This study is being conducted on a soil health demonstration farm as part of the Nebraska USDA/Natural Resources Conservation Service's (NRCS) Soil Health Initiative, and involves the farmer, the Nebraska On-Farm Research Network, and the USDA/NRCS. The two treatments, the use of winter terminated cover crops and the use of winter hardy cover crops, will be used in this five-year study (2016-2021). This is the fourth year of this study. The cover crops were drilled August 1, 2019. The winter terminated treatment was a mix of 30 lb/ac oats and 3 lb/ac turnips and radishes. The winter hardy treatment consisted of 30 lb/ac cereal rye and 3 lb/ac turnips and radishes. This study did not have a no-cover-crop control. Cattle were put out on the cover crop on November 17, 2019, and removed December 12, 2019. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 2, 2020. Baseline and soil health measures were collected in 2016, 2018, 2019, and 2020 (Table 1).

Results:

Table 1. Soil physical, chemical, and biological properties for winter hardy and winter terminated treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm ³)	Soil temp. (F)	Soil respiration ¹	Total soil health score ²
2016 (1 composite sample collected for all replications of a treatment; samples collected on Oct. 19, 2016)						
Winter hardy	1.30	-	1.22	59	- ³	19.5
Winter terminated	1.12	-	1.32	59	-	20.8
2018 (2 composite samples collected for all replications of a treatment, n=4 per treatment; samples collected on Oct. 31, 2018)						
Winter hardy	0.932	27.5 A	1.22 A	50.1 A	-	18.5
Winter terminated	0.743	24.7 A	1.26 A	50.6 A	-	18.5
P-Value	-	0.406	0.341	0.500	-	-
2019 (1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 24, 2019)						
Winter hardy	0.631 A	29.5 A	1.28 A	48.4 A	4.12 A	20.2 A
Winter terminated	2.259 A	28.1 A	1.20 A	49.7 A	4.38 A	21.4 A
P-Value	0.338	0.594	0.433	0.350	0.604	0.186

Table 1 Continued

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm ³)	Soil temp. (F)	Soil respiration ¹	Total soil health score ²
2020 (1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 15, 2020)						
Winter hardy	2.52 A	15.6 A	1.24 A	57.4 A	3.25 A	22.4 A
Winter terminated	4.85 A	15.7 A	1.25 A	57.9 A	3.00 A	22.5 A
P-Value	0.337	0.772	0.862	0.767	0.182	0.391

¹Soil respiration (Solvita® burst).

²Score based on field assessment. The overall indicator score is based on the sum of 8 indicators (1=degraded, 2=in transition, 3=healthy): soil structure, structure type, surface condition, soil management, soil pores, earthworms, biological activity, and smell.

³No test was completed in 2016 for soil moisture and 2016 and 2018 for soil respiration.

*Values with the same letter are not significantly different at a 90% confidence level.

Table 2. 2020 cover crop biomass and green cover for winter hardy and winter terminated cover crop treatments. Cover crop biomass measured on April 2, 2020.

	Biomass (lbs./acre)	Green cover (%)
Winter Hardy Cover Crop	685 A*	13.33 A
Winter Terminated Cover Crop	120 B	2.12 B
P-Value	<.0001	0.0001

*Values with the same letter are not significantly different at a 90% confidence level.

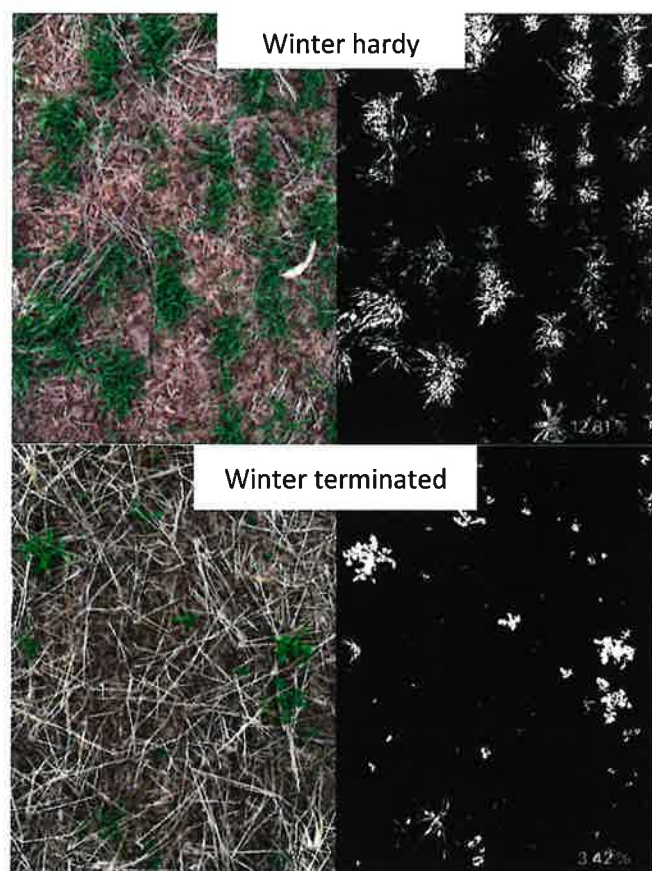


Figure 1. Cover crop green cover of winter hardy (top) and winter terminated (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on April 2, 2020.

Table 3. 2020 corn stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/ac)[†]	Marginal Net Return[‡] (\$/ac)
Winter Terminated Cover Crop	31,556 A*	53 A	21.1 A	213 A	719.79 A
Winter Hardy Cover Crop	30,352 A	53 A	20.9 A	208 A	701.16 A
P-Value	0.182	0.704	0.330	0.212	0.173

*Values with the same letter are not significantly different at a 90% confidence level.

[†]Bushels per acre corrected to 15.5% moisture.

[‡]Marginal net return based on \$3.51/bu corn, \$12/ac winter terminated cover crop seed mix, \$13.80/ac winter hardy cover crop seed mix, and \$14.40/ac drilling cost.

Summary:

- There were no differences in soil health parameters between the treatments in 2018, 2019, and 2020 (Table 1).
- In previous years, corn and soybeans in this portion of the field yielded lower when they followed the winter hardy cover crop. This was not the case this year. In 2020, there were no differences in corn population, moisture, test weight, yield, or net return. Results from this portion of the field in previous years follow.

Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled on September 29, 2016. The winter terminated treatment was a mix of oats, turnips, and common rapeseed, whereas the winter hardy treatment consisted of cereal rye, turnips, and common rapeseed. For uniformity, both cover crop mixes were sprayed with glyphosate on April 12, 2017. This terminated the winter hardy treatment and controlled weeds and brassicas, which had overwintered in the winter terminated cover crop treatment.

Table 4. 2017 corn stand counts, test weight, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/acre)	Test Weight (lb/bu)	Moisture (%)	Corn Yield (bu/acre) [†]	Marginal Net Return [‡] (\$/ac)
Winter Terminated	30,355 A*	54 A	18.0 B	183 A	546.97 A
Winter Hardy	30,023 A	52 B	19.1 A	168 B	498.00 B
P-Value	0.802	0.0209	0.0034	0.0003	0.0003

*Values with the same letter are not significantly different at a 90% confidence level.

[†]Bushels per acre corrected to 15.5% moisture.

[‡]Marginal net return based on \$3.15/bu corn and \$30.07 cost for cover crop seed and drilling in both treatments.

In 2017, corn planted after winter terminated cover crops had a higher yield, higher test weight, and was drier than the winter hardy cover crops. There were no differences in harvest stand counts for the corn following the winter terminated and winter hardy cover crops. The corn following the winter hardy mix was three days slower to tassel than the corn following the winter terminated mix.

YEAR TWO | In year two, cover crops were drilled on August 1, 2017. The winter terminated treatment was a mix of 30 lb/ac oats, 1.5 lb/ac canola/rapeseed, and 1 lb/ac turnip. The winter hardy treatment consisted of 30 lb/ac cereal rye, 1.5 lb/ac canola/rapeseed, and 1 lb/ac turnip. For uniformity, both cover crop mixes were sprayed with herbicide to terminate the cover crops on April 17, 2018.

Table 5. 2018 soybean stand counts, test weight, moisture, yield, and net return for winter hardy and winter terminated cover crop treatments.

	Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Soybean Yield [†] (bu/ac)	Marginal Net Return [‡] (\$/ac)
Winter Terminated	120,744 A*	56 B	11.3 A	65 A	452.80 A
Winter Hardy	120,246 A	56 A	11.2 A	59 B	410.75 B
P-Value	0.872	0.096	0.200	0.002	0.002

*Values with the same letter are not significantly different at a 90% confidence level.

[†]Bushels per acre corrected to 13% moisture for soybeans.

[‡]Marginal net return based on \$7.40/bu soybean, \$12.48/ac winter terminated cover crop seed mix, \$12.45/ac winter hardy cover crop seed mix, and \$14.40/ac drilling cost.

In 2018, soybeans planted after winter terminated cover crops had a higher yield, lower test weight, and higher net return than the winter hardy cover crops. The soybeans following the winter terminated had a darker green appearance.

YEAR THREE | In year three, wheat was planted following soybean harvest. No measurements were made on wheat yields in the winter terminated and winter hardy cover crop strips.