

**Incorporation of Dormant and Interseeded Cover Crop in an Irrigated Corn-Soybean-Field Pea Rotation
NRCS Soil Health Management Demonstration Field 4-year summary report**

Study ID: 0815093202101

County: Howard

Reps: 6

Tillage: Strip-till

Irrigation: Pivot

Soil Type: Kenesaw silt loam 1-6% slopes;

Valentine-Thurman Choose Soil Texture 0-17%

slopes; Thurman loamy fine sand 0-2% slope;

Thurman loamy fine sand 2-6% slopes; Kenesaw silt loam 0-1% slope

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. This study is examining three treatments: 1) dormant (post-harvest) seeded cover crops and interseeded cover crops, 2) dormant (post-harvest) seeded cover crops, and 3) no cover crop check. The three treatments were applied consistently during this four-year study (2018-2021).

Year 1 - Corn (2018 Crop)

Planting Date: 5/17/18

Harvest Date: 10/6/18

Population: 35,000

Row Spacing(in): 30

Hybrid: Pioneer 0157 AMXT

Previous Crop: Corn

Herbicides: *Pre:*32 oz/ac glyphosate on 5/10/18 *Post:* 32 oz/ac glyphosate and 5 oz/ac Status® on 6/1/18

Seed Treatment: Herculex® XTRA, Poncho® 1250 + VOTiVO®, AcreMax® Xtreme

Foliar Insecticides: None

Foliar Fungicides: None

Fertilizer: Average of 78.6 lb/ac variable rate 11-52-0 and average of 78.4 lb/ac variable rate 0-0-60 preplant; 5 gal/ac 32% UAN, 5 gal/ac 12-0-0-26, and 5 gal/ac 10-34-0 on 5/17/18; numerous fertigation applications from V4 to brown silk, totaling 200 lb/ac of N

Irrigation Total: 8.82"

In the fall of 2017, both the dormant seeded treatment strips and the dormant and interseeded treatment strips had a cover crop mix. The mix consisted of 40 lb/ac Elbon cereal rye, 1 lb/ac rapeseed/canola, 3 lb/ac winter oats, and 6 lb/ac hairy vetch. The cover crop was terminated on May 10 with glyphosate. During the 2018 growing season, the interseeded cover crop treatment strips were planted with a cover crop mix on June 26 using a Hiniker interseeder, at the V4 corn growth stage. The interseeding mix consisted of 6 lb/ac cowpea, 6 lb/ac soybean, 0.5 lb/ac crimson clover, 5 lb/ac sunnhemp, 2 lb/ac hairy vetch, 3 lb/ac buckwheat, 0.5 lb/ac chicory, 0.5 lb/ac flax, 0.5 lb/ac rapeseed/canola, 6 lb/ac Elbon cereal rye, and 6 lb/ac spring oats. Corn was harvested on October 6, 2018, and evaluated for yield and moisture. There was no yield or grain moisture difference between the treatments (Table 1). The net return was higher for the check treatment than the dormant and interseeded treatments because of cover crop planting and seed costs (Table 1).

Table 1. 2018 corn yield, moisture, and marginal net return for check, dormant and interseeded treatments.

	Moisture (%)	Yield† (bu/ac)	Marginal Net Return‡ (\$/ac)
Check	19.1 A*	203 A	654.96 A
Cover Crop – Dormant Seeded	18.8 A	205 A	624.81 AB
Cover Crop – Dormant + Interseeded	18.8 A	209 A	586.09 B
P-Value	0.280	0.674	0.048

*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 \$3.23/bu corn. Interseeded cover crop seed cost \$37.50/ac. The dormant seeded cover crop seed in 2017 prior to this growing season cost \$24/ac. A typical custom rate for the Hiniker interseeder is not available; therefore, both seeding methods (dormant drilled and interseeded) are estimated to be \$14.40/ac. The interseeded cover crop treatment this year also was preceded by a dormant seeded cover crop; therefore, both the dormant and interseeded seed and seeding costs were incurred by this treatment this year.

Year 2 – Soybeans (2019 Crop)

Planting Date: 5/3/19

Harvest Date: 10/8/19

Seeding Rate: 174,000

Row Spacing (in): 30

Variety: Pioneer® P24A00X

Herbicides: Pre: 32 oz/ac Buccaneer 5 Extra®, and 8 oz/ac Outlook® on 5/5/19 **Post:** 6 oz/ac clethodim, 18 oz/ac Buccaneer 5 Extra®, and 4 oz/ac Outlook® on 6/4/19; 48 oz/ac Buccaneer 5 Extra®, and 10 oz/ac Outlook® on 6/24/19

Seed Treatment: Lumisena™ and ExerGol® Energy SB

Foliar Insecticides: 2 oz/ac Serpent™ and 2 oz/ac Fanfare™ through pivot on 7/19/19; 2 oz/ac Serpent™ and 2 oz/ac Fanfare™ through pivot on 8/2/19

Fertilizer: 5 gal/ac 10-34-0+1z on 5/3/19

Irrigation Total: 3.92"

In year two, soybeans were grown, so interseeding of cover crops was not conducted during the 2019 growing season. On October 14, 2018, the dormant season seeded cover crop strips were direct seeded with a drill. The cover crop mix included 20 lb/ac Elbon cereal rye, 20 lb/ac winter wheat, 10 lb/ac triticale, 1 lb/ac annual ryegrass, 5 lb/ac winter oats, 3 lb/ac hairy vetch, 0.5 lb/ac camelina, and 3 lb/ac winter lentil. Soybeans were planted on May 3 with 30" row spacing. The cover crop mixes were terminated May 5, 2019, by herbicide on both the dormant seeded cover crop and the previous year's interseeded cover crop. Cover crops were 8-10" tall at the time of termination. Thistle caterpillars caused a large amount of defoliation of the soybeans in this field during June 2019. At harvest there was no yield or grain moisture difference between the treatments (Table 2). The net return was higher this year for the interseeded treatment than the dormant seeded treatment. This is because the cover crops interseeded in the summer of 2018 already had the cover crop seed and planting costs accounted for in the previous year's analysis; therefore, there were no additional costs of cover crop seed or planting in this analysis (Table 2).

Table 2. Soybean yield, moisture, and marginal net return for dormant and interseeded cover crop and no cover crop treatments.

Treatment	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ (\$/ac)
Check	13.5 A*	84 A	681.00 AB
Cover Crop – Dormant Seeded	13.8 A	87 A	661.85 B
Cover Crop – Dormant + Interseeded	13.5 A	89 A	724.21 A
P-Value	0.738	0.119	N/A

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

†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 13% moisture.

‡Marginal net return based on \$8.10/bu soybean, \$31.19/ac for seed mix for dormant seeded treatment, and \$14.40/ac for drilling for dormant seeded treatment. Interseeded cover crop costs were accounted for in the previous year's report, therefore they are not included in this analysis.

Year 3 – Field Peas (2020 Crop)

In year three, following soybean harvest, cover crops were drilled on October 16, 2019. Cover crop mix consisted of 20 lb/ac Elbon cereal rye, 20 lb/ac winter wheat, 10 lb/ac triticale, 1 lb/ac annual ryegrass, 5 lb/ac winter oats, 3 lb/ac hairy vetch, 0.5 lb/ac camelina, and 3.0 lb/ac winter lentil. Cover crop was chemically terminated on April 26, 2020. Field peas were planted on April 10, and harvested on July 18, 2020. Due to flooded areas resulting in crop death and late season weed pressure, no yield measurements were made for the check and dormant and interseeded treatments. The field was shredded in the fall to address late-season weed seed development in the areas that were drown out and had a failed crop.

Year 4 – Corn (2021 Crop)

Planting Date: 5/22/21

Harvest Date: 10/11/21

Seeding Rate: 37,000

Row Spacing (in): 30

Hybrid: Pioneer® P0446Q

Herbicides: Pre: 10 oz/ac Verdict® and 42 oz/ac Buccaneer® on 5/7/21; 32 oz/ac Liberty® on 6/7/21

Foliar Insecticides: 6 oz/ac Bifenthrin and 2 oz/ac Warrior® 7/24/21

Foliar Fungicides: 10 oz/ac Trivapro® on 7/24/21

Fertilizer: 100 lb/ac 0-0-60, 20 gal/ac 10-34-0-1 Zn, and 65 gal/ac 28-0-0-5

Irrigation Total: 12"

In crop year four, after field pea harvest, on July 25, 2020, a cover crop mix was drilled on both the dormant season seeded treatment strips and the interseeded treatment strips. The mix consisted of 3 lb/ac proso millet, 5 lb/ac grain sorghum, 5 lb/ac black oats, 5 lb/ac winter barley, 1 lb/ac flax, 4 lb/ac safflower, 5 lb/ac cowpeas, 3 lb/ac buckwheat, 0.5 lb/ac forage collards, 0.5 lb/ac rapeseed, 3 lb/ac sunn hemp, and 3 lb/ac sunflower. The cover crop was terminated in the treatment areas on May 7, 2021. Cover crop biomass measured on April 12, was on average 3,454 lb/ac for both cover crop treatment areas (Table 3). During the 2021 growing season, the interseeded cover crop treatment strips were planted with a cover crop mix on June 15, using a Hiniker interseeder. The interseeding mix consisted of 10 lb/ac annual ryegrass, 3 lb/ac red clover, 1 lb/ac rapeseed/canola, 3 lb/ac flax, 5 lb/ac buckwheat. There were no yield differences between the treatments (Table 3). Grain moisture was lower in the check treatment (Table 3).

In addition to soil health assessments (Table 7) and yield results, weed biomass and density in the interseeded cover crop and check treatments were measured in 2021, four years after experimental plots were established. The interseeded cover crop treatment seedbank had a significant increase in the proportion of pigweeds but a significant decrease in the number of other broadleaf weeds present (Table 4). Additionally, the interseeded cover crop seedbank was primarily composed of Palmer amaranth with low relative abundance of other species. In contrast, the check seedbank was dominated by scarlet pimpernel and was less dominated by the presence of Palmer amaranth (Table 5). Despite the significant increase in pigweed in the cover crop treatment area seedbank, no differences in the number of weeds or emerged pigweed occurred during the growing season (Table 6).

Table 3. Cover crop biomass, green cover, and corn yield, moisture, and marginal net return for dormant and interseeded cover crop and no cover crop treatments. Cover crop biomass and green cover measured on April 12th 2021.

	Cover crop biomass (lb/ac)	Green cover (%)	Moisture (%)	Yield (bu/ac) [†]	Marginal Net Return [‡] (\$/ac)
Check	0 B*	1.16 B	17.5 B	244 A	1271 B
Cover Crop – Dormant Seeded	3317 A	19.20 A	17.9 A	245 A	1230 A
Cover Crop – Dormant + Interseeded	3590 A	22.90 A	18.1 A	247 A	1249 AB
P-Value (dormant to check)	<0.0001	<0.0001	0.0022	0.9152	0.0277

[†]Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 15.5% moisture.

[‡]Marginal net return based on \$5.20/bu corn, \$31.19/ac for seed mix for dormant seeded treatment, and \$14.58/ac for drilling for dormant seeded treatment. Interseeded cover crop seed cost \$37.50/ac.

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

Green cover using the Canopeo measurement tool.

Table 4. Total number of weeds, pigweeds, grasses, broadleaves, and number of species identified for interseeded cover crop and check treatments. Seedbank was collected on April 12, 2021, by collecting twenty soil cores to a depth of 10 cm for each replication per treatment. Collected soil was put in the greenhouse and weed seedlings were permitted to freely germinate from collection date until November 1, 2021, with two periods of drying and resifting soil to stimulate new germination flushes. Seedlings were identified by species and counted to quantify the size and composition of the soil seedbank. Total number of weeds, pigweeds, grasses, and other broadleaves are reported in weeds per m², which was determined from the number of emerged seedlings.

	Total weeds (weeds/m ²)†	Species Identified	Pigweeds (weeds/m ²)	Grasses (weeds/m ²)	Broadleaves (weeds/m ²)
Check	3197 A*	12.0 A	686 B	539 A	2422 A
Interseeded Cover Crop	4178 A	13.3 A	3124 A	297 A	773 B
P-value	0.361	0.616	0.00401	0.569	0.00812

† Total weeds, pigweeds, grasses, and broadleaves are estimated in weeds/m², which is derived from the number of seedlings that emerged from the soil seedbank.

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

Table 5. Weed seedbank species composition for top five most abundant species in cover crop mix and check treatments. Seedbank was collected April 12, 2021, and permitted to freely germinate in the greenhouse until November 1, 2021.

Check – Species	Percentage of Total	Interseeded Cover Crop – Species	Percentage of Total
Scarlet pimpernel	47.1%	Palmer amaranth	67.3%
Palmer amaranth	15.9%	Scarlet pimpernel	10.0%
Barnyard grass	10.3%	Redroot pigweed	6.2%
Carpetweed	10.2%	Carpetweed	5.4%
Eastern black nightshade	5.1%	Green foxtail	2.9%

Table 6. In-season measurements were taken for weed density, pigweed density, and weed biomass at early (at crop emergence and before post-emergence herbicide application) and late season (before canopy closure and 4+ weeks after post-emergence herbicide application) for interseeded cover crop and check treatments. Measurements are reported in weeds per m² and grams of biomass per m².

	Early Season Weed Density (weeds/m ²)	Early Season Pigweed Density (weeds/m ²)	Weed Biomass (g/m ²)
Check	10.7 A*	6.5 A	0.141 A
Interseeded Cover Crop	23.9 A	15.5 A	0.0151 A
P-Value	0.384	0.284	0.561

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

Multi-Year Soil Health Assessment (2019 to 2021)

Soil health measures were collected in 2019 and 2021.

Table 7. Soil physical, chemical, and biological properties for cover crop and no cover crop treatments.

Treatment	Infiltration (in/hr)	Soil moisture (%)	Bulk density (g/cm ³)	Soil temp. (F)	Soil respiration ¹	Total soil health score ²
2019 (1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 29, 2019)						
Check	4.01 A*	16.50 A	1.24 A	37.33 A	2.42 A	15.28 A
Dormant Seeded	2.46 A	15.21 A	1.28 A	37.00 A	2.33 B	15.52 A
Dormant + Interseeded	5.00 A	13.33 A	1.24 A	37.17 A	3.42 A	14.88 A
P-Value	0.660	0.262	0.904	0.690	0.064	0.715
2021 (2 samples per treatment replication, n=12 per treatment; samples collected on Nov. 29, 2021)						
Check	8.70 A	16.2 A	1.50 A	43.4 A	1.67 A	17.6 B
Dormant Seeded	6.07 A	17.7 A	1.49 A	43.1 A	1.99 A	22.0 A
Dormant + Interseeded	12.19 A	17.0 A	1.46 A	43.5 A	1.79 A	19.4 AB
P-Value	0.238	0.741	0.9053	0.5992	0.653	0.0806

¹Soil respiration (Modified Solvita burst).

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

Soil assessment was not completed in 2018 as it was originally planned for every other year interval.

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

Summary:

- Interseeding cover crops resulted in neutral effects on corn yields.
- Total soil health score was higher for the cover crop strips in 2021.
- Interseeded cover crops resulted in a significant increase in the proportion of pigweeds in the seedbank but a significant decrease in the number of other broadleaf weeds present.
- The interseeded cover crop seedbank was primarily composed of Palmer amaranth with a low relative abundance of other species, while the check seedbank was dominated by scarlet pimpernel and was less dominated by Palmer amaranth.
- Despite significant increases in pigweeds in the interseeded cover crop seedbank, there were no differences in the number of weeds or pigweeds emerged, as measured in the field during the growing season.