Incorporation of Cover Crop in a Non-Irrigated Corn-Soybean-Small grain Rotation
NRCS Soil Health Management Demonstration Field 4-year summary report

Study ID: 0913037202101
County: Colfax
Reps: 6

Soil Type: Moody silty clay loam terrace, 0-2% slopes; Moody silty clay loam 6-11% slopes, eroded
Irrigation: None
Tillage: No-till

Introduction

This study is being conducted on a soil health demonstration field 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 field involved had been under no-till management for ~20 years. Two treatments are being evaluated in this five-year study: cover crop mix and no-cover crop check. These plots were maintained throughout the project timeline (2017-2021).

Year 1 – Corn (2018 Crop)

In year one, corn was planted in the field on all treatment strips. No treatment strip specific corn yields measurements were compiled.

Year 2 – Soybeans (2019 Crop)

Planting Date: 5/14/19
Harvest Date: 10/14/19
Seeding Rate: 140,000
Row Spacing (in): 15
Variety: Legend®25X924N
Herbicides: ***Pre:*** 6 oz/ac Zidua® PRO, 40 oz/ac Roundup®, and 8 oz/ac Dicamba on 5/10/19 ***Post:*** 7.25 oz/ac Marvel™, 32 oz/ac Roundup®, and 6 oz/ac Select Max® on 6/28/19
Foliar Insecticides: 2.8 oz/ac Leverage® on 7/30/19
Foliar Fungicides: 4 oz/ac Priaxor® on 7/30/19
Cumulative rainfall (in): 34

In year two, the cover crop was drilled on November 19, 2018. The cover crop mix was 8 lb/ac winter wheat, 8 lb/ac winter rye, 8 lb/ac triticale, 1 lb/ac Dwarf Essex rapeseed, 5 lb/ac winter oats, 8 lb/ac winter barley, 1 lb/ac camelina, 1 lb/ac hairy vetch, 2.5 lb/ac winter Morton lentil and 1 lb/ac Dixie crimson clover. The cover crop was terminated with herbicides on May 10, 2019, at a height of 10-18". There were no differences in soybean moisture or yield (Table 1). Marginal net return was lower for the cover crop treatment due to the additional cost of seed and drilling (Table 2).

Table 1. 2019 soybean yield, moisture, and marginal net return for cover crop mix and no cover crop treatments.

	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	11.8 A*	68 A	549.30 A
Cover Crop Mix	11.9 A	68 A	514.83 B
P-Value	0.607	0.994	0.002

*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, $20.11/ac cover crop seed, and $14.40 for cover crop drilling.

Year 3 – Wheat (2020 Crop)

Planting Date: 10/15/19
Harvest Date: 7/21/20
Population: 105 lb/ac
Row Spacing (in): 7.5
Hybrid: Valiant

Herbicides: ***Pre:*** 0.5 pt/ac 2,4-D and 0.8 oz/ac Affinity® Broadspec on 5/6/20 ***Post:*** None
Foliar Fungicides: 6.8 oz/ac Prosaro®
Fertilizer: 100 lb/ac 11-52-0 on 10/24/19; 30 gal/ac 32% UAN on 4/8/20
Cumulative rainfall (in): 25

In year three, wheat was planted following soybean harvest on the cover crop and check strips. There were no differences in wheat moisture, yield, or marginal net return between the treatments (Table 2).

Table 2. 2020 wheat moisture, yield, and net return for single species and multispecies cover crop treatments.

	Moisture (%)	Wheat Yield (bu/acre)†	Marginal Net Return‡ ($/acre)
Check	13.3 A*	82.4 A	358 A
Cover Crop Mix	13.0 A	84.8 A	369 A
P-Value	0.1089	0.4397	0.4397

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13.5% moisture.
‡Marginal net return based on $4.35/bu wheat. Costs of cover crop drilled after wheat harvest was not included in the analysis.

Year 4 – Corn (2021 Crop)

Planting Date: 4/30/21
Harvest Date: 11/1 – 11/4/2021
Seeding Rate: 30,000
Row Spacing (in): 30
Hybrid: Golden Harvest® G13H15
Herbicides: ***Pre:*** Burndown: 44 oz/ac Roundup PowerMAX®, 1 pt/ac 2,4-D, and 2.5 qt/ac Ravine™ ***Post:*** 3 oz/ac Bellum™, 1 pt/ac Medal® ll, 2.5 oz/ac Status®, and 32 oz/ac Roundup®
Foliar Insecticides: 2 oz/ac Baythroid® XL on 4/30/21
Foliar Fungicides: 10 oz/ac Headline AMP® on 7/27/21
Fertilizer: 4,000 gal of Hog Manure on 7/25/20; 7.5 gal/ac 6-24-6 and 10 gal/ac 32% UAN (35.5 lb N/ac) on 4/30/21; Average of 40 gal/ac 32% UAN (142 lb N/ac) applied through VRT Y-drop on 7/1/21
Cumulative rainfall (in): 35

In year four, following the wheat harvest on August 6, 2020, a cover crop mix of 15 lbs/ac cereal rye, 2 lbs/ac radish, 0.5 lbs/ac forage collards, 5 lbs/ac winter peas, 3 lbs/ac winter lentils, 1.5 lbs/ac sun hemp, 3 lbs/ac buckwheat, 10 lbs/ac spring oats, 1 lbs/ac pearl millet, and 0.5 lbs/ac camelina was drilled on the cover crop treatment strips. Cover crop biomass collected on April 9, 2021, was 2600 lb/ac (Table 3). Volunteer wheat grew throughout the field (biomass = 1372 lb/ac) including on the check strips. Cover crop species that did not winter terminate and the volunteer wheat was terminated with herbicides on April 30, 2021. Corn was planted on April 30, 2021, and harvested on November 1, 2021. Corn yield showed a decrease of 5 bu/ac following cover crop (Table 3). Marginal net return was lower for the cover crop treatment due to the additional cost of seed, drilling, and yield reduction (Table 3).

In addition to soil health assessments (Table 6) and yield results, weed biomass and density in the cover crop and check treatments were measured in 2021, four years after experimental plots were established (Table 4 & Table 5). No differences in the cover crop area and the check area seedbank were observed and the composition of the most abundant species in the respective seedbanks was similar as well.

Table 3. Cover crop biomass, green cover, and corn moisture, yield, and net return for check and cover crop mix treatments. Cover crop biomass and green cover were measured on April 9, 2021.

	Cover crop biomass (lb/ac)	Green cover (%)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	1372 B	23.6 B	18.64 A*	264 A	1371 A
Cover Crop Mix	2679 A	62.2 A	18.57 A	259 B	1309 B
P-Value	<0.0001	<0.0001	0.1540	0.001	< 0.0001

*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 $5.20/bu corn, $20.11/ac cover crop seed, and $14.40 for cover crop drilling.
Green cover assessed using the Canopeo measurement tool.

Table 4. Total number of weeds, pigweeds, grasses, broadleaves, and average number of species identified per replicate in the field for cover crop mix and check treatments strips. Seedbank was collected on April 9, 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 the 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 m^2, which was determined from the number of emerged seedlings.

	Total weeds (weeds/m^2)†	Average Number of Species Identified	Pigweeds (weeds/m^2)	Grasses (weeds/m^2)	Broadleaves (weeds/m^2)
Check	168 A*	2 A	21.6 A	0.00 A	137 A
Cover Crop Mix	164 A	3 A	19.6 A	24.2 A	121 A
P-Value	0.960	0.264	0.891	1.00	0.715

† Total weeds, pigweeds, grasses, and broadleaves are estimated in weeds/m^2, 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 9, 2021 and permitted to freely germinate in the greenhouse until November 1, 2021.

Check – Species	Percentage of Seedbank	Cover Crop Mix – Species	Percentage of Seedbank
Common woodsorrel	65.6%	Common woodsorrel	63.2%
Common waterhemp	29.7%	Common waterhemp	22.8%
Marestail	1.56%	Hardstem bulrush	7.04%
Buffalo bur	1.56%	Marestail	5.21%
Carpetweed	1.56%	Buffalo bur	1.80%

Multi-Year Soil Health Assessment (2017 to 2020)

Baseline and soil health measures were collected in 2017, 2019, and 2021.

Table 6. 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]
2017 *(1 sample per treatment replication, n=6 per treatment; samples collected on Oct. 30, 2017)*						
Check	15.58 A*	25.5 A	1.04 A	50.4 A	3.85 A	16.2 A
Cover Crop Mix	6.87 B	25.5 A	1.03 A	50.0 A	4.10 A	18.1 A
P-Value	0.0808	0.986	0.785	0.354	0.1817	0.342
2019 *(1 sample per treatment replication, n=6 samples per treatment; samples collected on Nov. 5, 2019)*						
Check	2.09 A	23.61 A	1.14 A	40.85 A	3.33 A	17.4 A
Cover Crop Mix	4.93 A	24.60 A	1.13 A	40.93 A	2.67 A	18.6 A
P-Value	0.422	0.336	0.478	0.794	0.102	0.295
2021 *(1 sample per treatment replication, n=6 samples per treatment; samples collected on Nov. 17, 2021)*						
Check	9.97 A	26.2 A	1.17 A	44.3 A	1.17 A	16.9 B
Cover Crop Mix	2.64 A	26.0 A	1.12 A	44.0 A	1.33 A	19.7 A
P-Value	0.109	0.948	0.421	0.750	0.611	0.0235

[1]Soil respiration (Modified Solvita burst).
[2]Score 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.
Soil assessment was not completed in 2018 and 2020 as it was only completed every other year interval.
*Values with the same letter are not significantly different at a 90% confidence level.

Summary:

- Incorporating cover crop in a corn-soybean-small grain rotation resulted in neutral effects on soybean and small grain yields and decrease in corn yield.
- Trends of increased total soil health score were observed in both check and cover crop mix treatment areas. In 2021, the soil health score was higher for the cover crop mix compared to the check.
- No differences were observed in the weed seedbank collected in 2021, after the cover crop and check treatment strips were established and maintained for 4 years.