Incorporation of Monoculture Rye vs Multispecies Cover Crop in Corn-Soybean-Small grain Rotation
NRCS Soil Health Management Demonstration Field 5-year summary report

Study ID: 0732167202101
County: Stanton
Tillage: No-Till
Reps: 5

Soil Type: Nora-Crofton complex 6-11% slopes, eroded; Moody silty clay loam 2-6% slopes
Irrigation: None

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. Two treatments are being evaluated in this five-year study (2017-2021): a monoculture cereal rye cover crop versus a multi-species cover crop mix. These treatment plots were maintained throughout the project time frame.

Years 1 and 2 – Soybeans and Wheat (2017-2018 Crops)

Planting Date: 10/24/17
Harvest Date: 7/16/18 and 7/21/18
Population: 1,000,000 seeds/ac
Row Spacing (in): 7.5
Variety: Redfield
Herbicides: Pre: None Post: None
Seed Treatment: Cruiser®
Fertilizer: Spring top-dress on 3/30/18; 300 lb/ac ammonium nitrate (102 lb N/ac), 40 lb/ac potash, 40 lb/ac ammonium sulfate (8 lb N/ac, 10 lb S/ac)
Cumulative Rainfall (in): 43

In year one, cover crops were drilled in October 2016. The single species cover crop was 50 lb/ac rye. The cover crop mix consisted of 35 lb/ac Elbon Rye, 0.5 lb/ac Bayou Kale, 0.5 lb/ac Impact forage collards, 0.5 lb/ac Trophy rape, 0.5 lb/ac purple top turnip, 0.5 lb/ac African cabbage, 3.5 lb/ac hairy vetch, 30 lb/ac Austrian winter pea, and 2 lb/ac winter lentil. Cover crops were terminated on May 14, 2017, and soybeans were planted on May 25, 2017, and harvested on September 29, 2017. The soybean yield data was not analyzed for crop year 2017.

In year 2, wheat was planted in October 2017. A summer hail event on June 23, 2018, decreased total yeild significantly. Wheat yield was obtained for each treatment using yield monitor data with a 15' buffer applied to the treatments. There was no difference in wheat yield or moisture for the monoculture versus cover crop mix (Table 1).

Table 1. 2018 wheat moisture and yield for single species and multi-species treatments.

	Moisture (%)	Wheat Yield† (bu/ac)
Single species Cover Crop	14.2 A*	35 A
Multi species Cover Crop	14.6 A	33 A
P-Value	0.591	0.366

†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13.5% moisture.
*Values with the same letter are not significantly different at a 90% confidence level.

Year 3 - Corn (2019 Crop)

Planting Date: 5/17/19
Harvest Date: 11/4-5/19
Seeding Rate: 30,919
Row Spacing (in): 20
Hybrid: Golden Harvest® 09Y24-3220A E-Z Refuge
Herbicides: 8 oz/ac 2,4-D, 40 oz/ac glyphosate

Seed Treatment: Avicta® 500 FS
Fertilizer: 5 gal/ac 8-20-8-4-2 on 5/17/19; 150 lb/ac urea and 20 lb/ac AMS on 5/22/19
Cumulative Rainfall (in): 32

In year three, cover crops were drilled on July 27, 2018, following wheat harvest. The single species cover crop was 50 lb/ac cereal rye. The cover crop mix was 30 lb/ac cereal rye, 3 lb/ac red clover, 2 lb/ac rapeseed/canola, and 6 lb/ac hairy vetch. Cover crops were terminated on May 16, 2019, and corn was planted on May 17, 2019. The corn yield was very close to a statistically significant difference, with the monoculture cereal rye cover crop area having a higher yield than the multispecies cover crop area (Table 2). This did result in the monoculture cereal rye cover crop area having a higher net return (Table 2).

Table 2. 2019 corn yield, moisture, and marginal net return for single species and multi species treatments.

	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Single species Cover Crop	20.3 A*	192 A	708.03 A
Multi species Cover Crop	19.9 A	179 A	655.90 B
P-Value	0.317	0.101	0.085

†Yield values are from cleaned yield monitor data. Bushels per acre adjusted to 15.5% moisture.
‡Marginal net return based on $3.83/bu corn, $27.33/ac for the rye seed and drilling, and $31.34/ac for the mix seed and drilling.
*Values with the same letter are not significantly different at a 90% confidence level.

Year 4 – Soybeans (2020 Crop)

Planting Date: 4/30/20
Harvest Date: 10/9/20
Population: 133,650
Row Spacing (in): 20
Variety: Golden Harvest® GH2041X
Herbicides: ***Pre:*** 1.5 pt/ac Stalwart® C, 1.0 pt/ac Clash™, 32 oz/ac Buccaneer®, 3.0 oz/ac Tronido™ on 5/14/20
Post: 12 oz/ac fomesafen, 0.4 oz/ac Cadet®, 32 oz/ac Buccaneer®, 10.0 oz/ac clethodim, 1.0 pt/ac Helmet on 6/26/20
Seed Treatment: CruiserMaxx®, Vibrance®
Foliar Fungicides: 10 oz/ac Quilt Xcel® Fertilizer: 5 gal/ac 5-18-5 on 4/30/20
Cumulative Rainfall (in): 22

In year four, cover crops were drilled in November following corn harvest in 2019. The monoculture cover crop was 50 lb/ac cereal rye. The cover crop multi-species mix was 30 lb/ac cereal rye, 10 lb/ac winter barley, 3 lb/ac red clover, 1 lb/ac rapeseed, 4 lb/ac hairy vetch, and 0.5 lb/ac camelina. Cover crops were terminated on May 14, and soybeans were planted on April 30 and harvested on October 9, 2020. Soybeans planted in the multispecies treatment area had a higher yield than those in the single species area (Table 3). These observations are in agreement with the crop vigor analysis (NDVI) that showed higher values in the multispecies area (Figure 1).

Table 3. 2020 soybean moisture and yield, cover crop biomass and green cover for single species and multispecies cover crop treatment areas. Cover crop biomass and green cover were measured May 6, 2020.

	Cover crop Biomass (lbs/ac)	Green cover (%)	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Single species Cover Crop	85.3 A*	3.303 A	8.25 A*	48.3 B	431 B
Multispecies Cover Crop	14.9 B	0.703 B	7.63 B	55.4 A	495 A
P-Value	<.0001	0.0002	0.032	0.0497	0.0589

*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, $27.33/ac for the rye seed and drilling, and $31.34/ac for the mix seed and drilling.
Green cover using the Canopeo measurement tool.

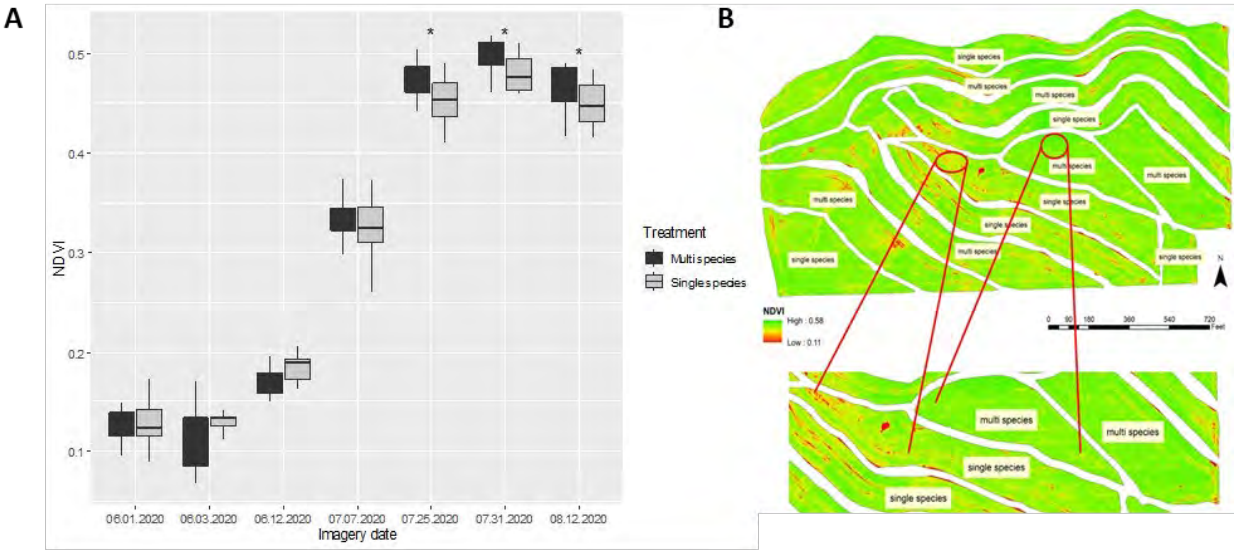

Figure 1. (A) Normalized difference vegetation index (NDVI) values from aerial imagery for the soybean crop following single species and multi-species cover crops. Asterisk (*) within each date indicates significant differences ($p < 0.10$) between single species and multi-species cover crop areas at a 90% confidence level. (B) Aerial imagery from July 31 displayed as soybean normalized difference vegetation index (NDVI). Areas with single and multi-species cover crop are indicated.

Year 5 – Corn (2021 Crop)

Planting Date: 5/11/21
Harvest Date: 10/8-12/21
Seeding Rate: 31,000
Row Spacing (in): 20
Hybrid: Golden Harvest® 16-52222A E-Z Refuge
Herbicides: ***Pre:*** 1.5 pt/ac atrazine, 3.5 oz/ac Bellum™, 2 pt/ac Stalwart® C, 0.5 pt/ac 2,4-D LV6 Ester, and 12 oz/ac Absorb 100 on 5/13/21 ***Post:*** 0.5 pt/ac atrazine, 3 oz/ac Bellum™, 19.2 oz/ac Padlock Plus, and 32 oz/ac Buccaneer 5 Extra® on 6/13/21
Seed Treatment: Cruiser® Complete
Foliar Fungicides: 10.5 oz/ac Quilt Xcel® on 6/13/21
Fertilizer: 182 lb/ac urea on 6/18/21; 35 ton/ac manure on 10/15/21
Note: Wind damage on 7/10/21; hail damage on 8/31
Cumulative Rainfall (in): 34

In year five, cover crops were drilled on October 17, 2020, following soybean harvest. The monoculture cover crop was 50 lb/ac cereal rye. The cover crop multi-species mix was 30 lb/ac cereal rye, 10 lb/ac winter barley, 3 lb/ac red clover, 1 lb/ac rapeseed, 4 lb/ac hairy vetch, and 0.5 lb/ac camelina. Cover crops were terminated on May 5, and corn was planted on May 11 and harvested on October 8-10, 2021. There was wind damage on July 10, and hail damage on August 31. There was no difference in corn moisture, yield, or marginal net return for the monoculture versus cover crop mix areas (Table 4).

Table 4. 2021 corn yield, moisture, and marginal net return for single species and multi-species treatments.

	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Single species Cover Crop	19.4 A*	200 A	1015 A
Multi species Cover Crop	18.2 A	200 A	1007 A
P-Value	0.1158	0.8548	0.7265

†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, $27.33/ac for the rye seed and drilling, and $31.34/ac for the mix seed and drilling.
*Values with the same letter are not significantly different at a 90% confidence level.

Multi-Year Soil Health Assessment (2016 to 2020)

Baseline and soil health measures were collected in 2016, 2019, 2020, and 2021.

Table 5. Soil physical, chemical, and biological properties for single species and multi-species 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]
2016 *(2-5 composite samples collected for all replications of a treatment; samples collected on Nov. 14, 2016)*						
Single species	3.13 A*	26.7 A	1.02 A	48.3 A	3.33 A	19.7 A
Multi species	8.50 A	27.6 A	1.17 A	48.2 A	2.33 B	17.2 B
P-Value	0.762	0.734	0.103	0.991	<0.001	0.0903
2018 *(2-5 composite samples collected for all replications of a treatment; samples collected on Nov. 20, 2018)*						
Single species	-[3]	-	1.07 A	29.8 A	3.25 A	18.8 A
Multi species	-	-	1.11 A	31.5 A	2.62 A	19.5 A
P-Value			0.710	0.139	0.239	0.149
2019 *(1 sample per treatment replication, n=5 per treatment; samples collected on Nov. 5, 2019)*						
Single species	12.24 A	25.63 A	1.13 A	36.24 A	3.13 A	19.9 A
Multi species	18.88 A	25.11 A	1.10 A	36.61 A	3.22 A	19.8 A
P-Value	0.356	0.766	0.5083	0.454	0.879	0.885
2020 *(1 sample per treatment replication, n=5 per treatment; samples collected on Nov. 4, 2020)*						
Single species	12.7 A	23.1 A	1.17 A	45.1 A	3.19 A	19.6 A
Multi species	13.6 A	22.7 A	1.11 A	46.5 A	3.64 A	17.9 B
P-Value	0.873	0.615	0.201	0.449	0.252	0.023
2021 *(1 sample per treatment replication, n=5 per treatment; samples collected on Nov. 9, 2021)*						
Single species	5.38 A	27.4 A	1.11 A	45.3 A	2.19 A	20.7 B
Multi species	1.23 A	31.4 A	1.13 A	45.7 A	2.57 A	21.6 A
P-Value	0.311	0.116	0.740	0.645	0.345	0.0297

[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 2017 and 2018 as it was originally planned for every other year interval.

[3]No test was completed in 2018 for soil moisture and infiltration.

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

Summary:

- Incorporating single or multi-species cover crop in a corn-soybean-small grain rotation resulted in neutral effects on corn and small grain yields. Soybean planted in the multi-species cover crop treatment area had a higher yield than the single species treatment area.
- Total soil health score was higher for the single-species treatment both in 2016 and 2020, but higher in the multi-species treatment in 2021.