

Impact of Mono Cereal Grain versus Multiple Cereal Grains in Cover Crop Mixtures on Subsequent Crop Yield and Soil Quality Indicators, NRCS Demo Farm

Study ID: 0388131202001

County: Otoe

Soil Type: Judson silt loam 2-6% slopes; Pawnee clay loam 4-8% slopes, eroded; Wymore silty clay loam 2-6% slopes

Planting Date: 6/2/20

Harvest Date: 10/14/20

Population: 167,000

Row Spacing (in): 10

Hybrid: Channel® 3.1-3.2

Reps: 4

Previous Crop: Cool season forage for hay

Tillage: No-Till

Herbicides: **Pre:** Roller-Crimper on 6/2/20 **Post:** 14 oz/ac Mad Dog® K6, 42 oz/ac Noventa™, 2.5 lb/ac AMS, 5 lb/ac ARRAY® on 7/14/20

Seed Treatment: None

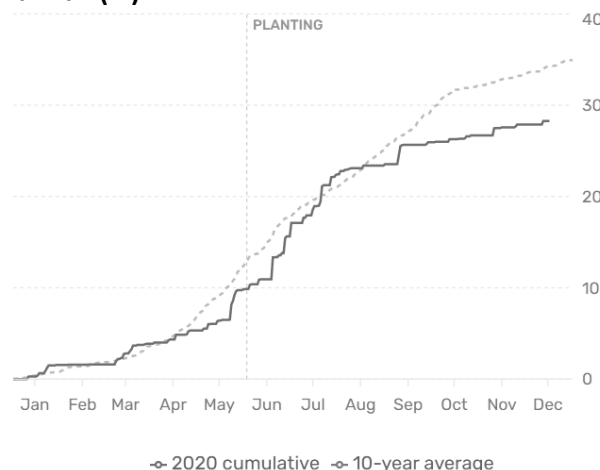
Foliar Insecticides: None

Foliar Fungicides: None

Fertilizer: 24 lb/ac N, 13 lb/ac P, 30 lb/ac K, 15 lb/ac S applied on April 21, 2020.

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, a cover crop mixture with one cereal grain and a cover crop mixture with multiple cereal grains, will be used in this five-year study (2016-2021). 2020 was the fourth year of this study. The cover crop monospecies (60 lb/ac cereal rye) and multiple cereal grain (wheat, triticale, winter barley, spring barley, and oats) were drilled in October 2019, following warm-season forage harvest. Cover crop was terminated on June 6 and 7 by roller crimper. Soybeans were planted in standing green cover crop on June 2, 2020, and harvested on October 14, 2020. Baseline and soil health measures were collected in 2016, 2017, 2018, 2019, and 2020 (Tables 1 and 2).

Results:

Table 1. Soil physical, chemical, and biological properties for cover crop mix with one cereal rye and multiple cereal grains 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. 18, 2016)						
Cover Crop – Rye	9.60	33.3	1.12	57.0	3.0	21.5
Cover Crop – Mix	2.29	37.1	1.18	58.6	2.5	18.0
2018 (1 sample per treatment replication, n=4 per treatment; samples collected on Nov. 1, 2018)						
Cover Crop – Rye	1.11 A*	30.1 A	1.07 A	48.5 A	– ³	22.1 A
Cover Crop – Mix	0.88 A	29.2 A	1.08 A	48.5 A	–	21.6 A
P-Value	0.6038	0.643	0.788	0.959	–	0.670
2019 (1 sample per treatment replication, n=4 per treatment; samples collected on Oct. 30, 2019)						
Cover Crop – Rye	2.34 A	26.4 A	1.11 A	42.3A	3.75 A	21.0 A
Cover Crop – Mix	1.32 A	24.3 A	1.14 A	44.5 A	3.50 A	20.5 A
P-Value	0.419	0.279	0.514	0.365	0.604	0.2522

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. 20, 2020)						
Cover Crop – Rye	27.5 A	20.5 A	1.22 A	50.6 A	3.25 A	21.7A
Cover Crop – Mix	23.6 A	21.2 A	1.19 A	50.4 A	2.62 B	19.9 A
P-Value	0.892	0.8838	0.235	0.6928	0.0796	0.50

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 2018 for soil respiration.

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

Table 2. Haney soil health test from 2016, 2017, 2018, and 2019 for cover crop mix with one cereal rye and multiple cereal grains treatments.

Treatment ¹	Solvita CO ₂ Burst (ppm)	Total N (ppm)	Org. N (ppm)	Total Org. C (ppm)	Nitrate (ppm)	Ammonium (ppm)	Inorg. N (ppm)	Org. C:N	Org. N Release (ppm)	Soil Health Score ²
2016 Baseline	118	27.3	17.9	184	9.3	1	10.2	10.3	17.9	15.05
2017 Cover Crop - Rye	71.8	16.3	12.5	180	2.7	0.1	2.8	14.4	12.5	12.02
2017 Cover Crop - Mix	119.2	20.1	13.5	194	4.7	1.5	6.2	14.4	13.5	15.17
2018 Cover Crop - Rye	136.3	21.7	12.3	199	9	2.5	11.5	16.2	12.3	16.57
2018 Cover Crop - Mix	74.5	23.7	14.1	202	8.7	2.9	11.6	14.3	14.1	12.9
2019 Cover Crop - Rye	66.2 A*	27.4 A	17.4 A	201 A	8.32 A	1.5 A	9.78 A	11.6 A	16.4 A	12.4 A
2019 Cover Crop - Mix	61.1 A	26.2 A	17.4 A	208 A	7.6 A	1.85 A	9.43 A	12.0 A	17.1 A	12.0 A
P-value	0.684	0.637	0.977	0.869	0.649	0.504	0.86	0.548	0.671	0.795

¹A representative sample was taken from each treatment for Haney soil tests in 2016-2018 and in 2019 one sample was taken per treatment replication (n=4 per treatment), which allowed statistical analysis on treatment effects.

²Calculated using the amount of CO₂-C release in 24 h along with a separate procedure from the H3A extract to measure soil concentrations of water-extractable organic C (WEOC) and water-extractable organic N (WEON). SH score = CO₂/10 + WEOC/100 + WEON/10 (Roper et al., 2017).

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

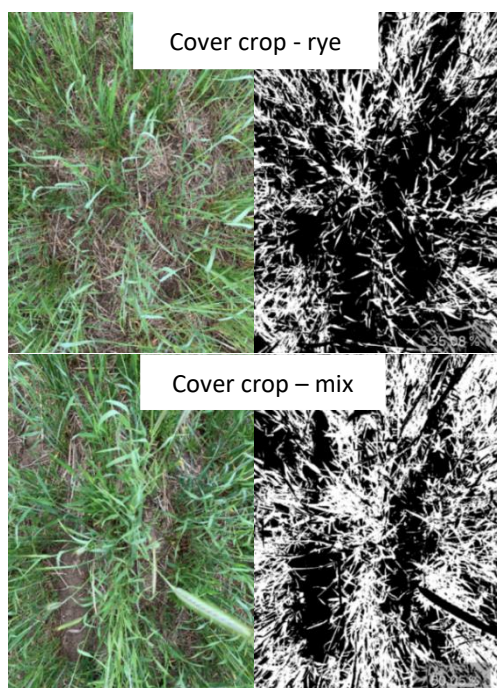


Figure 1. Cover crop green cover of rye (top) and mix (bottom) strips displayed as true color (left) and using the Canopeo measurement tool (right). Cover crop biomass measured on May 20, 2020.

Table 3. 2020 cover crop biomass and green cover for cover crop mix with one cereal rye and multiple cereal grains treatments. Cover crop biomass measured on May 20, 2020.

	Biomass (lbs./acre)	Green cover (%)
Cover Crop – Rye	2652 B*	44.0 A
Cover Crop – Mix	3715 A	48.7 A
P-Value	0.0039	0.3022

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

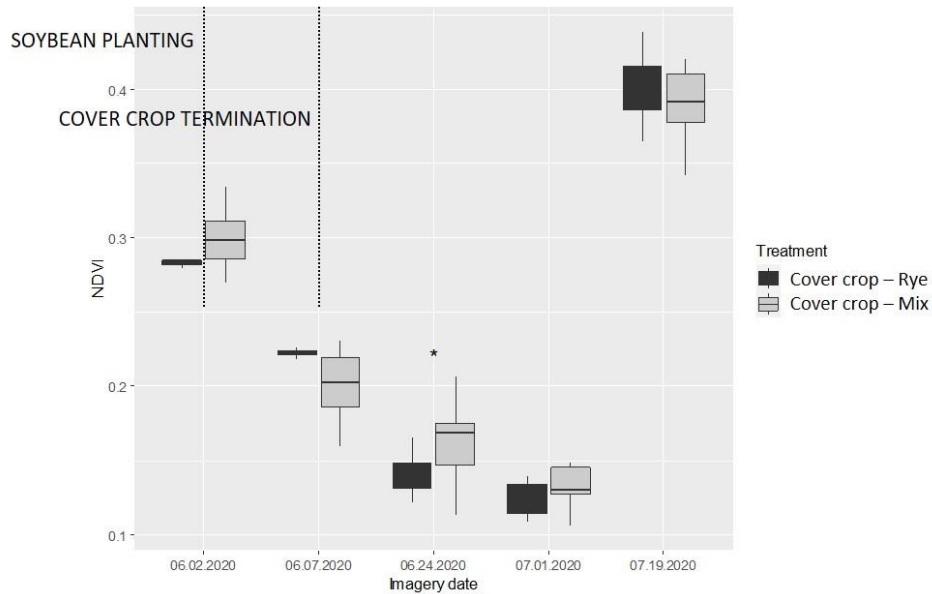


Figure 2. Normalized difference vegetation index (NDVI) values from aerial imagery for the cover crop and soybean crop following mix with one cereal grain and mix with multiple cereal grains cover crops. Asterisk (*) within each date indicates significant difference ($p < 0.10$) between treatments at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



Figure 3. Cover crop termination by roller crimper. As the farmer drives over the cover crop, the roller crimper pushes the plants down, crimping the stems every seven inches. Image courtesy: Gary Lesoing.

Table 4. 2020 soybean moisture, yield, and net return for mix with one cereal grain and multiple cereal grains cover crop treatments.

	Moisture (%)	Soybean Yield (bu/acre) [†]	Marginal Net Return [‡] (\$/ac)
Cover Crop – Rye	10.5 A	27.8 A	210 A
Cover Crop – Mix	10.4 A	28.1 A	217 A
P-Value	0.647	0.964	0.922

*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, \$53.84/acre for cover crop mix with one cereal grain, \$50.21/acre for cover crop mix with multiple cereal grains.

Summary:

- There were no differences in most of the soil health parameters between the treatments (2016-2020) (Tables 1 and 2).
- Aerial imagery normalized difference vegetation index (NDVI) analysis after cover crop was roller crimped showed higher values for multiple cereal grains cover crop treatment on June 24. These observations are in agreement with cover crop biomass measurements that showed higher biomass production in the cover crop mix (Table 3 and Figures 1, 2, and 3).
- There were no differences in soybean moisture, yield, or marginal net return between the treatments (Table 4). The late termination timing and dry soil conditions might help explain the low soybean yields. These observations are in agreement with the crop vigor (NDVI) calculated for soybeans that showed no differences between the two cover crop treatments (July 19). Results from previous years follow.

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Summary of Previous Years

YEAR ONE | In year one, cover crops were drilled in the fall of 2016. Both mixtures included annual rye, canola, Balansa clover, camelina, vetch, crimson clover, winter lentils, alfalfa, and northern annual field peas. The cover crop mix with one cereal grain included cereal rye as a base whereas the cover crop mix with multiple cereal grains included winter oats, spring barley, winter barley, triticale, wheat, and cereal rye. The cover crops were terminated with glyphosate herbicide on 4/16/17. This is an early termination date relative to the corn planting date of May 7 for the area (NRCS Zone 3). In 2017, there was no significant differences in yield, moisture, or marginal net return for the two treatments.

Table 5. 2017 corn yield, moisture, and net return for soybeans following cover crops with one cereal grain and with multiple cereal grains

	Moisture (%)	Corn Yield (bu/acre) [†]	Marginal Net Return [‡] (\$/ac)
Cover Crop – Rye	14.6 A	157 A	421.56 A
Cover Crop – Mix	14.8 A	159 A	432.92 A
P-Value	0.209	0.708	0.588

*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 corrected to 15.5% moisture.

[‡]Marginal net return based on \$3.15/bu corn, \$53.84/acre for cover crop mix with one cereal grain, \$50.21/acre for cover crop mix with multiple cereal grains.

YEAR TWO | In year two, cover crops were drilled in late October 2017. The one cereal grain mix included 56 lb/ac cereal rye, 2 lb/ac annual ryegrass, and 1.3 lb/ac canola. The cover crop mix with multiple cereal grains included 10 lb/ac cereal rye, 1.3 lb/ac annual ryegrass, 1.3 lb/ac canola, 10 lb/ac winter barley, 6.7 lb/ac triticale, 10 lb/ac oats, 6.7 lb/ac winter wheat, 8 lb/ac spring barley, and 1.3 lb/ac turnip. The cover crops were terminated with the pre-herbicide application on May 6, 2018. In 2018, there were several challenges to soybean production. Dectes stem borer was evident. There was no rain from July 12 through August 22. Excessive rain after maturity delayed harvest and negatively impacted the crop quality and harvestability. There were no differences in moisture, soybean yield, or net return for the two treatments.

Table 6. 2018 soybean yield, moisture, and net return for soybeans following cover crops with one cereal grain and with multiple cereal grains.

	Moisture (%)	Soybean Yield [†] (bu/ac)	Marginal Net Return [‡] (\$/ac)
Cover Crop – Rye	11.3 A	65 A	452.80 A
Cover Crop – Mix	11.2 A	59 B	410.75 B
P-Value	0.200	0.002	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 corrected to 13% moisture.

[‡]Marginal net return based on \$7.40/bu soybean, \$53.84/ac for the one cereal grain mix, and \$50.21/ac for the multiple cereal grain mix with multiple cereal grains.

YEAR THREE | In year three, Fridge winter triticale and oats (2lb/ac) forage was drilled (November 2018) across all field following soybean harvest. The forage was cut in June 2019. In early July 2019, warm-season forage was drilled (35 lb/ac sorghum-sudangrass, 30.1 lb/ac German millet) and cut and laid in the field in early August and September 2019. No measurements were made on warm-season forage in the monospecies and multispecies cover crop strips.