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Impacts of Interseeding Cover Crop into Silage Corn Grown on Wide Row Spacings

Abstract

Using cover crops as soil protective cover or as a winter livestock feed source is a practice several southern Idaho producers would like to incorporate into their operations. Planting cover crops after longer season crops, such as corn silage, has proven challenging. A study was designed to determine if cover crops could be interseeded into silage corn grown on wider rows, increasing cover crop biomass, while maintaining silage corn yield. The three-year study (2020-2022) design used 44-inch and 60-inch twin-rows, with cover crops interseeded at the v4 growth stage, and 30-inch rows with no cover crops as the check. Study results indicated that the 44-inch rows with cover crops statistically matched or exceeded the silage corn yield of the 30-inch check and were statistically higher yielding than the 60-inch rows with cover crops. The results show that in two of the three years, cover crop forage yield was statistically equal for both 44- and 60-inch treatments.

Introduction

Cover crop use in Idaho is increasing. According to numbers analyzed by The Soil Health Institute comparing USDA Census of Agriculture data from 2012 and 2017, Idaho farmers planted 24.6% more acres to cover crops (Myers, LaRose, 2019). While that is encouraging, the data also show Idaho ranks 31st in total cover crop acres and only 4.4% of farm acres are planted to cover crops. There are many challenges to using cover crops, but timing and adequate growth in the established rotation are two of the biggest challenges. In southern Idaho, crop rotations can include spring or winter cereals, silage or grain corn, alfalfa, dry bean, sugar beet, and potatoes, along with several less common options. Producers have identified two major reasons to implement cover crops: winter soil cover and/or livestock forage. The most common practice for cover crop establishment is to plant immediately after cereal grains are harvested in August. August planting gives sufficient time for cover crop growth and to develop adequate root and plant mass. Planting after other crops are harvested in September and October has proven difficult as day length and heat unit accumulation are reduced. Demonstration studies conducted at the University of Idaho (UI) Kimberly Research & Extension Center farm have shown that planting on September 30th does not give enough time for cover crop species, other than cereals, to establish. Cereals only emerge and grow a few inches before cold weather forces plants into dormancy (unpublished data). Planting late does not meet producer goals of improved soil health practices or winter forage production.

A team of UI Extension Educators conducted a demonstration on-farm study in southern Idaho to determine the feasibility of interseeding cover crops into corn for silage and determining the best planting date (Hogge et al., 2020). The results indicated that cover crops could be established by interseeding, and the V4-V6 growth stage was the ideal planting time. At this growth stage of corn, weed control operations are often completed and the corn has not yet closed canopy. As the corn canopy closed cover crop growth slowed. Once the corn was harvested in September, the cover crop resumed growth with more direct sunlight and additional irrigation. In that study, the cover crop was clipped for yield in mid-October. In 2017, the cover crop produced 1153 lbs. of dry matter/acre(DM/ac) and in 2018, it produced 783 lbs. of DM/ac. A study conducted by Gailans (2019) comparing interseeding cover crops into grain corn grown on wider (60-inch) versus normal rows (30-inch) found mixed results on corn yield and cover crop biomass. This study was designed to determine if silage corn could be grown on wider rows while maintaining yield and increasing cover crop production. Silage corn was chosen because in Idaho 68% of the corn acreage is harvested for silage (USDA-NASS, 2022).

Methods

The study was set up as a randomized complete block design with four replications. Each plot was 215 feet long x 8 rows wide. The treatments were 44-inch-wide twin rows with cover crops interseeded, 60-inch-wide twin rows with cover crops interseeded, and 30-inch standard width rows with no cover crops interseeded as the yield check (Figure 1).

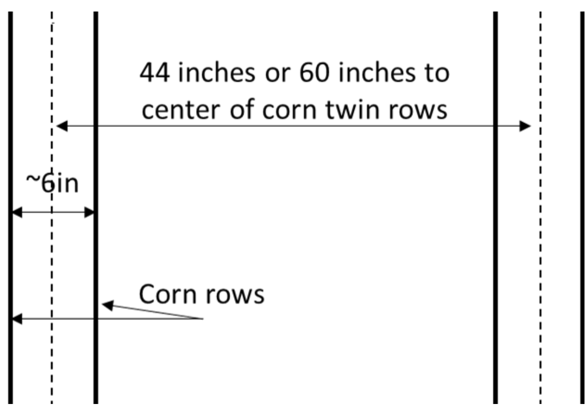

Figure 1. Diagram of twin-row corn layout (not to scale).

The field was conventionally tilled and fertilized for 35-ton yield based on the UI fertility guide recommendations (Brown et al., 2009). Nitrogen was split-applied with one-third preplant incorporated (ammonium sulfate and monoammonium phosphate) and the remaining two-thirds applied in two separate irrigation events using liquid urea ammonium nitrate (UAN 32). No pre-plant herbicide was used due to potential cover crop damage. A Roundup Ready® corn variety was used each year. The relative maturity ratings were 99 in 2020, 88 in 2021, and 89 in 2022. The planters used were a

Kinze 7000 4-30 inch pull type and an Allis-Chalmers 78 4-22 inch 3-point mounted. Both planters use sprocket transmissions and were set to plant approximately 40,000 seeds/acre. The actual seeding rate was 38,500 seeds/acre. To achieve the twin rows, the planters were offset approximately three inches from the center and pulled in one direction, turned around and pulled back the other direction in the same path so the offsets were in opposite directions achieving the six-inch twin rows. The appropriate planter units had to be disabled to skip every other row. The corn was irrigated throughout the growing season using solid set sprinklers. Approximately 30" of water was applied throughout the season.

The cover crop was interseeded each year using an Earthway Model 2750 hand spreader to simulate commercial broadcast methods. The cover crop was planted at approximately 35 lbs./acre when the corn was at the V-5 stage and after the final glyphosate herbicide application. In 2020, the seed was broadcasted and allowed to germinate. In 2021 and 2022, a M&W 10-foot rotary hoe was pulled through the plots after planting to improve seed-to-soil contact. The cover crop mix in 2020 and 2021 was red clover, crimson clover, sweet clover, annual ryegrass, and forage radish. In 2022, the mix included red clover, annual ryegrass, Italian ryegrass, forage rapeseed, forage radish, and turnip. The percentages of each cover crop species in the mix are shown in Table 1.

Table 1. Cover crop species used in mixes, expressed as percent of mix.

Cover crop species	Mix used in 2020 and 2021	Mix used in 2022
Red clover	9%	16%
Yellow sweet clover	9%	
Crimson clover	9%	
Annual ryegrass	64%	33%
Italian ryegrass		33%
Forage radish	9%	6%
Forage rapeseed		6%
Turnip		6%

The cover crop was clipped for yield the day before harvest. About 9 ft^2 of material was collected using a clipping frame that measured 1 x 3 ft. Samples were taken from the top third, middle third and bottom third of each plot with cover crops. The corn was harvested when it reached approximately 68% whole plant moisture. The kernel milk line was used to gauge maturity. The center four rows of each plot were harvested for yield data. The entire 215 feet of each plot was harvested using a Kemper Champion C 1200 two-row forage harvester front mounted on a John Deere 6420. The silage was blown into a Haldrup M-63 silage harvester mounted on the back of the same tractor (Figure 2).

Figure 2. Tractor with front and rear mounted harvest equipment.

The Haldrup unit weighed the cut corn and allowed for a well-mixed sample of the entire plot to be pulled for dry matter calculations. The corn and cover crop samples were dried at a commercial laboratory. Actual plant moisture was calculated from reported dry matter percentages. Forage quality was not measured as that was not part of the study objectives.

Results

Corn silage yield results were corrected to 70% moisture for comparison and cover crop yields were reported as tons of dry matter per acre (tons DM/ac). Results for corn silage and cover crop yield were analyzed separately for each year. Analysis of variance (ANOVA) and two-sample t-tests were performed in R statistical software version 4.2.1 (R Core Team 2022). Where the ANOVA indicated significant treatment effects (alpha ≤ 0.05), treatment means were separated using least significant difference (LSD). The results are summarized in Table 2.

Table 2. Silage corn and cover crop yield from 2020 to 2022 at Kimberly ID USA.

Corn Yield (ton/acre @ 70% moisture)	**2020**	**2021**	**2022**
30 inch no CC	30.7 ab*	35.5 a	37.3 a
44-inch + CC	34.7 a	36.0 a	36.5 a
60-inch + CC	27.1 b	32.0 b	31.3 b
P-value	0.024	0.009	0.05
LSD (0.05)	5.03	2.53	1.21
Cover Crop Yield (tons/acre dry matter)			
44-inch	0.58 a§	0.49 a	1.02 a
60-inch	0.91 a	0.33 a	1.47 a
P-value	0.21	0.13	0.05

*Within column for corn yield, means followed by the same letters are statistically similar according to least significant difference at the 0.05 probability level. Data were analyzed separately for each year.
§Within column for cover crop yield, means followed by the same letters are statistically similar according to two-sample t-test at the 0.05 probability level.

In 2020, corn silage yield in the 44-inch and 60-inch treatments were statistically equal to the 30-inch check. There was a significant difference between the 44-inch rows with 34.7 tons/acre and the 60-inch rows with 27.1 tons/acre (Table 1). In 2021, corn silage yield from the 60-inch treatment was significantly lower (32.0 tons/acre) than the 44-inch and 30-inch check (35.5 tons/acre, 36.0 tons/acre). In 2022, the 60-inch silage treatment was again significantly lower (31.3 tons/acre) than both the 44-inch and the 30-inch check (36.5 tons/acre, 37.3 tons/acre).

The cover crop yield results indicate there was no significant difference between cover crops interseeded into 44-inch or 60-inch rows in all three years (Table 2). Although year-to-year differences cannot be compared as fields, growing conditions, and seed mixes varied, it appears changing mixes in 2022 had a positive effect on cover crop yield (Table 2).

Discussion

The 44 and 60-inch treatments were selected because corn in southern Idaho is typically grown in either 22-inch or 30-inch-wide rows. Skipping every other planted row doubles the row widths to either 44-inch or 60-inch. Data indicate that silage corn grown on 44-inch rows and interseeded with cover crops can equal or exceed corn silage yields grown on 30-inch rows without cover crops. It is unknown why the 60-inch corn silage did not yield higher and could be a project for future research. The wide-row treatments were planted in twin rows to keep the seeding population the same as the yield check plots. The twin rows were easy to accomplish in a small plot situation by simply offsetting the planter and driving up and back through the same plot, a practice that would not be practical in a large field. Modern field planters can be set to plant high seeding rates in a single row. The Kemper Champion Forage Harvester had a row-independent rotary head for easy harvest of the twin rows. Anecdotally, when the field was cleaned off after the data rows were harvested, a John Deere 3970 pull-type harvester with a three-row row-dependent head was used. The twin rows did not cut and gather smoothly. The harvester had to be pulled slower than ideal to prevent corn from being knocked down in the twin rows. If the twin-row concept were to be applied, harvest equipment options must be carefully considered.

The cover crops were planted using a hand-type spreader to simulate aerial seeding, a practice commonly used to interseed cover crops. In year one of the project the cover crop seed was broadcast with no attempt to incorporate it into the soil. In years two and three, a rotary hoe was pulled over the plots after cover crop planting to achieve better seed-to-soil contact. It is difficult to say with any confidence that the rotary hoe made a difference.

The cover crop mix was changed in 2022 because the cover crop was not yielding as expected using wide-row practices. In 2017-18, an on-farm demonstration was conducted interseeding cover crops into 22-inch row spaced corn and planted at approximately the same time (V6, mid-June) yielded 0.58 tons DM/ac in 2017, and 0.39-tons DM/ac in 2018 (Hogge et al., 2020). The cover crop mix used in 2022 had a higher brassica component which contributed more to the biomass. The cover crop mix used in 2020 and 2021 had more clover. Clovers are slow to establish and do not grow well in partial shade. The researchers do not believe changing mixes affected the study since the driving question was, “can silage corn be grown in wider than normal rows while maintaining yield relative to the check treatment and provide enough cover crop biomass for grazing or soil cover?” A 1 x 3 ft clipping rectangle was used to collect cover crop samples which allowed for a more complete mix of plant components from a single collection location. The yield results of the cover crops were highly variable, but each treatment across the years produced enough biomass for grazing or soil protection. Producers would likely continue to irrigate the cover crop to maximize production before frost stopped growth. Though not part of the study, a second cover crop yield sample was taken on November 11th, 2021. The 44-inch treatment increased from 0.49 tons DM/ac to 0.57 tons DM/ac, and the 60-inch treatment increased from 0.33 tons DM/ac to 0.70 tons DM/ac indicating a high percentage of additional dry matter accumulation is possible.

Additionally, the researchers wanted to demonstrate the advantage of including perennial species in cover crop mixes. Figure 3 shows the 2020 plots in April of 2021, before the ground was tilled for the next crop. In March of 2021, the local Natural Resource Conservation Service district conservationist used a line transect to determine the percentage of soil covered by crops or residue. The 44-inch rows had 70% coverage, the 60-inch rows had 60% coverage, and the 30-inch check with no cover crop had 20% coverage indicating the cover crops made a considerable difference for soil cover and protection. Further, spring plant growth could provide an additional grazing opportunity in a livestock system.

Figure 3. Cover crop spring regrowth: 44-inch (l), 60-inch (c), and 30-inch check (r).

Conclusion

The purpose of this study was to determine if silage corn could be grown in wider than normal rows while maintaining yields relative to the check treatment and provide enough cover crop biomass for grazing and/or soil surface protection. The study results indicate that both goals are achievable when grown on 44-inch row spacing but cover crop yield was variable from year to year. The cover crop mixes chosen for this study were commercially available through local suppliers. When selecting the cover crop mix, it is important to consider management goals and planting methods to improve success. If this study was replicated, the authors would more carefully select the cover crop species used specifically for interseeding. Finally, it would be beneficial to discover a planting method that ensured greater stand percentages, such as an interseeding drill.

This initial research provides a basis to examine other questions such as other row widths, selection of corn hybrids with traits conducive to interseeding, seeding rates, and cover crop species best suited to growing in a partially shaded environment.

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