Evaluating overwintering cover crops options in strip-till corn: Part 2 (Brant and Norfolk Counties)

Purpose:

To evaluate a variety of potential overwintering cover crop options ahead of corn, measure their growth and determine their impact on corn development and yield.

Highlights:

- Various overwintering cover crop species were compared ahead of strip-till corn in 2021 and 2022.
- The performance of crimson clover and Austrian winter pea in mixtures with oats and radish was disappointing. Oats outcompeted the legumes and limited both fall growth and overwintering.
- Cereal rye established well as part of a 5-species mix in 2021 and provided modest growth in the spring of 2022. It did not affect corn yield positively or negatively when terminated two days prior to spring strip-tillage and corn planting.

Methods:

The trial was conducted in 2020-2021 and a modified version was repeated in 2021-2022. In 2020-21, cover crop treatments were established on a Haldimand Silty Clay soil just outside Caledonia, Brant County, on August 19th (Caledonia-2021). In 2021, cover crops were seeded on a Bookton Fine Sandy Loam soil near Boston, Norfolk County, on August 24th (Boston-2022).

All cover crops were established following winter wheat (straw spread) using a John Deere 1910 no-till air seeder.

Cover crop comparisons

Three cover crop treatments were evaluated in 2021 and four in 2022 (Table 1). No fall termination by herbicide was conducted in the fall of 2020 or 2021. Treatment 1 was a control comprised of the cooperating farmer's normal seeding mix of winterkilled species (Table 1). Treatments 2, 3 and 4 varied between seasons but included some combination of potentially overwintering species. There were three replicates of each treatment in Caledonia-2021 and Boston-2022, though corn yield is reported only from two replicates at Boston-2022. Yield from Boston-2022 was reported from treatments 1 and 2 and treatments 3 and 4 combined.

Table 1. Treatment details, including cover crop species, seeding rate and date and termination.

Treatment	Caledonia-2021		Boston-2022	
	Species	**Seeding rate (lbs/ac)**	**Species**	**Seeding rate (lbs/ac)**
1	Winterkill mix: Oats Field peas Buckwheat Tillage radish	49 total 32 13 2 2	Winterkill mix: Oats Field peas Buckwheat Tillage radish	48 total 30 14 3 1
2	Winterkill mix + Austrian winter pea (substituted for field peas)	13	Winterkill mix + Crimson clover	5
3	Winterkill mix + Crimson clover (substituted for field peas)	13	Winterkill mix + Cereal rye	30
4	n/a	n/a	Winterkill mix + Crimson clover and cereal rye	5 30

Management practices

N-Rich® was applied at 2 tons/acre 1-2 weeks prior to cover crop seeding at both trial locations, which supplied approximately 40 lbs/acre of available nitrogen. At Caledonia-2021, 10 gallons/acre of 28% urea ammonium nitrate (UAN) was applied to the cover crop as well, which provided an additional 30 lbs-N/acre.

Strip-tillage was performed in the fall of 2020 (October 18-19) with a Soil Warrior (no row cleaners) to create a seedbed for corn planting at Caledonia-2021. Strips were refreshed just prior to planting. Due to wet fall conditions in 2021, a single

strip-tillage pass was performed by a Soil Warrior (row cleaners added) on May 13, 2022 at Boston-2022.

All treatments received the same rate of nitrogen in each season.

At Caledonia-2021, the total nitrogen rate was 192 lbs-N/acre, split across four applications. A total of 84 lbs-N/acre was applied at or before planting, with the balance applied by Y-drop on July 12, 2021.

At Boston-2022, the total rate was 186 lbs-N/ac, also split over four applications. 85 lbs-N/acre was applied at or before planting, with 101 lbs-N/acre applied via Y-drop on July 4, 2022.

Cover crop sampling

Cover crop aboveground biomass was collected on November 10, 2020 at Caledonia-2021, and on November 5, 2021 at Boston-2022, just prior to hard frosts (Figures 1 and 2). Samples were either oven-dried or air-dried to 0% moisture and weighed. Spring cover crop biomass samples were not collected at either site. Instead, photos were taken. Cover crops were terminated in spring by herbicide (1.1 L Roundup + 2 L Acuron per acre) on May 13, 2021 at Caledonia-2021 and on May 11, 2022 (1 L Roundup + 2 L Acuron per acre) at Boston-2022.

Figure 1. Cover crop mixture at Caledonia-2021 site on November 10, 2020.

Figure 2. Cover crop at Boston-2022 site on November 5, 2021. Biomass was sampled and separated by species (top right). A crimson clover plant is shown bottom right.

In season measurements

Corn (50% DKC44-80 and 50 % DKC46-40) was variable rate planted on May 20th and 21st at Caledonia-2021 at 28,000-36,000 seeds/acre (average: 33,000 seeds/acre) at 30-inch spacing. Corn population and development was not evaluated due to minimal differences in conditions across treatments.

At Boston-2022, corn (DKC49-09; one replicate with 50% DKC49-09 and 50% NK9991) was variable rate planted on May 14th, 2022, also at 28,000-36,000 seeds/acre (average: 34,300 seeds/acre) at 30-inch spacing. The stand was evaluated by counting plants per 1/1,000th of an acre in 6 locations treatment on June 10, 2022.

Grain yield

Corn yield was determined by yield monitor, with values post-calibrated based on weighed grain. At the Boston-2022 site, treatments 1 and 2 were combined, as were treatments 3 and 4, to compare no cereal rye to cereal rye (there was very limited crimson clover in spring). Only two of three replicates at Boston-2022 were used to calculate average yields because of differences in proportions of corn hybrids grown between treatments in one replicate.

Due to minimal differences in yield across treatments, statistical tests were not performed.

Results:

Cover crop biomass, fall

Cover crop biomass was significantly greater at Caledonia-2021 than Boston-2022 (Table 2). This was due to a few different factors. Firstly, cover crops were seeded five days earlier in 2020 than 2021. Second, the fall of 2021 was extremely wet. Saturated field conditions at Boston-2022 – made worse by plugged tile – limited cover crop growth. Finally, treatments at the Caledonia-2021 site received an additional 30 lbs-N/acre from 28% UAN applied around cover crop seeding, which contributed to lush oat growth.

Oats was the dominant cover crop across all treatments in both seasons. Its growth, especially at Caledonia-2021, left little room for other species. Austrian winter pea had minimal growth, averaging only 264 lbs/ac of dry matter, which was similar to field peas (Table 2). Crimson clover established well in the fall of 2020, with average of 7 plants/square foot, but had very little biomass (72 lbs/ac).

At Boston-2022, rye established well but put on very little growth in the fall (Table 2). Crimson clover did not establish well, likely in part due to saturated soil conditions in the fall of 2021. In most sampling quadrates, there was no clover present.

Table 2. Dry biomass in pounds/acre for cover crops from each treatment, based on sampling from 12 locations (4-6 locations for non-winterkilled species).

Treatment	Average dry biomass (lbs/acre)	
	Caledonia-2021	Boston-2022
Oats	3,425	852
Field peas	360	82
Buckwheat	-	-
Tillage radish	808	86
Austrian winter pea	264	n/a
Crimson clover	72	3
Cereal rye	n/a	119

- no data (killed by light frost)

n/a – not applicable to trial location

Cover crop biomass, spring

At Caledonia-2021, spring growth consisted largely of volunteer wheat (Figure 3, left). Crimson clover (top right) did over-winter, but it was sparse. The population was found to have been reduced by about two-thirds and its growth was limited at the time of termination. Austrian winter pea had very poor over-wintering, with only the odd plant actively growing in spring (bottom right).

Figure 3. Spring growth at Caledonia-2021. May 14, 2021.

At Boston-2022, treatments that included cereal rye (3 and 4) had relatively uniform growth of the winter cereal. Rye reached up to 18 inches in height and was well into jointing when terminated by herbicide on May 11th. Estimated dry matter biomass for rye was 500-1,000 lbs/acre. Crimson clover was extremely sparse and small in treatments 2 and 3.

Figure 4. View from the tractor cab of treatments 3 and 4 on May 13th, 2022 at Boston-2022 site.

Figure 5 shows the difference in strips created in treatment 1 and 2 (no cereal rye) compared to treatments 3 and 4 (with cereal rye). The root mass of rye prevented working/containment coulters from lifting soil at edges of the strip, which resulted in strips only as wide as tillage coulters (Figure 5, left). Strips made in soil without cereal rye were wider and less chunky (Figure 5, right). Some plant material from the rye ended up on top of the strip following tillage.

Figure 5. Strips immediately after tillage in rye (left) vs. volunteer wheat only (right).

Corn stand and development

Corn stand and development was not evaluated at Caledonia-2021 due to limited spring growth of cover crops and very similar soil conditions across treatments.

Evaluations made at Boston-2022 are summarized below in Table 3. There was no difference in plant stand, growth stage or height between treatments that included cereal rye (Figure 6) vs. those that did not.

Table 3. Corn stand, average growth stage and average height by treatment at Boston-2022. Measured on June 10th, 2022.

Treatment	Corn stand (plants per acre)	Average Vegetative Growth Stage	Average Height (in.)
1 & 2 – no cereal rye (Oats, field peas, buckwheat, tillage radish +/- crimson clover)	32,143	3.6	7.1
3 & 4 – cereal rye (Oats, field peas, buckwheat, tillage radish,	32,000	3.3	7.0

cereal rye, +/- crimson clover)			

Figure 6. Corn growing in strips made in a cereal rye cover crop, Boston-2022. June 10, 2022.

Corn yield

At Caledonia-2021, corn yield was within 1 bu/ac across all three treatments and grain moisture was within 0.2% (Table 4). This result was not surprising, as crimson clover and Austrian winter pea biomass were both minimal at the time of corn planting. Soil conditions were similar across treatments, with volunteer wheat as the primary species present. There was no treatment that included fall termination of volunteer wheat, so it was not possible determine whether it negatively impacted corn yield.

Table 4. Corn yield and moisture at Caledonia-2021 trial location.

Treatment	Average corn grain yield at 15.5% moisture (bu/ac)	Average corn grain moisture (%)
1. Winterkill mix: Oats Field peas Buckwheat Tillage radish	243	20.1
2. Winterkill mix + Austrian winter pea	244	20.2
3. Winterkill mix + Crimson clover	244	20.3

The result at Boston-2022 was similar. Average corn yield was the exact same in treatments 1 & 2 (no rye) and 3 & 4 (rye) at 199.5 bushels per acre (Table 5). Moisture was nearly identical as well.

Table 5. Corn yield and moisture at Boston-2022 trial location.

Treatment	Average corn grain yield at 15.5% moisture (bu/ac)	Average corn grain moisture (%)
1 & 2. Winterkill mix, no cereal rye	199.5	21.3
3 & 4. Winterkill mix, cereal rye	199.5	21.2

These results mirror those from a 2017 trial conducted with Brant Soil and Crop Improvement Association (unpublished). In that trial, corn was planted into rye drilled the previous October at 40 lbs/ac. The rye was terminated 3-4 days prior to corn planting and achieved a similar amount of growth. In this 2017 trial, the corn planted into standing rye yielded the same as the treatment terminated by herbicide three weeks before planting.

As Practical Farmers of Iowa (PFI) have shown through on-farm trials, planting corn green into cereal rye often causes a yield reduction (5% on average) relative to early termination or no rye. Disease transfer, allelopathy and nitrogen tie-up are all potential contributors. Growers in Iowa routinely achieve large rye cover crops ahead of corn planting compared to Ontario, especially when termination is delayed until corn planting. PFI's trials show a negative correlation between crop heat units accumulated before corn planting and crop yield. In other words, the less heat a rye cover crop receives, the smaller it stays, and the less its negative yield impact on corn. Cooler spring temperatures in Ontario relative to Iowa may limit rye growth and naturally minimize yield reductions under some circumstances, such as those at Boston-2022. An upfront nitrogen rate over 80 lbs-N/ac at Boston-2022 may also have helped to ensure that nitrogen tie-up was not a limitation.

For the lowest risk to corn yield, rye should be terminated 10-14 days before corn planting, when 12 inches in height or less. Another approach to minimizing risk is to increase the physical distance between rye and corn seedlings. This can be achieved by strip-tillage. It can also be done by blocking drill runs and leaving gaps in the stand of cereal rye where corn can be planted the following spring. This technique has been shown to reduce disease transfer and lessen corn yield reductions relative to solid-seeding rye in some research. Ontario trials on this approach has been conducted by the University of Guelph (2020-2022) and it has also shown a trend toward lower reductions in corn yield (personal communication).

Summary:

The purpose of these trials was to evaluate a variety of potential overwintering cover crop options ahead of corn. Three different cover crop options were evaluated over two seasons: crimson clover, Austrian winter pea and cereal rye. The performance of Austrian winter pea and crimson clover as part of a mixture was disappointing. Oats outcompeted the legumes and limited fall growth, which highlighted the importance of species selection, seeding rates and fertility management if growth of overwintering species is desired. Overwintering of the legumes, especially of Austrian winter pea, was poor. On the other hand, cereal rye established well in 2021 and overwintered to provide a relatively uniform stand ahead of corn planting in 2022. It proved itself to be the most dependable of the cover crop options evaluated for overwintering and spring growth.

No overwintering cover crop evaluated impacted corn yield, either negatively or positively. The cooperating farmer reported in 2021 that the presence of live roots (mostly volunteer wheat) helped the soil work up very nicely on his spring refresh tillage pass. In 2022, the roots of cereal rye held the soil together such that spring strips were chunkier and not as wide. Although there was no corn yield impact, the farmer reported added anxiety from managing a fast-growing cereal ahead of corn planting. These types of human factors must be weighed against the benefits of including an overwintering species within cover crop mixtures ahead of corn.

Next Steps:

A similar trial evaluating overwintering cover crops before corn in a strip-till system was conducted in 2021 and results are reported in a separate Crop Advance report titled “Evaluating overwintering cover crops options in strip-till corn: Part 1 (Haldimand County).” Future research should evaluate mixtures that enable more vigorous growth of overwintering legumes.

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Location of Project Final Report:

This is the final project report.