2019

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THE UNIVERSITY OF VERMONT EXTENSION

**2019 INTERSEEDING COVER CROPS INTO WIDE-ROW CORN SILAGE**

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There has been increased interest in interseeding cover crops into corn. Cover cropping is a way to prevent soil erosion, maintain and/or improve soil nutrients, improve soil aggregation, prevent nutrient loss from runoff, and increase water retention. Such soil improvements can promote conditions that add resiliency to a crop, especially in light of extreme weather patterns that may affect yields. Interseeding can be beneficial by providing year round ground coverage and maximizing a short growing season by interseeding early to allow for full cover crop growth. It can be difficult to grow a successful cover crop, given other demands from a farm operation and weather limitations. One challenge that farmers face when trying to implement interseeding is establishing the cover crops into dense rows of corn. Shading by corn plants restricts cover crop growth especially as the season progresses. Traditionally corn is planted in dense 30-in. rows to maximize yields and decrease weed pressure. In 2018, Practical Farmers of Iowa conducted on-farm research trials to study the effect of wide rows (60-inch) on corn grain yields and cover crop biomass, and researchers saw mixed results (Gailans, 2018). This innovative practice may be a viable solution for farmers in the northeast but research needs to be conducted to determine the impact of wide rows on corn silage yield and quality and cover crop biomass. In 2019, the University of Vermont Extension Northwest Crops and Soils Program initiated a trial to examine the impact of corn row spacing on interseeded cover crop success, and corn yield and quality here in the northeast.

## MATERIALS AND METHODS

The experimental design was a randomized complete block with split plots and 4 replicates. Main plots were three combinations of row widths and corn populations (Table 1). The subplots were three different types of cover crops interseeded into corn; varietal information and seeding rate are provided in Table 2 below. Plots were 20’ x 30’.

**Table 1. Treatment descriptions for wide row corn trial, Alburgh, VT, 2019.**

| Treatment | Row widths | Corn populations |
|---|---|---|
| | in. | plants $ac^{-1}$ |
| 60-25 | 60 | 25,000 |
| 30-30 | 30 | 30,000 |
| 30-34 | 30 | 34,000 |

Specifics of the trial management are included in Table 3. The soil type at the Alburgh location is a Covington silty clay loam. The seedbed was prepared with spring disking followed by a spike tooth harrow. The previous crop was corn grain.

Plots were planted on 30-May with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA) at a rate of 49,000 seeds $ac^{-1}$. On 5-Jul, plots with 30-in. row spacing were thinned to either 30,000 or 34,000 plants $ac^{-1}$ depending on treatment; plots with 60-in. spacing were not thinned. Plots consisted of 8 rows of corn 30 inches apart or 4 rows of corn 60 inches apart. Cover crops were interseeded into corn on 5-Jul and 9-Jul.

**Table 2. Cover crop information for wide row corn trial, Alburgh, VT, 2019.**

| Cover crop | Seeding rate lbs $ac^{-1}$ | Species |
|---|---|---|
| Cow pea | 60 | VNS |
| Summer solar mix | 50 | cow pea 'Iron Clay', buckwheat 'VNS', sunn hemp ''VNS', Peredovik sunflower |
| Mix | 30 | Annual ryegrass, tillage radish, red clover |

Photosynthetic Active Radiation (PAR) was measured using a LI-COR LI-191R Line Quantum Sensor equipped with a LI-1500 GPS (Lincoln, NE) enabled data logger. In each plot two readings were taken, one above the corn canopy to capture the total available sunlight, and one under the canopy at approximately ground level in the center of the plot. These two measures were used to calculate PAR canopy infiltration (%). On 27-Sep, cover crop samples were taken, by collecting two 0.25 $m^2$ quadrats per plot. Samples were weighed and dried to determine yield and dry matter content. On 30-Sep, the corn was harvested with a John Deere 2-row chopper and a wagon fitted with scales. An approximate 1 lb subsample was taken from each plot and dried to calculate dry matter content. The dried subsamples were ground on a Wiley sample mill to a 2mm particle size and to 1mm particle size on a cyclone sample mill from the UDY Corporation. The samples were then analyzed for quality at the University of Vermont Cereal Testing Lab (Burlington, VT) with a FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer.

**Table 3. Wide row corn agronomic and trial information, Alburgh, VT, 2019.**

| Location | Borderview Research Farm Alburgh, VT |
|---|---|
| **Soil type** | Covington silty clay loam |
| **Previous crop** | Corn grain |
| **Plant population (seeds $ac^{-1}$)** | 25,000 – 60 in<br>34,000 – 30 in<br>30,000 - 30 in |
| **Corn variety** | NK8618 (Roundup Ready) - 86RM |
| **Plot size (ft.)** | 20 x 30 |
| **Planting date** | Corn: 30-May<br>Cover crop: 5-Jul & 9-Jul |
| **Tillage operations** | Spring disk, spike tooth harrow |
| **Starter fertilizer (gal $ac^{-1}$)** | 5 (9-18-9) |
| **Additional fertilizer (lbs $ac^{-1}$)** | 200 (10-20-20) |
| **Harvest date** | Cover crop: 27-Sep<br>Corn: 30-Sep |

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) content of forages. The CP content is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility (NDFD). This analysis can be conducted over a wide range of incubation periods from 30 to 240 hours. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDFD. Forages with increased NDFD will result in higher energy values and, perhaps more importantly, increased forage intakes. Forage NDFD can range from 20 – 80% NDF. The undigested NDF (uNDF) is the residue after fermentation for a given amount of time, from 30 to 240 hours. 240-hr uNDF is typically used for forages as it represents the indigestible fiber portion of the total DM content.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and hybrids were treated as fixed. Hybrid mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. Yield data and stand characteristics were analyzed using the PROC MIXED procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and application treatments were treated as fixed. Treatment mean pairwise comparisons were made using the Tukey-Kramer adjustment. Treatments were considered different at the 0.10 level of significance. At the bottom of each table, a level of significance is presented for each variable (i.e. yield). Treatments that differed at a level of significance >0.10 were reported as being not significantly different. Treatments within a column with the same letter are statistically similar. In the example, treatment C is significantly different from treatment A but not from treatment B. This means that these treatments did not differ in yield. The same letter indicates that treatment B was not significantly lower than the top yielding treatment C, indicated in bold.

| Treatment | Yield |
|---|---|
| A | $6.0^{b}$ |
| B | $7.5^{a}$ |
| C | **$9.0^{a}$** |
| **Level of significance** | <0.10 |

# RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4). Overall the season began cooler and wetter than normal but became hot and dry in the middle of the summer. The month of July brought above normal temperatures and little rainfall. The longest period without rainfall in July lasted 12 days. This dry period, which occurred around the time corn plants were developing tassels and silks for pollination, may have negatively impacted corn plant growth and productivity. This was evident in smaller than normal ears and poor tip fill experienced in corn fields around the region. However, these warm conditions did provide corn with well-needed Growing Degree Days (GDDs). Although the season was relatively cool a total of 2254 GDDs accumulated May-Sep, 42 above normal.

**Table 4. Weather data for Alburgh, VT, 2019.**

| **Alburgh, VT** | May | June | July | August | September |
|---|---|---|---|---|---|
| Average temperature (°F) | 53.3 | 64.3 | 73.5 | 68.3 | 60.0 |
| Departure from normal | -3.11 | -1.46 | 2.87 | -0.51 | -0.62 |
| | | | | | |
| Precipitation (inches) | 4.90 | 3.06 | 2.34 | 3.50 | 3.87 |
| Departure from normal | 1.45 | -0.63 | -1.81 | -0.41 | 0.23 |
| | | | | | |
| Growing Degree Days (50-86°F) | 189 | 446 | 716 | 568 | 335 |
| Departure from normal | -9 | -29 | 76 | -13 | 17 |

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Measurements of light infiltration began at the time of interseeding (9-Jul) and continued until 9-Sep (Figure 1). Light infiltration was highest for 60-in row widths until 6-Aug. In August, light infiltration was below 20% for both row widths but increased slightly as corn began to dry down and become more mature.

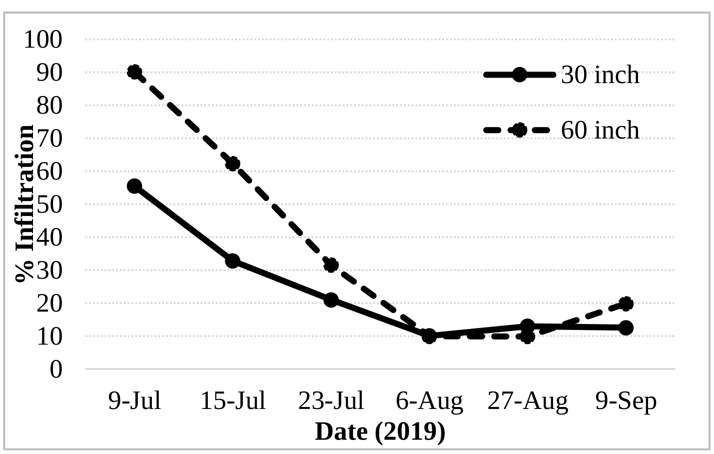


**Figure 1. Percent light infiltration through canopy to soil surface by row width, Alburgh, VT, 2019**

### *Cover crop by row spacing interaction*

There was a significant interaction (p=0.0304) between row width and cover crop treatment for predicted milk yield (lbs) per acre (Figure 2). The corn silage grown in combination with the Summer Solar cover crop mixture resulted in the highest predicted lbs of milk per acre for the 60-25 and the 30-34 treatment. Interestingly, the annual ryegrass/radish/clover mix resulted in the highest milk per acre for the 30-30 treatment and the lowest milk per acre for the 60-25 and 30-34 treatments. This difference indicates that the Summer Solar mix may have contributed more to overall yield/quality in the 60-in rows compared to the 30-inch rows. This makes sense as the Summer Solar mix contained species, such as sunflower, that may have actually provided some additional yield in the sider row. The ryegrass/radish mixture was shorter and with less biomass, hence likely contributing less in the case of the 60-in rows. There were no significant interactions between other harvest or quality measures.

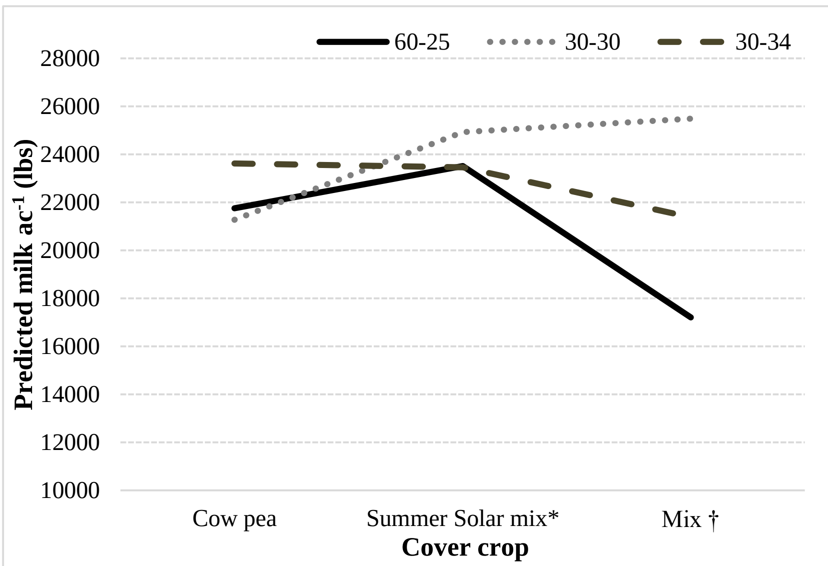


**Figure 2. Predicted milk ac$^{-1}$ for each cover crop type by row width/population treatment, Alburgh, VT, 2019.**

### *Cover crop results*

There were significant differences in dry matter yield between cover crop types (Table 5). All three cover crop types were significantly different from one another. Cow peas had the highest dry matter yield (1397 lbs ac$^{-1)}$ and that was almost 3 times more than the lowest yielding cover crop, which was the mix of annual ryegrass, tillage radish, and red clover (502 lbs ac$^{-1}$).

**Table 5. Impact of cover crop type on cover crop yield, Alburgh, VT, 2019.**

| Cover crop ŧ | Dry matter yield |
|---|---|
| | lbs ac$^{-1}$ |
| Cow pea | **1397**[a]† |
| Summer Solar mix* | 1017[b] |
| Mix † | 502[c] |
| *p* value | <.0001 |
| Trial mean | 1035 |

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold**.
ŧ Cow pea 'Iron Clay'; Summer Solar mixture, cowpea 'Iron Clay', buckwheat 'VNS', sunn hemp "VNS', Peredovik sunflower; Mix, annual ryegrass 'VNS', tillage radish 'Ground Hog', red clover 'Mammoth'.

Cover crop type had no significant impact on corn harvest yield or quality (Table 6). The corn yields averaged 21.5 tons per acre with an average dry matter of 41.2%. The only quality parameter that was significantly different between cover crop treatments was the predicted milk (lbs) ac$^{-1}$. The summer solar mix had a predicted milk yield of 23,972 lbs ac$^{-1}$, which was statistically similar to the cow pea treatment.

**Table 6. Impact of cover crop type on corn harvest and quality, Alburgh, VT, 2019.**

| Cover crop ŧ | DM | Yield, 35% DM | Starch | Crude protein | Lignin | Ash | ADF | NDF | 24-hr NDFD | 48-hr NDFD | 240-hr uNDF | Milk | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | tons ac$^{-1}$ | -------------------------% DM---------------------- | | | | | | -----% NDF---- | | % DM | lbs ton$^{-1}$ | lbs ac$^{-1}$ |
| Cow pea | 41.0 | 21.6 | 29.5 | 8.24 | 2.65 | 4.57 | 26.3 | 46.7 | 52.6 | 63.7 | 12.2 | 2937 | 22222[ab]† |
| Summer Solar mix* | 40.7 | 22.7 | 30.8 | 8.16 | 2.64 | 4.19 | 25.6 | 46.0 | 52.1 | 63.3 | 12.3 | 2981 | **23972[a]** |
| Mix † | 41.9 | 21.0 | 32.2 | 8.07 | 2.62 | 4.09 | 24.8 | 44.7 | 52.3 | 64.3 | 11.5 | 2972 | 21359[b] |
| *p* value | NS¥ | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.0803 |
| Trial mean | 41.2 | 21.5 | 30.8 | 8.16 | 2.64 | 4.29 | 25.6 | 45.8 | 52.3 | 63.7 | 12.0 | 2963 | 22518 |

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold**.
ŧ Cow pea 'Iron Clay'; Summer Solar mixture, cowpea 'Iron Clay', buckwheat 'VNS', sunn hemp "VNS', Peredovik sunflower; Mix, annual ryegrass 'VNS', tillage radish 'Ground Hog', red clover 'Mammoth'.
¥NS: no significant difference at p=0.10.

### *Row width and population results*

There was a significant impact on cover crop yield by row width and population (Table 7). The cover crops grown in the 60-25 treatment had the highest dry matter yield at 1924 lbs ac$^{-1}$. Cover crops in the 60-in. rows yielded almost 3 times more than either of the other two treatments. There was no significant difference between the 30-in. rows with a corn population of 30,000 plants $ac^{-1}$ and the rows with 34,000 plants $ac^{-1}$.

**Table7. Impact of row width and population on cover crop yield, Alburgh, VT, 2019.**

| Treatment | DM yield |
|---|---|
| | lbs $ac^{-1}$ |
| 60-25 | **1924**[a†] |
| 30-30 | 678 [b] |
| 30-34 | 502[b] |
| *p* value | <.0001 |
| Trial mean | 1035 |

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold**.

Row width and plant population significantly impacted corn yields (Table 8). The 30-in. rows with 30,000 plants $ac^{-1}$ had the highest yield at 23.1 tons $ac^{-1}$, and that was statistically similar to the 30-in. rows of 34,000 plants $ac^{-1}$ (22.3 tons $ac^{-1}$). This indicates that similar corn silage yields can be obtained with less seed, potentially an economic savings to the farmer. The corn grown in 60-in rows yielded 2 to 3 tons less per acre compared to 30-in row corn. There was a significant difference in predicted milk (lbs) $ac^{-1}$ between row width and population treatments. The 30-in. rows with 30,000 plants $ac^{-1}$ had a predicted 23,899 lbs $ac^{-1}$, which was statistically similar to the 30-in. rows with 34,000 plants $ac^{-1}$.

**Table 8. Corn harvest measures and quality by treatment, Alburgh, VT, 2019.**

| Treatment | DM | Yield, 35% DM | Starch | Crude protein | Lignin | Ash | ADF | NDF | 24-hr NDFD | 48-hr NDFD | 240-hr uNDF | Milk | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | tons $ac^{-1}$ | ----------------------% DM--------------------- | | | | | | -----% NDF----- | | % DM | lbs $ton^{-1}$ | lbs $ac^{-1}$ |
| 60-25 | 40.7 | 19.8[b] | 32.2 | 8.24 | 2.58 | 4.26 | 25.0 | 44.6 | 52.3 | 64.6 | 11.7 | 3001 | 20829 [b†] |
| 30-30 | 41.1 | **23.1**[a] | 29.6 | 8.27 | 2.63 | 4.31 | 26.0 | 46.5 | 52.6 | 63.7 | 12.1 | 2959 | **23899** [a] |
| 30-34 | 41.8 | 22.3[a] | 30.6 | 7.96 | 2.71 | 4.29 | 25.6 | 46.2 | 52.1 | 62.9 | 12.3 | 2930 | 22825 [a] |
| *p* value | NS ƚ | <0.05 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | <0.05 |
| Trial mean | 41.2 | 21.5 | 30.8 | 8.16 | 2.64 | 4.29 | 25.6 | 45.8 | 52.3 | 63.7 | 12.0 | 2963 | 22518 |

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold**.

ƚ NS: no significant difference at p=0.10.

## DISCUSSION

In 2019, the interseeded cover crops produced more biomass when planting into wide row corn. Corn planted with 60-in. row-widths had almost 3 times more cover crop biomass by the time the corn was harvested in late September. While all cover crop types in this trial did better with 60-in. spacing, the cow peas had the highest dry matter yield compared to the summer solar and cover crop mix. One of the challenges for farmers of integrating wider row corn, is the potential to decrease corn yields in a given area compared to conventional 30-in. row-widths. Overall, corn yields were higher in the 30-in. rows compared to the 60-in. rows. The corn yields were not impacted by cover crop type. Corn quality was not impacted by row spacing or by cover crop type. When implementing wide row-widths, farmers need to consider some factors when making management decisions. In corn that has been interseeded with cover crops, farmers cannot go through rows to spray or cultivate weeds once cover crops have established or else the plants can get damaged. Wider rows also do not suppress weeds as well as densely packed rows. The light infiltration was higher in the wider rows which may lead to higher weed biomass, but if cover crops establish better in wider rows as was seen in this trial, then the cover crops can be a viable weed control strategy. Farmers may also have to plant corn at a higher seeding rate in 60-in. rows to account for the decrease in rows per acre. Further investigation on other corn row widths should be investigated as yield decline may be less severe in 36 or 42 in rows. These data only represent one year of research at one location. More research, including on farm trials needs to be done for 60-in. row-widths to be a viable option for farmers.

## LITERATURE CITED

Gailans, S. 2018. Planting corn in 60-in. row-widths for interseeding cover crops. Practical Farmers of Iowa Cooperators' Program, Ames, IA. https://practicalfarmers.org/research/planting-corn-in-60-in-row-widths-for-interseeding-cover-crops/

## ACKNOWLEDGEMENTS

UVM Extension Northwest Crops and Soils Program would like to thank Ben & Jerry's for their generous support for this project. A special thanks to Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial as well as John Bruce, Catherine Davidson, Hillary Emick, Haley Jean, Shannon Meyler, and Lindsey Ruhl for their assistance with data collection and entry. We would also like to thank the seed companies for their seed and cooperation in these study. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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