2021 Integrating Solar Corridors in Corn Silage Production Systems to Meet Agronomic & Conservation Goals

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2021 INTEGRATING SOLAR CORRIDORS IN CORN SILAGE PRODUCTION SYSTEMS TO MEET AGRONOMIC & CONSERVATION GOALS

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There has been increased interest in interseeding as a strategy to integrate cover crops into corn silage systems earlier in the season to maximize the conservation and ecological benefits. Cover cropping can improve soil health and minimize soil and nutrient losses to the environment. Farmers are also selecting cover crop species for specific value-added benefits. One of these targeted benefits is that it can be used as forage after the cash crop harvest. This can increase the tangible benefits while potentially decreasing additional costs or inputs for the farmer. However, there are several challenges limiting farmer adoption and success with interseeding cover crops. Interseeding when corn is between the V2 to V6 growth stage is preferable because after corn has reached the V6 stage, most seeding equipment is not tall enough, increasing the risk of damaging the corn crop. This requires owning or having access to specialized cover crop interseeding equipment. Another challenge is that typical corn row spacings create shade that limits cover crop establishment and growth. The solar corridor system is an alternative cropping system that is designed to increase the availability of sunlight to all rows, which can improve crop growth and nutrient cycling in the soil. Increasing the row width of corn silage may improve interseeded cover crop growth, but it is still important to maintain cash crop yields. Practical Farmers of Iowa found that over three years of on-farm trials in grain corn, 60" rows produced significantly more cover crop biomass, but reduced grain yields by an average of 12% (Gailans, 2018, 2019, 2020). The University of Vermont Extension Northwest Crops and Soils Program (UVM Extension NWCS) has conducted two years of research trials in corn silage, comparing corn yield and cover crop biomass in 30" and 60" rows, and found similar results. Increasing corn row widths to 36" or 40" may minimize the yield loss while still allowing for successful cover crop establishment. In 2021, UVM Extension NWCS conducted two field experiments and an on-farm research trial to study the effect that corn row width has on silage yields and cover crop or forage crop establishment.

MATERIALS AND METHODS

The field trials were conducted at Borderview Research Farm, Alburgh, VT (Tables 1 and 2). Trial 1 evaluated the effect of corn row width on silage yields. Trial 2 evaluated the impact of corn row width on silage yield and quality, as well as biomass production of three interseeded forage crop treatments. The forage treatments can be found in Table 3 below. The on-farm research trial was conducted on a farm in St. Albans, VT and evaluated the effect of row width on corn silage yields (Table 4).

<u>Trial 1 – The impact of corn row width on silage yields</u>

The experimental design for Trial 1 was a randomized complete block design where the treatments were corn row widths (30", 36", 40" and 60" row spacings) and were replicated three times. Plots were 40' long and consisted of 4 rows. To accommodate wider row spacing, plot size was adjusted based on the corn row width. Plots were 10', 12', 14' and 20' wide for 30", 36", 40" and 60" spacing respectively.

In Trial 1, corn was planted on 18-May and 250 lbs. ac^{-1} of 10-20-20 was applied as starter fertilizer. The 30" and 60" plots were planted with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA). The 36" and 40" plots were planted with a Monosem 2-row precision air planter (Edwardsville, KS). All plots were planted to meet a target population of 30,000 plants ac^{-1}. All plots were interseed with a cover crop mixture of annual ryegrass (60%), red clover (30%) and tillage radish (10%) on 14-Jun. Cover crop biomass was not measured in this trial. On 17-Jun, plots were top-dressed with 24-12-18 at a rate of 400 lbs. ac^{-1}. Light intensity was measured using HOBO® pendant temperature and light sensors from Onset Computer Corporation (Bourne, MA). Sensors were set to log light information every 10 minutes and report light intensity in lumens ft^{-2}. Sensors were placed just above the soil surface between rows of corn. Corn was harvested on 16-Sep using a John Deere 2-row corn chopper and collected in a wagon fitted with scales to weigh the yield of each plot. An approximate 1 lb. subsample was collected, weighed, dried, and weighed again to determine dry matter content and calculate yield. Quality analyses were not conducted on the corn silage from Trial 1.

Table 1. Trial 1 management, Alburgh, VT, 2021.

Location	Borderview Research Farm - Alburgh, VT
Soil type	Benson rocky silt loam, over shaly limestone, 3-8% slopes
Previous crop	Grain corn
Replicates	3
Corn variety (Relative maturity)	Brevant B95V86AM (95 RM)
Row width (inches)	30, 36, 40, 60
Target population (plants ac^{-1})	30,000
Corn planting date	18-May
Tillage operations	Pottinger TerraDisc
Starter fertilizer (lbs. ac^{-1})	10-20-20 (250)
Herbicide (ac^{-1})	Roundup Power Max® (1 qt.); 14-Apr
Top dress fertilizer (lbs. ac^{-1})	24-12-18 (400); 17-Jun
Date of interseeding	14-Jun
Cover crop mixture	25 lbs. ac^{-1} Annual ryegrass (60%) Red clover (30%) Tillage radish (10%)
Corn harvest date	16-Sep

Trial 2 – The impact of corn row width on silage productivity and establishment of interseeded forages

The experimental design for Trial 2 was a randomized complete block with split plot design and replicated four times. Main plots were corn row width (30”, 40” and 60”) and split plots were interseeded forage treatments (alfalfa, orchardgrass/ alfalfa mix, and orchardgrass). All plots were 32’ long and consisted of 4 rows. To accommodate the wider row spacing, plots were 10’, 14’ and 20’ wide for 30”, 40” and 60” row spacing respectively.

In Trial 2, 300 lbs. ac^{-1} of 19-19-19 were applied on 6-Apr. Corn was planted on 19-May to meet a target population of 30,000 plants ac^{-1}. Seeding rate was adjusted based on row width. The 30” and 60” plots were planted with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA). The 40” plots were planted with a Monosem 2-row precision air planter (Edwardsville, KS). Plots were top-dressed on 17-Jun with 24-12-18 at a rate of 400 lbs. ac^{-1}. Cover crops were interseed on 18-

Jun, at a rate of 20 lbs. ac^{-1}. Prior to corn harvest, cover crop establishment was measured on 14-Sep. A $0.25m^2$ quadrat sample was taken between the center two rows of each plot, weighed, dried, and weighed again to determine dry matter content and calculate yield. In the 40" plots, cover crop establishment was not measured. On 22-Sep, corn from Trial 2 was harvested as noted in Trial 1. Then subsamples were ground to 2mm using a Wiley sample mill and then to 1mm using a cyclone sample mill (UDY Corporation). The samples were analyzed at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) with a FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. The NIR procedures and corn silage calibration from Dairy One Forage Laboratories (Geneva, NY) were used to determine crude protein (CP), starch, lignin, acid detergent fiber (ADF), ash corrected neutral detergent fiber (aNDFom), total digestible nutrients (TDN), net energy lactation (NE_L), undigestible neutral detergent fiber (uNDFom; 30h), and neutral detergent fiber digestibility (NDFD; 30h).

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. Total digestible nutrients (TDN) is a measure of the energy value in a feedstuff. Neutral detergent fiber expressed on an organic matter basis (aNDFom) is used when high ash content leads to ash remaining in the fiber residue. 30-hr uNDFom is the undigestible NDF on an organic matter basis after 30 hours in rumen fluid. This can cause an overvaluation of the NDF and can cause nutritionists to underfeed fiber.Net energy lactation (NEL) is estimated energy value of feed used for maintenance plus milk production during dairy cow lactation or last two months of gestation for dry, pregnant cows.

Table 2. Trial 2 management, Alburgh, VT, 2021.

Location	Borderview Research Farm - Alburgh, VT
Soil type	Covington silty clay loam, 0-3% slopes
Previous crop	Corn silage
Replicates	4
Corn variety (Relative maturity)	Brevant B95V86AM (95 RM)
Row width (inches)	30, 40, 60
Target population (plants ac^{-1})	30,000
Corn planting date	19-May
Tillage operations	Pottinger TerraDisc
	Roundup Power Max® (1 qt.); 27-May

Herbicide (ac^{-1})	Roundup Power Max® (1qt.) and Resolve® Q (1.5oz); 2-Jun Roundup Power Max® (1qt.); 14-Jun
Top dress fertilizer (lbs. ac^{-1})	24-12-18 (400); 17-Jun
Date of interseeding	18-Jun
Cover crop harvest date	14-Sep
Corn harvest date	22-Sep

Table 3. Trial 2 cover crop treatments, Alburgh, VT, 2021.

Cover crop treatment	Seeding rate (lbs. ac^{-1})
Organic 309 alfalfa	20
Echelon orchardgrass/ Organic 309 alfalfa	8 12
Echelon orchardgrass	20

On-farm research trial to evaluate the effect of row width on corn silage yields

In the on-farm research trial, corn was planted on 5-May using a John Deere 7200 planter. Row units were individually controlled by Ag Leader® SureDrive electric drives. The 30" rows were planted at a rate of 32,000 seeds ac^{-1} and the 60" rows at a rate of 60,000 seeds ac^{-1}. Starter fertilizer, 32-0-0, was applied at 8 gal ac^{-1}. Alfalfa was interseeded on 7-Jun at a rate of 20 lbs. ac^{-1}. On 1-Sep, corn population was measured by counting the number of plants in three 17.5' sections in both 30" and 60" plots. Corn yield was also measured by collecting and weighing the plants from three 17.5 sections in each plot. After weighing, 5 corn plants were ground through a woodchipper and an approximate 1lb subsample was collected, weighed, dried, and reweighed to determine dry matter content and yield. Subsamples were ground and analyzed for forage quality following the same procedures outlined for Trial 2. Cover crop establishment and growth was minimal due to very dry conditions during the growing season. As a result, cover crop biomass was not measured in this trial.

Table 4. On-farm trial management, St. Albans, VT, 2021.

Location	Tommary Holsteins - St. Albans, VT
Soil type	Copake fine sandy loam
Previous crop	Corn silage
Tillage	No-till
Rotation	5-year grass, 5-year corn with cover crop
Corn variety	Brevant B90R92Q (90 RM)
Plant population (seeds ac^{-1})	32,000 – 30". 60,000 – 60".
Planting date	Corn: 5-May Cover crop: 7-Jun
Cover crop (lbs. ac^{-1})	Alfalfa (20 lbs. ac^{-1})
Fall manure application (gal ac^{-1})	4,000
Starter fertilizer (gal ac^{-1})	32-0-0 (8)
Side dress fertilizer (lbs. ac^{-1})	46-0-0 (200)
Herbicide	Glyphosate and Dupont™ Resolve® Q
Corn harvest date	7-Sep

Data were analyzed using a general linear model procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. Variations in genetics, soil, weather, and other growing conditions can result in variations in yield and quality. Statistical analysis makes it possible to determine whether a difference between treatments is significant or whether it is due to natural variations in the plant or field. At the bottom of each table, an LSD value is presented for each variable (i.e., yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. This means that when the difference between two treatments within a column is equal to or greater to the LSD value for the column, there is a real difference between the treatments 90% of the time. Treatments within a column that have the same letter are statistically similar. In this example, treatment C was significantly different from treatment A, but not from treatment B. The difference between C and B is 1.5, which is less than the LSD value of 2.0 and so these treatments were not significantly different in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0 indicating the yields of these treatments were significantly different from one another. The letter 'a' indicates that treatment B was not significantly lower than the top yielding treatment, indicated in bold.

Treatment	Yield
A	6.0[b]
B	7.5[ab]
C	**9.0[a]**
LSD	2.0

RESULTS

Weather data were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 5) and on-farm in St. Albans, VT (Table 6). In Alburgh, temperatures were above normal in June and August, but over 4 degrees cooler than normal in July. A similar trend was seen in St. Albans. The region experienced drought during the growing season. By August, counties in northern Vermont were in moderate drought (D1) according to the U.S Drought Monitor. From May through September, Alburgh received 13.02 inches of rain, 6.27 inches below average. Likewise, St. Albans received 11.38 inches of rain, 7.43 inches less than the 30 year average. This season, in Alburgh, there were 2,613 Growing Degree Days (GDDs) and in St. Albans there were 2,639 GDDs. The total GDDs are within the range of required GDDs for corn silage (2,200 to 2,800).

Table 5. Weather data for Trial 1 and 2, Alburgh, VT, 2021.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	58.4	70.3	68.1	74.0	62.8
Departure from normal	-0.03	2.81	-4.31	3.25	0.14
Precipitation (inches)	0.66	3.06	2.92	2.29	4.09
Departure from normal	-3.10	-1.20	-1.14	-1.25	0.42
Growing Degree Days (50-86°F)	334	597	561	727	394
Departure from normal	33.0	73.0	-134	85.0	7.00

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Table 6. Weather data for on-farm trial, St. Albans, VT, 2021.

St. Albans, VT	May	June	July	August	September
Average temperature (°F)	56.7	71.4	68.7	73.6	63.6
Departure from normal	0.72	6.3	-1.44	5.56	3.43
Precipitation (inches)	0.87	2.5	2.99	2.74	2.28
Departure from normal	-2.52	-1.13	-1.23	-1.17	-1.38
Growing Degree Days (50-86°F)	313	615	580	708	423
Departure from normal	21	128	-50	126	63

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Trial 1 – The impact of corn row width on silage yields

Corn silage yields were significantly impacted by corn row width (Table 7). Corn planted in 30" rows produced the highest yield at 35% DM, 25.5 tons ac^{-1}. This was statistically similar to the corn planted in 36" rows. The 60" corn resulted in the lowest yields, 11.4 tons ac^{-1}, which is less than half the yield of the top performer.

Table 7. Corn silage yield by row width in Trial 1, Alburgh, VT, 2021.

Row width	**Yield, 35% DM**
	tons ac^{-1}
30-in.	25.5^{a†}
36-in.	20.7^{ab}
40-in.	17.1^{bc}
60-in.	11.4^{c}
LSD (p=0.10) ‡	6.65
Trial mean	18.7

†Treatments within a column with the same letter are statistically similar.
‡LSD –Least significant difference at p=0.10.

Light sensors were placed in between the rows of corn to measure the intensity of light reaching the soil surface. The light intensity, measured in accumulated lumens ft^{-2}, was similar for all row widths during the first two weeks after the cover crop was interseeded (Figure 1). By 14-Jul, a month after interseeding, the 60" rows had the most light reaching the soil surface, followed by the 40", 36", and then 30" row widths. The 30" rows consistently had the lowest light intensity up through the beginning of September. By mid-August, there was little difference in accumulated lumens ft^{-2} between 36" and 40" rows. Then by the end of August, the accumulated lumens ft^{-2} was nearly the same for all row widths except 30" rows, which about 1.3 times lower. The light intensity was not measured up to corn harvest, 16-Sep, but the data indicate that the accumulated lumens ft^{-2} may have been highest in the 36" rows at harvest. The light intensity in the 60" rows began to level out in mid-August, likely due to the increased cover crop growth. The high cover crop biomass in the 60" rows prevented light infiltration to the soil later in the season.

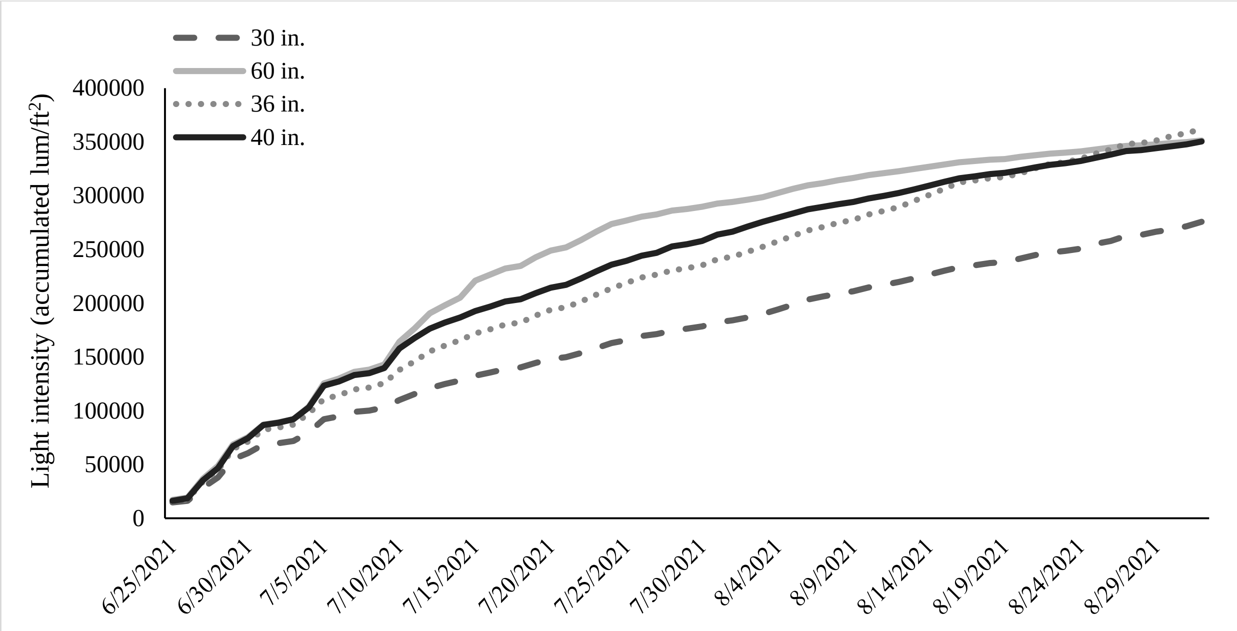

Figure 1. Light intensity at the soil surface by row width in Trial 1, Alburgh, VT, 2021.

Trial 2 – The impact of corn row width on silage productivity and establishment of interseeded forages

Interactions

There was a significant interaction (p=0.0201) between corn row width and cover crop treatment (Figure 2). All three cover crop treatments had higher dry matter yields when interseeded into 60” rows compared to 30” rows. The orchardgrass/alfalfa mix had the highest yield in the 60” plots, but the alfalfa had the highest yield in the 30” plots. The dry matter yield of the orchardgrass/alfalfa mix was 6.4 times greater in 60” rows compared to 30” rows. The orchardgrass and alfalfa treatments alone were only 3.2 and 1.5 times greater in the 60” rows. The orchardgrass did not establish well when planted alone in either of the row spacings but was much more successful when planted with the alfalfa. Orchardgrass is a good companion plant for alfalfa and can improve stand yields, as seen in this trial.

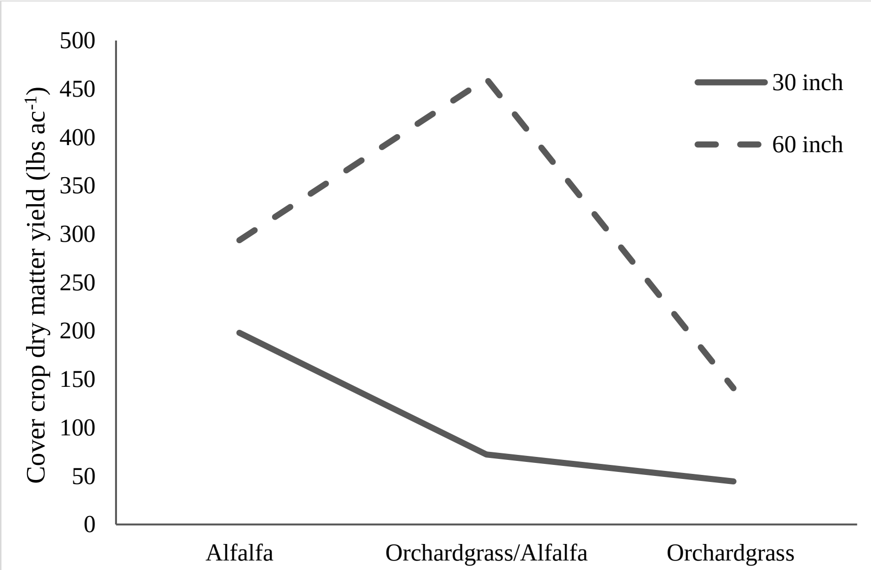

Figure 2. Cover crop DM yield for each cover crop treatment by corn row width in Trial 2, Alburgh, VT, 2021.

Impact of Row Width

There was a significant difference in harvest population between the treatments (Table 8). The 30” rows had a significantly higher population, 39,122 plants ac^{-1}, than the other row widths. The population of the 40” rows (19,738 plants ac^{-1}) was about half the population of the 30” rows. This is likely due to the different corn planters used and difficulty reaching the target seeding rate at planting in the 40” rows. Silage yields at 35% DM were highest in 30” rows, 33.1 tons ac^{-1}, likely due to that higher population at harvest. Even with the lowest harvest population, the 40” rows had the second highest yields (23.2 tons ac^{-1}) and was statistically higher than the 60” rows (21.4 tons ac^{-1}). The corn hybrid planted (B90R92Q) in this trial was a semi-flex ear variety. Flex ear hybrids are more cost effective when planted at lower seeding rates as they can adjust corn ear size relative to plant population to remain high yielding despite fewer plants. This may explain why 40” plot yields were high even with such low populations at harvest.

Row width had a significant impact on some of the silage quality characteristics (Table 9). The 40” rows had the highest TDN content (65.8%) but was statistically similar to the 30” rows (65.5%). The 30-hr uNDFom content in the 40” rows (15.5%) was significantly lower than the other row widths. The 40” rows also had a 30-hr NDFD content (58.1%) that was statistically greater than the other rows widths. The 40” rows had the highest predicted milk yield per ton of dry matter (DM), 3181 lbs. ton^{-1} and that was statistically similar to the 60” rows (3112 lbs. ton^{-1}). When differences in yield are considered, the 30" rows had the highest milk yield per acre (34,235 lbs. ac^{-1}) and was significantly greater than the other row widths. Flex ear hybrids can change the size of ears formed depending on resources available (i.e. populations) and we would expect there to be a higher proportion of ear material compared to the less digestible fiber materials in the 40” row spacing where the populations were very low. The 40” rows produced silage that had little quality differences compared to the 30” rows, even when the overall yield in the 30” rows was that there could be a higher proportion of ear material as a result of the flex ear characteristic.

Table 8. Corn silage yield and population by row width in Trial 2, Alburgh, VT, 2021.

Row width	Harvest population	Yield, 35% DM
	plants ac^{-1}	tons ac^{-1}
30-in.	39122[a†]	33.1[a]
40-in.	19738[c]	23.2[b]
60-in.	32384[b]	21.4[c]
LSD (p=0.10) ‡	2285	1.78
Trial mean	30415	25.9

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.

Table 9. Corn silage quality characteristics by row width in Trial 2, Alburgh, VT, 2021.

Row width	CP	ADF	aNDFom	Lignin	Starch	TDN	30-hr uNDFom	30-hr NDFD	NE_L	Milk	
	-----------------------------------% of DM------------------------------------							% of NDF	Mcal lb^{-1}	lbs. ton^{-1}	lbs. ac^{-1}
30-in.	7.58	21.1	37.7	2.40	36.9	65.5[a†]	17.4[b]	53.8[b]	0.690	2897[b]	34235[a]
40-in.	7.85	20.1	36.8	2.43	36.6	65.8[a]	15.5[a]	58.1[a]	0.694	3181[a]	25077[b]
60-in.	7.93	21.4	38.5	2.68	35.4	64.0[b]	17.1[b]	55.5[b]	0.669	3112[a]	25208[b]
LSD (p = 0.10) ‡	NS[¥]	NS	NS	NS	NS	1.39	1.38	2.06	NS	198	3543
Trial mean	7.78	20.8	37.6	2.50	36.3	65.1	16.6	55.8	0.684	3063	28173

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.
¥ NS – There was no statistical difference between treatments in a particular column (p=0.10).

Impact of Row Width and Forage Crop on Establishment

The cover crop yield was significantly impacted by row width (Table 10.) Cover crop yield was 2.8 times greater in the 60” rows compared to 30” rows.

Table 10. Cover crop yield by row width in Trial 2, Alburgh, VT, 2021.

Row width	Dry matter yield
	lbs. ac^{-1}
30-in.	105[b†]
60-in.	298[a]
LSD (p=0.10)‡	75.4
Trial mean	202

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.

There was a significant difference in forage yield between the treatments (Table 11). The orchardgrass/ alfalfa mix produced the highest yield, 266 lbs. ac^{-1}, but this was not significantly different from the alfalfa treatment. The yield of the orchardgrass was significantly less than the other two forage treatments.

Table 11. Dry matter yield by cover crop treatment in Trial 2, Alburgh, VT, 2021.

Cover crop	Dry matter yield
	lbs. ac^{-1}
Alfalfa	246[a†]
Orchardgrass/Alfalfa	266[a]
Orchardgrass	93[b]
LSD (p=0.10) ‡	92.4
Trial mean	202

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.

<u>On-farm research trial to evaluate the effect of row width on corn silage yields</u>

In the on-farm trial in St. Albans, there was not a significant difference in corn populations at harvest between the two row widths (Table 12). Since 60” row widths result in half the total number of rows in a field, the seeding rate was doubled to account for the loss of rows. These results indicate that the planting equipment used was able to accurately plant at a high seeding rate (60,000 seeds ac^{-1}) in the 60” rows. The average dry matter at harvest was 36.3%. Even though there were no differences in harvest population, there was a significant difference in yield. The 30” rows produced 3.2 tons ac^{-1} more than the 60” rows, with yields of 24.9 and 21.7 tons ac^{-1} respectively.

The corn row width had minimal impacts on the silage quality characteristics (Table 13). The ADF content was statistically lower in the 60” rows (21.3%) compared to the 30” rows (24.9%). The aNDFom content was also significantly lower in the 60” rows (36.9%). The 60” rows had statistically greater predicted milk yield per ton of dry matter (DM), 3275 lbs. ton^{-1}. When differences in yield are considered, there was no significant difference in the milk yield per acre between the 60” and 30” row widths.

Table 12. Corn harvest characteristics by row width, St. Albans, VT, 2021.

Row width	Harvest population	Harvest DM	Yield, 35% DM
	plants ac^{-1}	%	tons ac^{-1}
30-in.	28542	35.7	24.9[a†]
60-in.	28044	37.0	21.7[b]
LSD (p=0.10) ‡	NS[¥]	NS	2.51
Trial mean	28293	36.3	23.3

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.
¥NS- no significant difference at p=0.10.

Table 13. Corn silage quality characteristics by row width, St. Albans, VT, 2021.

Row width	CP	ADF	aNDFom	Lignin	Starch	TDN	30-hr uNDFom	30-hr NDFD	NE$_L$	Milk	
	--% of DM---							% of NDF	Mcal lb^{-1}	lbs. ton^{-1}	lbs. ac^{-1}
30-in.	8.03	24.9b†	41.7b	2.90	33.0	62.7	20.1	51.8	0.642	3115b	27218
60-in.	8.20	21.3a	36.9a	2.57	36.4	64.0	16.7	54.6	0.673	3275a	24888
LSD (p = 0.10) ‡	NS¥	3.19	2.39	NS	NS	NS	NS	NS	NS	122	NS
Trial mean	8.12	23.1	39.3	2.73	34.7	63.3	18.4	53.2	0.658	3195	26053

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.
¥NS- no significant difference at p=0.10.

DISCUSSION

The results from this season are consistent with what has been observed in the past two years of research at Borderview Research Farm. Since 2019, corn planted in 30" rows have produced significantly higher yields than 60" rows (Figure 3). One of the on-going challenges of planting corn in 60" rows is planting at a seeding rate high enough to make up for the wider row spacing. The seeding rate for 60" rows need to be about twice as high as the 30" rows in order to maintain number of plants per acre and reduce yield loss. This is likely one of the reasons why the wider rows produced lower yields. Not all equipment can plant at such high seeding rates. Variety selection is even more crucial when planting at such high populations, to ensure that plants will still produce good size ears even in dense rows. More research needs to be done on selecting hybrids that will perform well at high seeding rates. Flex ear hybrids have the potential to make up for lower populations and still produce adequate yields by increasing ear size when planted at those low seeding rates. Nonetheless, majority of corn silage yield comes from the stover and less plants per acre, or smaller plants, will likely result in less overall biomass. Even with the most appropriate variety it may be difficult to overcome the yield gap between 30" and 60" corn. Continuing to test row widths of 36" to 40" might lead to viable options.

The wider row spacing however, has led to significantly higher cover crop yields regardless of the cover crop treatments. Increased light infiltration between rows allows for better cover crop establishment and results in high biomass production. Planting corn in 36" and 40" rows may have the potential to minimize the yield loss while allowing successful cover crop establishment. Unfortunately, these large biomass and often tall diverse cover crop mixtures are largely removed during silage harvest. If the cover crop is an annual, it will no longer survive and will not provide ground cover. Hence, a low growing or perennial crop needs to be planted in the wider rows. In 2021, our team experimented with interseeding forage crops between the rows of corn. Ultimately, if forage can be established it could provide an incentive to incorporate wider rows of corn. If silage yields can be maintained, then farmers can begin to select their interseed cover crops for more targeted benefits. A growing number of farmers and researchers are interested in using interseeded crops as forage. The goal of this trial was to select perennial forage species that would begin establishing while the corn was growing and continue to grow the following spring. Orchardgrass and alfalfa are commonly used in Vermont, and these data suggest that the two species perform better when planted in a mixture than alone. More research needs to be done on selecting perennial forage species for interseeding into corn silage.

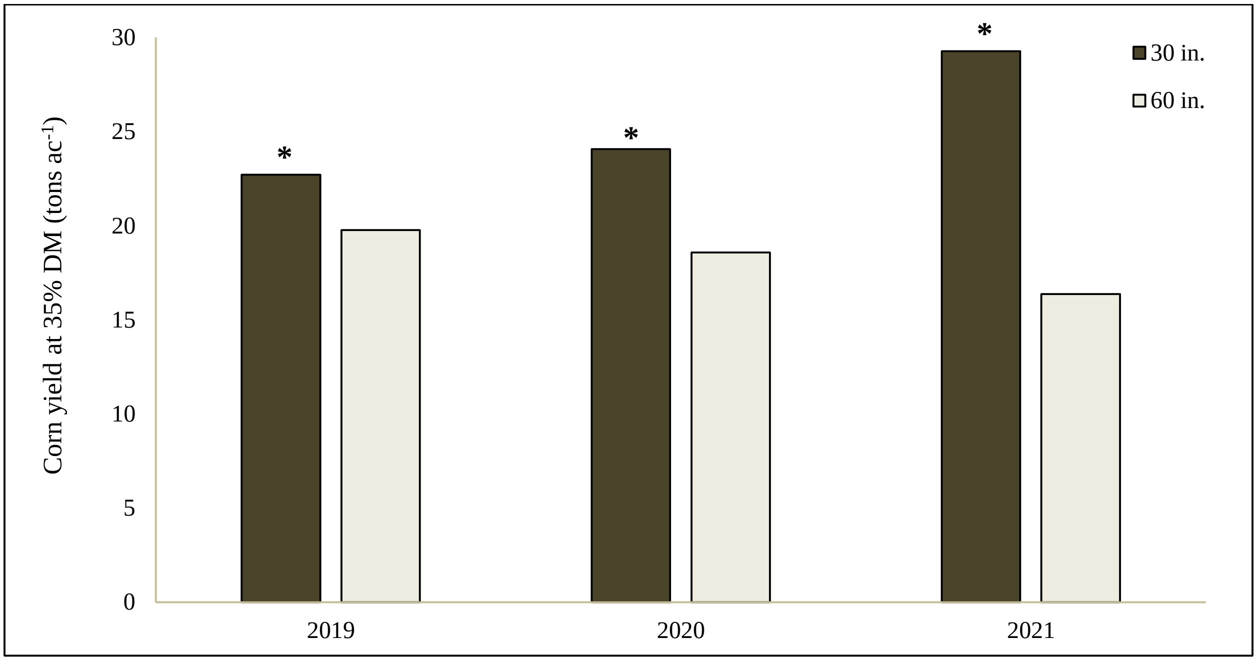

Figure 3. Corn silage yield in 30” and 60” rows by year, Alburgh, VT, 2019-2021. An asterisk (*) indicates a statistically significant (p=0.10) difference between treatments for that year.

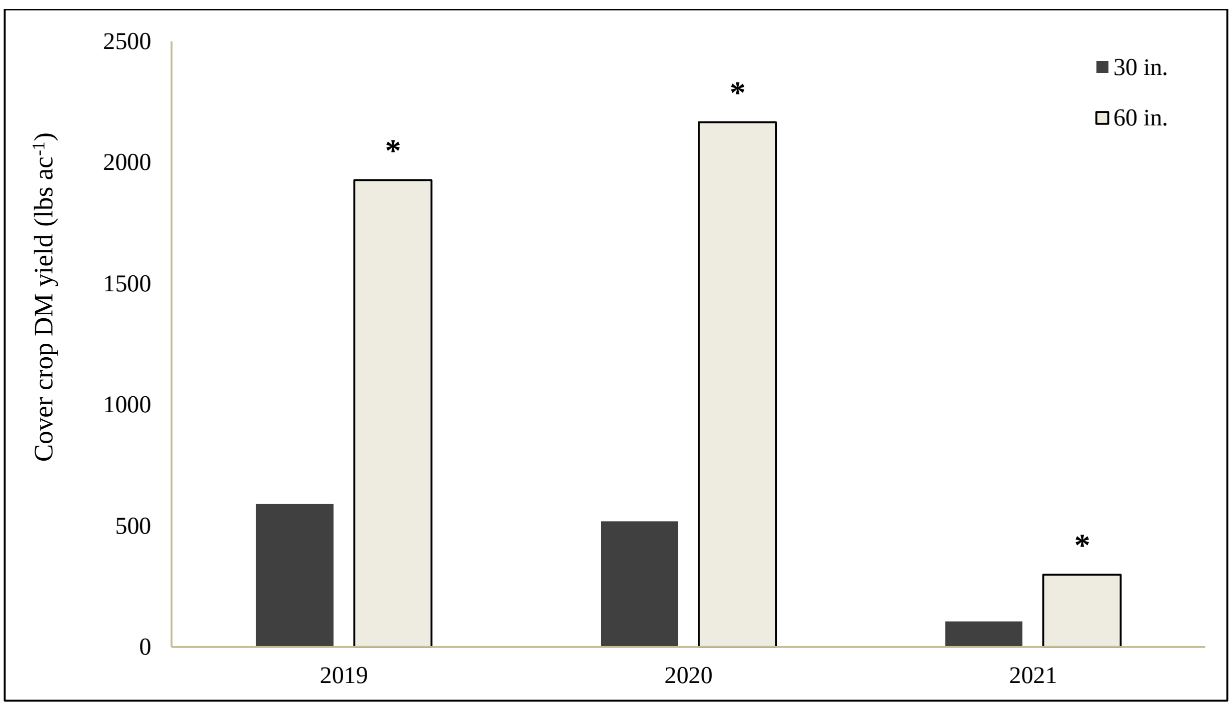

Figure 4. Cover crop yield in 30” and 60” rows by year, Alburgh, VT, 2019-2021. An asterisk (*) indicates a statistically significant (p=0.10) difference between treatments for that year.

LITERATURE CITED

Gailans, S., J. Boyer, F. Abels, C. Teachout, B. Kessel, H. Kessel and J. Johnson. 2018. Planting Corn in 60-in. Row-Widths for Interseeding Cover Crops. Practical Farmers of Iowa Cooperators' Program. https://practicalfarmers.org/research/planting-corn-in-60-in-row-widths-for-interseeding-cover-crops/ (accessed 10 Dec 2021).

Gailans, S., F. Abels, R. Alexander, N. Anderson, J. Boyer, J. Gustafson and M. Yoder. 2019. Planting Corn in 60-in. Row-Widths for Interseeding Cover Crops. Practical Farmers of Iowa Cooperators' Program. https://practicalfarmers.org/research/planting-corn-in-60-in-row-widths-for-interseeding-cover-crops-2/ (accessed 10 Dec 2021).

Gailans, S., F. Abels, N. Anderson, J. Olsen, T. Sieren, and M. Yoder. 2020. Planting Corn in 60-in. Row Widths for Interseeding Cover Crops. https://practicalfarmers.org/wp-content/uploads/2021/02/20.FC_.CC.Planting-corn-60-in.-rows-interseeding_FINAL.pdf (accessed 10 Dec 2021).

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