2022 Integrating Solar Corridors in Corn Silage Production Systems to Meet Agronomic & Conservation Goals

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2022 INTEGRATING SOLAR CORRIDORS IN CORN SILAGE PRODUCTION SYSTEMS TO MEET AGRONOMIC & CONSERVATION GOALS

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Interseeding is a strategy to plant cover crops directly into a growing crop of corn silage providing for earlier planting to hopefully maximize the conservation and ecological benefits of the cover crop. Farmers are interested in selecting cover crop species for specific value-added benefits. As an example, farmers are interested in using cover crops as a high-quality forage. This strategy can increase the direct benefit to 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 row spacings and plant populations 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. The ability to establish a perennial forage crop into the growing corn crop might provide additional value to the farm. The University of Vermont Extension Northwest Crops and Soils Program (NWCS) has conducted three years of research trials incorporating solar corridors into corn silage crop systems, comparing corn yield and cover crop biomass in different row spacings, and found that typical 30" row spacing produces significantly higher corn yields compared to 60" row spacing. Inversely, cover crop biomass significantly increases when interseeded into 60" rows compared to 30" rows. There is increasing interest from producers to incorporate alternative cropping systems, but these practices need to be fine-tuned, in order to maintain crop productivity and increase interseeded cover crop success. Increasing corn row widths to 36" or 40" may minimize the yield loss while still allowing for successful cover crop establishment. In 2022, UVM Extension NWCS conducted two field experiments and two on-farm research trials to study the effect that corn row width has on silage yields and cover crop and forage establishment.

MATERIALS AND METHODS

The field trials were conducted at Borderview Research Farm, Alburgh, VT. Trial 1 evaluated the effect of corn row width on silage yield and quality. Trial 2 evaluated the impact of corn row width on silage yield, as well as biomass production of three interseeded forage crop treatments. The on-farm research trials were conducted on farms in St. Albans, VT and in Enosburg Falls, VT and evaluated the impact of row width on corn yields and interseeded forage crop establishment.

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

The experimental design for Trial 1 was a randomized complete block design where the treatments were corn row widths (20", 30", 36", 40" and 60" row spacings) and were replicated six times (Table 1). 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 8', 10', 12', 14' and 20' wide for 20", 30", 36", 40" and 60" spacing respectively.

In Trial 1, the entire field was fertilized on 9-May with 200 lbs ac^{-1} of 7-18-36 and the corn was planted on 25-May. The 30" and 60" plots were planted with a John Deere MaxEmerge 1750 4-row planter (Moline, IL). The 20", 36" and 40" plots were planted with a custom-made planter that included John Deere plate row-units on an adjustable tool bar. All plots were planted to meet a target population of 30,000 plants ac^{-1}. To control weeds, Resolve®Q was applied at a rate of 1.5 oz ac^{-1} on 4-Jun. All plots were interseeded with a cover crop mixture of annual ryegrass (60%), red clover (30%) and tillage radish (10%) on 2- and 6-Jul. On 20-Jun, plots were top-dressed with 46-0-0 plus the inhibitor ContaiN MAX™ at a rate of 300 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 the light information every two hours and report light intensity in lumens ft^{-2}. Sensors were placed just above the soil surface between rows of corn and a control was placed outside of the corn rows. Corn plant population at harvest was assessed by counting the number of plants in the center two rows of each plot. Corn was harvested on 30-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. Cover crop biomass was not measured in this trial.

The dried forage 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, ash, 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).

Table 1. Trial 1 management, Alburgh, VT, 2022.

Location	Borderview Research Farm - Alburgh, VT
Soil type	Benson rocky silt loam, over shaly limestone, 3-8% slopes
Previous crop	Corn silage
Replicates	6
Corn variety (Relative maturity)	Pioneer P9608Q (96 RM)
Row width (inches)	20, 30, 36, 40, 60
Target population (plants ac^{-1})	30,000
Corn planting date	25-May
Tillage operations	Pottinger TerraDisc
Fertilizer (lbs. ac^{-1})	7-18-36 (200); 9-May
Herbicide (ac^{-1})	Resolve®Q (1.5 oz.); 4-Jun
Top dress fertilizer (lbs. ac^{-1})	46-0-0 (300) plus ContaiN MAX™; 20-Jun
Date of interseeding	2- and 6-Jul
	25 lbs. ac^{-1}

Cover crop mixture	Annual ryegrass (60%) Red clover (30%) Tillage radish (10%)
Corn harvest date	30-Sep

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

The experimental design for Trial 2 was a randomized complete block with split plot design and replicated four times (Table 2). Main plots were corn row widths (30", 40" and 60") and split plots were interseeded forage treatments (alfalfa, orchardgrass/ alfalfa mix, and orchardgrass). The forage treatment descriptions can be found in Table 3. All plots were 35' 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, the entire field was fertilized on 9-May with 200 lbs ac^{-1} of 7-18-36, and corn was planted on 25-May. Seeding rate was adjusted based on row width. The 30" and 60" plots were planted with a John Deere MaxEmerge 1750 4-row planter (Moline, IL). The 40" plot was planted with a custom-made planter that included John Deere plate row-units on an adjustable tool bar. All plots were planted to meet a target population of 30,000 plants ac^{-1}. To control weeds, Resolve®Q was applied at a rate of 1.5 oz ac^{-1} on 4-Jun. Forages were interseeded on 2- and 6-Jul, at a rate of 20 lbs. ac^{-1}. On 20-Jun, plots were top-dressed with 46-0-0 plus ContaiN MAX™ at a rate of 300 lbs. ac^{-1}. On 30-Sep, prior to corn harvest, ground cover by interseeded forage was measured by processing photographs using the Canopeo© smartphone application. Forage establishment was poor; therefore, biomass samples were not collected prior to harvest. Corn plant populations at harvest were assessed by counting the number of plants in the center two rows of each plot. On 30-Sep, corn from Trial 2 was harvested as noted in Trial 1. An approximate 1 lb. representative subsample was collected for each row width, weighed, dried, and weighed again to determine dry matter content. Quality analyses were not conducted on corn silage from Trial 2.

Table 2. Trial 2 management, Alburgh, VT, 2022.

Location	Borderview Research Farm - Alburgh, VT
Soil type	Benson rocky silt loam, over shaly limestone, 3-8% slopes
Previous crop	Corn silage
Replicates	4
Corn variety (Relative maturity)	Pioneer P9608Q (96 RM)
Row width (inches)	30, 40, 60
Target population (plants ac^{-1})	30,000
Corn planting date	25-May
Tillage operations	Pottinger TerraDisc
Fertilizer (lbs. ac^{-1})	7-18-36 (200); 9-May
Herbicide (ac^{-1})	Resolve®Q (1.5 oz.); 4-Jun
Top dress fertilizer (lbs. ac^{-1})	300 lbs ac^{-1} of 46-0-0 plus ContaiN MAX™; 20-Jun
Date of interseeding	2- and 6-Jul
Corn harvest date	30-Sep

Table 3. Trial 2 forage treatments, Alburgh, VT, 2022.

Forage treatment	Seeding rate (lbs. ac^{-1})
King's organic 309 alfalfa	20
Echelon orchardgrass/ King's organic 309 alfalfa	8 12
Echelon orchardgrass	20

<u>On-farm research trials to evaluate the effect of row width on corn yields and establishment of interseeded forages</u>

In 2022, two on-farm trials were conducted in St. Albans and Enosburg Falls, Vermont. In the on-farm trial in St. Albans, corn was planted on 7-May using a John Deere 7200 planter (Table 4). Row units were individually controlled by Ag Leader® SureDrive electric drives. Row widths were 30" and 60". The 30" rows were planted at a rate of 30,000 seeds ac^{-1} and the 60" rows at a rate of 60,000 seeds ac^{-1} to reach the target corn population of 30,000 plants ac^{-1}. Starter fertilizer (32-0-0) was applied at a rate of 8 gal ac^{-1}. Alfalfa was interseeded on 22-Jun at a rate of 20 lbs ac^{-1}. On 7-Sep, corn populations were measured in both 30" and 60" rows by counting the number of plants in two 10ft sections. Corn yield was also measured by collecting and weighing the plants from the two 10ft sections in each plot. After weighing, five 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 1. Interseeded forage establishment and growth was minimal in the 30" rows and was not measured. In the 60" rows, forage height and biomass were recorded at the time of corn harvest. Alfalfa was collected from three 9 in^2 quadrats then weighed, dried, and reweighed to determine yield.

In the on-farm trial in Enosburg Falls, VT, corn was planted on 8-May using a Great Plains 1225 planter (Table 5). Row widths were 20" and 40". The 20" rows were planted at a rate of 34,000 seeds ac^{-1} and the 40" rows at a rate of 68,000 seeds ac^{-1} to meet the target corn population of 34,000 plants ac^{-1}. Starter fertilizer, 9-18-9 and 32-0-0, was applied at a rate of 5 gal and 10-gal ac^{-1} respectively. Alfalfa was interseeded on 2-Jul at a rate of 20 lbs ac^{-1}. Corn was harvested by the farmer on 1-Oct and yields were recorded using a yield monitor and were reported at harvest moisture. Interseeded forage establishment and growth was not recorded in the 20" rows due to poor establishment and growth. In the 40" rows, after the corn was harvested, alfalfa height was recorded, and a representative composite sample of alfalfa was collected by clipping plant material within three 9 in^2 quadrats. The sample was weighed, dried, and reweighed to calculate yield. Quality analyses were not conducted on corn or alfalfa from the on-farm trial in Enosburg Falls, VT. Statistical analyses were not done on data collected in either on-farm trial.

Table 4. On-farm trial management, St. Albans, VT, 2022.

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)
Seeding rate (plants ac^{-1})	30" - 30,000 60" - 60,000
Interseeded forage (lbs ac^{-1})	Alfalfa (20)
Planting date	Corn: 7-May Alfalfa: 22-Jun
Fall manure application (gal ac^{-1})	7,000
Starter fertilizer (gal ac^{-1})	32-0-0 (8)
Topdress fertilizer (lbs ac^{-1})	46-0-0 (150)
Herbicide applications (oz ac^{-1})	Glyphosate (24) and Dupont™ Resolve®Q (1.25)
Harvest date (corn & alfalfa)	7-Sep

Table 5. On-farm management, Enosburg Falls, VT, 2022.

Location	Gervais Family Farm- Enosburg Falls, VT
Soil type	Colton gravelly sandy loam
Previous crop	Corm silage
Tillage	Minimum tillage
Rotation	Continuous corn with cover crop
Corn variety	Pioneer 9998AM (99 RM)
Seeding rate (plants ac^{-1})	20" - 34,000 40" - 68,000
Interseeded forage (lbs ac^{-1})	Alfalfa (20)
Planting date	Corn: 8-May Alfalfa: 2-Jul
Starter fertilizer (gal ac^{-1})	9-18-9 (5) 32-0-0 (10)
Herbicide applications (ac^{-1})	Atrazine (0.5 lbs), Charger Max®ATZ Lite (1.5 qts), Dupont™ Resolve®Q (1.25 oz), Roundup PowerMAX® (24 oz), Stinger® (4 oz)
Harvest date	Corn: 1-Oct Alfalfa: 6-Oct

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 (Table 6), in St. Albans (Table 7), and in Enosburg Falls, VT (Table 8). In Alburgh, temperatures were below normal throughout the growing season. May was the only month that had warmer than average temperatures. From May through September, Alburgh received 23.89 inches of rain, which is almost twice as much precipitation received in 2021. The accumulated rainfall in Alburgh was 4.6 inches higher than the 30-year normal for May through September. This season, in Alburgh, there were 2500 Growing Degree Days (GDDs) which falls within the range of required GDDs for corn silage (2200 to 2800).

Unlike Alburgh, the temperatures at the St. Albans location were warmer than normal from May through September. May and August were 4.53 and 4.22 degrees above the 30-year average respectively. Like Alburgh, precipitation was higher than normal, and there was a total of 21.8 inches of rain, 2.66 inches above normal. Overall, there were 2597 accumulated GDDs. At the Enosburg Falls location, precipitation was higher than normal as well, with above average rainfall in May, June, and September. There was a total of 26.3 inches of rain, 5.68 above normal. Overall, there were 2275 accumulated GDDs at the Enosburg Falls location. Both of the on-farm locations had a sufficient number of GDDs for corn silage.

Table 6. Weather data for Trial 1 and 2, Alburgh, VT, 2022.

Alburgh, VT	May	June	July	August	Sept
Average temperature (°F)	60.5	65.3	71.9	70.5	60.7
Departure from normal	2.09	-2.18	-0.54	-0.20	-1.99
Precipitation (inches)	3.36	8.19	3	4.94	4.4
Departure from normal	-0.40	3.93	-1.06	1.40	0.73
Growing Degree Days (50-86°F)	394	459	674	630	343
Departure from normal	93	-64	-20	-11	-44

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 7. Weather data for the on-farm trial in St. Albans, VT, 2022.

	2022				
St. Albans, VT	May	Jun	Jul	Aug	Sep
Average temperature (°F)	60.5	65.9	72.9	72.2	61.5
Departure from normal	4.53	0.81	2.83	4.22	1.34
Precipitation (inches)	3.22	4.96	5.1	4.79	3.71
Departure from normal	-0.02	0.85	1.00	1.05	-0.22
Growing Degree Days (50-86°F)	407	481	681	655	373
Departure from normal	162	28	56	96	54

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 St. Albans, VT.

Table 8. Weather data for the on-farm trial in Enosburg Fals, VT, 2022.

	2022				
Enosburg Falls, VT	May	Jun	Jul	Aug	Sep
Average temperature (°F)	59.7	63.4	69.6	69.1	58.6
Departure from normal	3.10	-1.60	0.10	1.20	-1.90
Precipitation (inches)	5.38	6.16	4.18	3.28	7.33
Departure from normal	1.71	1.78	-0.07	-1.10	3.36
Growing Degree Days (50-86°F)	367	411	609	590	299
Departure from normal	60	-39	3	35	-48

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 Enosburg Falls, VT.

Trial 1- The impact of corn row width on silage productivity

Harvest population and yield at 35% dry matter were significantly impacted by the row spacing treatments (Table 9). Corn populations were significantly greater in the 30" rows at harvest compared to the other row widths, with 31,363 plants ac^{-1}. All the other treatments had populations below the seeding rate target of 30,000 plants ac^{-1}. Harvest dry matter was not significantly different between the treatments, and all had a dry matter close to the target of 35% and ranged from 35.7-37.6%. Corn yield was highest in the 30" rows (25.5 tons ac^{-1}) but was not statistically different from the 20" rows (24.9 tons ac^{-1}). The 40" and 60" rows had the lowest yields, 18.1- and 18.5-tons ac^{-1} respectively. The higher yields in the 20" and 30" rows are likely because of the higher plant populations at harvest. There were no significant differences in silage quality between the row widths (Table 10).

Table 9. Corn silage yield by row width in Trial 1, Alburgh, VT, 2022.

Row width	Harvest population	Dry matter	Yield, 35% DM
	plants ac^{-1}	%	tons ac^{-1}
20-in.	29144[b]†	36.9	24.9[ab]
30-in.	**31363[a]**	**37.6**	**25.5[a]**
36-in.	28465[b]	36.4	22.3[b]
40-in.	26343[c]	37.0	18.1[c]
60-in.	25573[c]	35.7	18.5[c]
LSD (*p*=0.10) ‡	1674.2	NS§	2.65
Trial mean	28178	36.7	21.9

†Treatments within a column with the same letter are statistically similar. Top performers are in **bold**.
‡LSD –Least significant difference at p=0.10.
§NS- No significant difference at p=0.10.

Table 10. Corn silage quality by row width in Trial 1, Alburgh, VT, 2022.

Row width	Starch	Crude protein	aNDFom	TDN	30-hr uNDFom	30-hr NDFD	NE_L	Milk	
	--------------% of DM----------------					% of NDF	Mcal lb^{-1}	lbs. ton^{-1}	lbs. ac^{-1}
20-in.	32.5	8.50	40.3	63.5	16.6	59.0	0.658	2245	19086
30-in.	29.9	8.70	42.9	62.8	17.7	58.8	0.639	2118	18775
36-in.	31.8	8.90	41.5	63.0	17.6	57.7	0.648	2297	17722
40-in.	32.7	9.20	40.3	63.5	16.3	59.6	0.657	2306	14703
60-in.	33.5	8.70	38.9	64.0	15.9	59.2	0.667	2376	15872
LSD (*p* = 0.10) ‡	NS§	NS	NS	NS	NS	NS	NS	NS	NS
Trial mean	32.1	8.80	40.8	63.4	16.8	58.8	0.654	2268	17231

‡LSD –Least significant difference at p=0.10.
§NS- No 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, and a control was placed outside of the corn rows. The light intensity, measured in accumulated lumens ft^{-2}, was similar for all row widths and the control during the first two weeks after the cover crop was interseeded (Figure 1). This figure provides a visualization of light intensity but does not, however, state that these differences are statistically significant. The 20” and 30” rows had the least amount of light reaching the soil surface, and there was little difference between the two treatments. Light intensity was greater throughout the season in the 40” rows compared to the 60” rows. Increased weed pressure in the wider row widths continues to be a challenge and may have resulted in this trend. Light sensors were removed approximately 3 weeks before harvest, and at that time, the rate of change of accumulated lumens ft^{-2} had slowed down, and there would likely be little increase in accumulated lumens ft^2 in any of the treatments except for the control due to canopy closure.

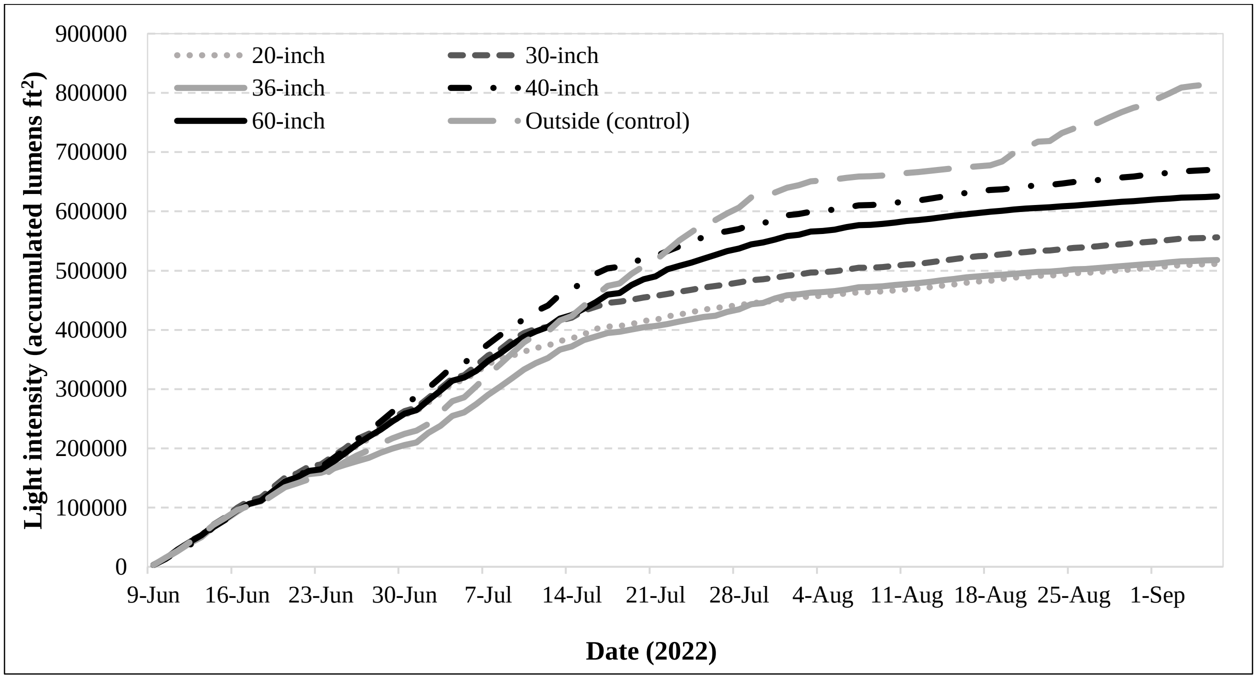

Figure 1. Light intensity at the soil surface by row width compared to a control in Trial 1, Alburgh, VT, 2022.

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

Interactions

There was a significant row spacing by forage type interaction (p=0.033) for percent ground cover just before corn harvest (Figure 2). All three forage types performed best in the 60” rows compared to the 30” and 40” rows. In the 30” rows, alfalfa and the orchardgrass/alfalfa mix had higher ground over than the orchardgrass alone. The inverse of this trend was observed in the 40” rows where the orchardgrass treatment performed better than both the alfalfa and the orchardgrass/alfalfa mix. The orchardgrass alone performed better in the wider 40” and 60” rows, whereas the alfalfa was able to establish better in the narrow 30” rows. These results indicate that different forages react differently to the various row widths, and therefore it is important to continue to study the optimal row spacing for interseeded forage establishment.

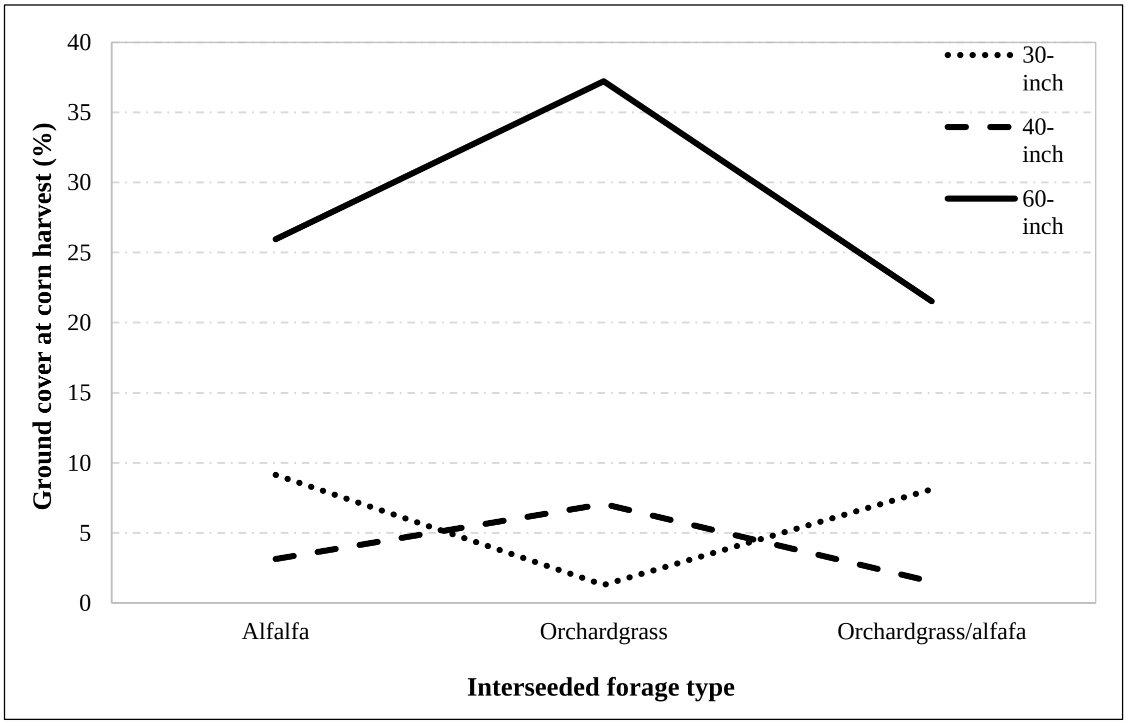

Figure 2. Ground cover provided by interseeded forages by corn row width in Trial 2, Alburgh, VT, 2022.

Impact of Row Width

There was a significant difference in ground cover, corn harvest population, and corn yield between the row widths (Table 11). The 60" rows had significantly higher ground cover from the interseeded forages, 28.2%, and the 30" and 40" rows had ground cover of only 6.19% and 3.91% respectively. The wider row spacing allows for better establishment of the interseeded crop, but overall, the forage yields were low and therefore not measured. Corn populations at harvest were highest in the 40" rows, 30,774 plants ac^{-1}, and that was statistically greater than the 30" and 60" rows, both of which were below the target population of 30,000 plants ac^{-1}. Corn yield was highest in the 30" rows, 28.0 tons ac^{-1}, and that was significantly more than the other row spacings. Interestingly, the 40" rows had the highest harvest population but the lowest corn yields, 15.9 tons ac^{-1}, which is 1.3 and 1.8 times less than the 30" and 60" rows.

Table 11. Ground cover, corn silage yield and population by row width in Trial 2, Alburgh, VT, 2022.

Row Width	Ground cover	Corn population	Corn yield, 35% DM
	%	plants ac^{-1}	tons ac^{-1}
30-in.	6.19[b]	28003[b]	28.0[a]
40-in.	3.91[b]	**30774[a]**	15.9[c]
60-in.	**28.2[a]**†	25669[b]	21.6[b]
LSD (*p*=0.10) ‡	4.82	2395	2.14
Trial mean	12.8	28149	21.9

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

Impact of Forage Type

The interseeded forage type had no impact on the ground cover at harvest, corn harvest population, or corn yield (Table 12). All three forage types had low ground cover at the time of corn harvest; the trial average was 12.8%. With the poor establishment observed in this trial, it is not surprising that the interseeded forages had no impact on corn yields at harvest.

Table 12. Ground cover, corn silage yield and population by forage type in Trial 2, Alburgh, VT, 2022.

Interseeded forage type	Ground cover	Corn population	Corn yield, 35% DM
	%	plants ac^{-1}	tons ac^{-1}
Alfalfa	12.7	28373	**22.3**
Orchardgrass/alfalfa	10.4	27409	21.7
Orchardgrass	**15.2**	**28664**	21.5
LSD (*p*=0.10) ‡	NS§	NS	NS
Trial mean	12.8	28149	21.9

‡LSD –Least significant difference at p=0.10.
§NS- No significant difference at p=0.10.

<u>On-farm research trials to evaluate the effect of row width on corn yields and establishment of interseeded forages</u>

Statistical analyses were not done on data collected at either on-farm trial location, therefore any differences between treatments cannot be considered statistically significant. At the St. Albans location, corn population and yield were greater in the 30" rows compared to the 60" rows (Table 13). Corn silage in the 30" rows produced 5.5 more tons ac^{-1} in 2022 than in 60" rows at the same location. The harvest population in 30" rows was 33,106 corn plants ac^{-1}, above the target seeding rate of 30,000 plants ac^{-1}. The harvest population in 60" rows was only 24,829 corn plants ac^{-1}, which is 8277 less plants ac^{-1} than the 30" rows and 5171 plants ac^{-1} below the target seeding rate. Alfalfa was only harvested in the 60" rows due to poor establishment in the narrower 30" rows. The average dry matter yield of interseeded alfalfa at the time of corn silage harvest was 174 lbs ac^{-1}. Overall, the interseeded alfalfa produced little biomass, but the dry matter yield observed in this year's trial was comparable to the biomass production of alfalfa interseeded into corn silage in last year's trial conducted at the Alburgh, VT location.

At the Enosburg Falls, VT location, corn silage yield was slightly higher in the 20" rows (18.8 tons ac^{-1}) than in the 40" rows (18.4 tons ac^{-1}). Harvest populations were also higher in the 20" rows; there was approximately 2,900 more plants ac^{-1} in the 20" rows (Table 14). The alfalfa interseeded into 20" rows did not establish well and was not measured, but in 40" rows, the dry matter yield of interseeded alfalfa just after corn harvest was 51.2 lbs ac^{-1}.

Table 13. Harvest characteristics of corn silage and alfalfa, St. Albans, VT, 2022.

Row width	Corn silage			Alfalfa	
	Harvest population	Dry matter at harvest	Yield, 35% DM	Average height	Dry matter yield
	plants ac^{-1}	%	tons ac^{-1}	Cm	lbs ac^{-1}
30-in.	**33106**	**39.0**	**29.9**	--	--
60-in.	24829	37.2	24.4	14.5	174
Trial mean	28967	38.1	27.1	N/A	N/A

Top performers are in **bold.**

Table 14. Harvest characteristics of corn silage and alfalfa, Enosburg Falls, VT, 2022.

Row width	Corn silage		Alfalfa	
	Harvest population	Yield, harvest moisture	Average height	Dry matter yield
	plants ac^{-1}	tons ac^{-1}	cm	lbs ac^{-1}
20-in.	**31218**	**18.8**	--	--
40-in.	28314	18.4	3.9	51.2
Trial mean	29766	18.6	N/A	N/A

Top performers are in **bold.**

DISCUSSION

In 2022, the UVM Extension Northwest Crops and Soils Program conducted two research trials at Borderview Farm in Alburgh, VT and two on-farm trials in St. Albans and Enosburg Falls, VT. At all three research sites, there were sufficient Growing Degree Days (GDDs) for corn silage, which ranges from 2200 to 2800 GDDs. Precipitation was high throughout the 2022 season and all the sites received above average rainfall. Temperatures fluctuated by site. It was unseasonably cool in Alburgh throughout the season, but temperatures in St. Albans were above average from May through September. At all three sites however, May was a particularly warm month, with average temperatures above the 30-year normal.

Trial 1 in Alburgh studied the impact of corn row width on silage productivity, and included 20”, 30”, 36”, 40”, and 60” row widths. The 30” rows had s statistically greater harvest population and silage yield than the other row widths. One of the challenges that arises when planting corn in alternative row widths is that most equipment that is available is designed for conventional 30” row widths. To reach a target seeding rate of 30,000 plants ac^{-1} in 60” rows, the seeding rate must be doubled to make up for the loss of rows, but not all equipment is capable of accurately planting at such high seeding rates. The increased yield observed in the 30” rows could be due to the statistically lower harvest populations in the other row widths or the increased competition within the row with higher plant populations. There were no observed differences in corn silage quality between the different row widths. Unsurprisingly, the wider row widths, 40” and 60”, had higher light infiltration to the soil surface compared to the narrower row widths (20”, 30”, and 36”).

Trial 2 evaluated the impact of row width on silage productivity and interseeded forage establishment. The row widths in this trial were 30”, 40”, and 60” and the forages included alfalfa, orchardgrass, and an alfalfa/orchardgrass mix. The different forages reacted differently to the row widths. For example, orchardgrass alone does not establish well in narrow 30” rows, but does better in wider row widths with increased light availability. Alfalfa established well even in the 30” rows, and there was little difference in dry matter yield between the alfalfa and orchardgrass/alfalfa mix when interseeded into 30” rows. This indicates that most of the biomass in those mixed treatment was from the alfalfa and not the orchardgrass. Expectedly, all the interseeded forages performed best in the 60” row widths, and ground cover at the time of corn harvest was highest in the wider rows. Corn populations at harvest were statistically greater in the 40” row widths, but that did not result in high yields. The 40” rows had a statistically lower corn silage yield compared to the other treatments and was likely due with difficulties harvesting this row spacing with a standard corn chopper. More research still 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. In 2022, the interseeded forages had no impact on silage yields. In years with suboptimal conditions (i.e., drought) an interseeded forage could potentially compete with the cash crop for resources which may result in lower yields. The results of these two trials were like those observed in past years (Figure 3).

The two on-farm trials studied impact of row width on silage productivity and interseeded forage success. At both locations, the narrow row width (20” and 30”) produced higher yields than the wider row widths (40” and 60”). Corn populations were also lower in the wider row widths. Like what was observed in the two research trials done in Alburgh, establishing a good corn population is crucial, and the alterative row widths had lower corn populations resulting in lower yields. Alfalfa was interseed into the corn silage at both locations, and overall establishment was poor. At both sites, alfalfa biomass could only be collected in the wider row width, and average dry matter yields were low. Alfalfa is a perennial forage species that is commonly grown in Vermont and a growing number of farmers and researchers are interested in using interseeded crops as forage. While the alfalfa did not establish well while the corn crop was growing, it may continue to grow next spring, increasing ground cover in 2023 prior to corn planting. More research needs to be done on the long-term success of interseeded forages like alfalfa. But if silage yields can be maintained, then farmers can begin to select their interseed cover crops for more targeted benefits. It is important to remember that these data represent only one year of research at three sites. The UVM Extension NWCS program plans to repeat these research trials again in 2023.

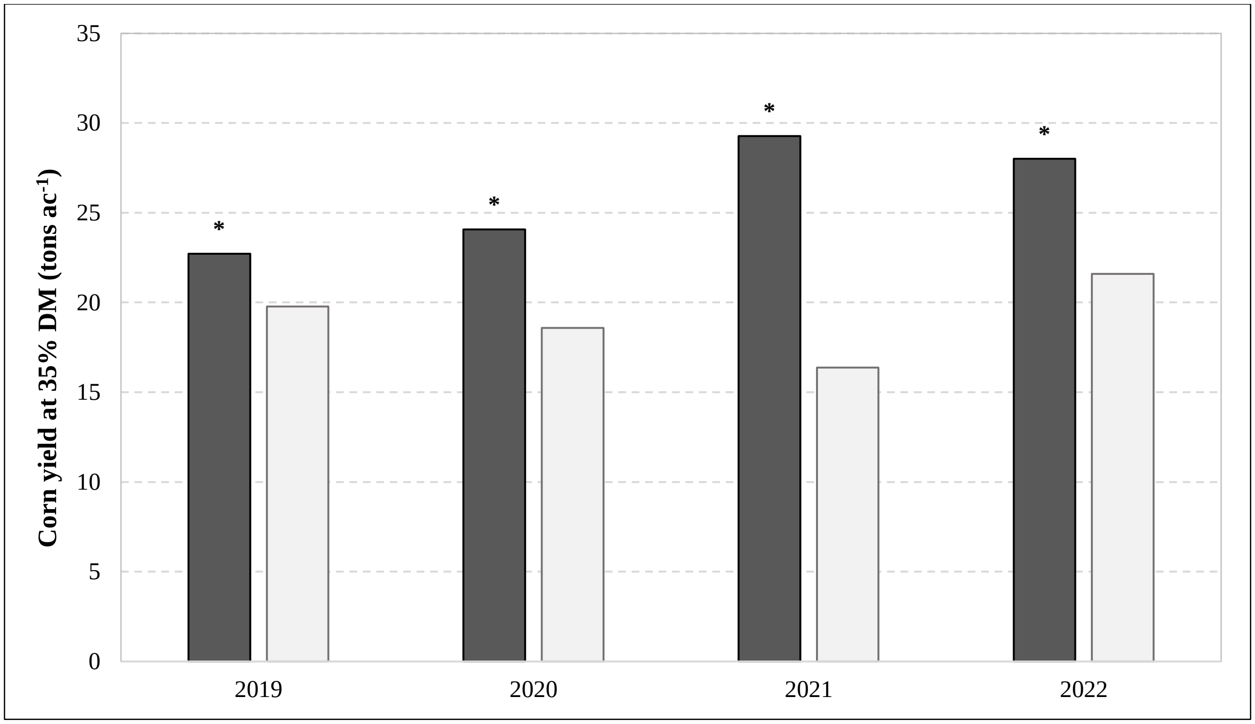

Figure 3. Corn silage yield in 30” and 60” rows by year, Alburgh, VT, 2019-2022. An asterisk (*) indicates a statistically significant (p=0.10) difference between treatments for that year.

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