

Project Title: Evaluating Perennial Living Mulches in a Silage Corn Production System in the Northeast

Sponsored by NE SARE (Partnership Grant ONE17-299) PI : Sid Bosworth (Originally Dan Hudson)

Cooperating Farmers: Steve Stocking, Farilee, VT (2017/19) and Steve Carson, Newbury, VT (2018)

Collaborator: The Connecticut River Watershed Farmer’s Alliance (CRWFA)



2018 Trial - In 2018, we conducted a three-replication strip-plot trial on a cornfield at the Stocking Farm to assess the feasibility of establishing perennial legumes interseeded into corn grown for silage. The corn was grown for silage and planted on May 14th at a population target of 32,000 plants per acre. Treatments included five perennial legumes interseeded (broadcast followed by light raking) in combination with four seeding time/herbicide treatments. **See the next page for a plot map showing details of the treatments.**

Results

Legume germination and early establishment was poor across all three seeding times (data not shown). It was very dry in June and July of 2018 preventing the germination of legume seed and/or death of stressed seedlings. On May 30 during the 2-leaf seeding and on June 20 when seeding the 4L treatments, alfalfa had the most seedlings of all the legumes. However, by June 20, the weeds in the CP treatment were well in advance and competing heavily with any legume seedlings as well as competing with the corn plants. By the end of the season, there were hardly any legumes present in the CP or 2L treatments.

Weed control (Table 1) – As expected, there was extremely poor weed control with the Corn Planting time (CP) treatment since no herbicide was applied at all. A one-time application of glyphosate at the two-leaf corn stage provided about 50% to 70% control by the end of the season. However, the 2X applications resulted in good to excellent season long control.

Table 1. Weed control ratings of legume seeding time treatments by specie and control taken on September 13, 2018.

Treatment Information				Weed Control Ratings on 9/13/18 ¹						
Legume Seeding Time	Seeding Date	Glyphosate Application		Kura	Subteranian	White	Red	Seeding Time		
Treatments	Date	30-May	20-Jun	Alfalfa	Clover	Clover	Clover	clover	Control ²	Average ³
Corn Planting	15-May	no ²	no	1.0 a ⁴	1.0 a	1.0 a	1.0 a	1.0 a	5.3 b	1.0 x ⁵
2-Leaf Stage	30-May	yes	no	5.7	5.7	5.7	5.3	5.7	5.0	5.6 y
4-Leaf Stage-1X	20-Jun	yes	no	6.3	6.3	7.0	6.0	6.7	5.7	6.5 y
4-Leaf Stage-2X	20-Jun	yes	yes	8.7	9.0	8.7	9.0	9.0	9.0	8.9 z
Species Average				5.4	5.5	5.6	5.3	5.6	-	

¹ Ratings (visual % control): 1 - 0 to 10%; 2 - 20 to 30%; 3 - 30 to 40%; 4 - 40 to 50%; 5 - 50 to 60%; 6 - 60 to 70%; 7 - 70 to 80%; 8 - 80 to 90%; 9 - 90 to 100%

² No herbicide was applied at corn planting time; however, the Corn Planting control plots were treated with glyphosate on 5/30

³ Seeding time averages do not include the control ratings since glyphosate was applied to the Corn Planting control plots only on 5/30.

⁴ Species and control means with different letters (a,b) are significantly different at 5% level of probability. Rows with no letters indicates no significance

⁵ Seeding time average means with different letters (x,y,z) are significantly different at 5% level of probability.

Corn Yield – Due to limited time and labor, only the 1X and 2X glyphosate applications of the alfalfa plots of the 4 L seeding time treatments were evaluated for plant population and yield (Table 2). The 2X plots had about 1.7 t/a greater yield compared to the 1x significant at the 10% level of probability. Although yields were not collected for the CP and 2L treatments, corn plants in the CP plots were visually shorter compared to the 4L plots and were likely to have had a significantly lower yield considering the level of weeds in those plots.

Table 2. Plant population, dry matter content, and silage equivalent yield of corn grown for silage

Legume Seeding Time	Seeding Date	Glyphosate Application		Plant Population	Dry Matter Content	Corn Silage Yield
Treatments	Date	30-May	20-Jun	ppa	%	t/a @ 35%dm
4-Leaf Stage-1X	20-Jun	yes	no	29,621	31.6	20.0 a ¹
4-Leaf Stage-2X	20-Jun	yes	yes	30,492	32.8	24.8 b
Significance				n.s.	n.s.	#

¹ Means with different letters (a,b) are significantly different at 10% level of probability.

Summary for 2018 – Legume establishment was disappointing in this study most likely due to extremely dry conditions and a high corn population. However, these findings suggest that glyphosate (a non-soil residual herbicide) applied at the 2 to 3 leaf stage followed by a second application at the 4 to 5 leaf stage could potentially be utilized to adequately control weeds allowing the interseeding of cover crops without the risk of herbicide residual injury nor impacting corn silage yields. However, this needs further investigation.

Living Mulch Study - 2018

Stocking Farm

Corn Planting

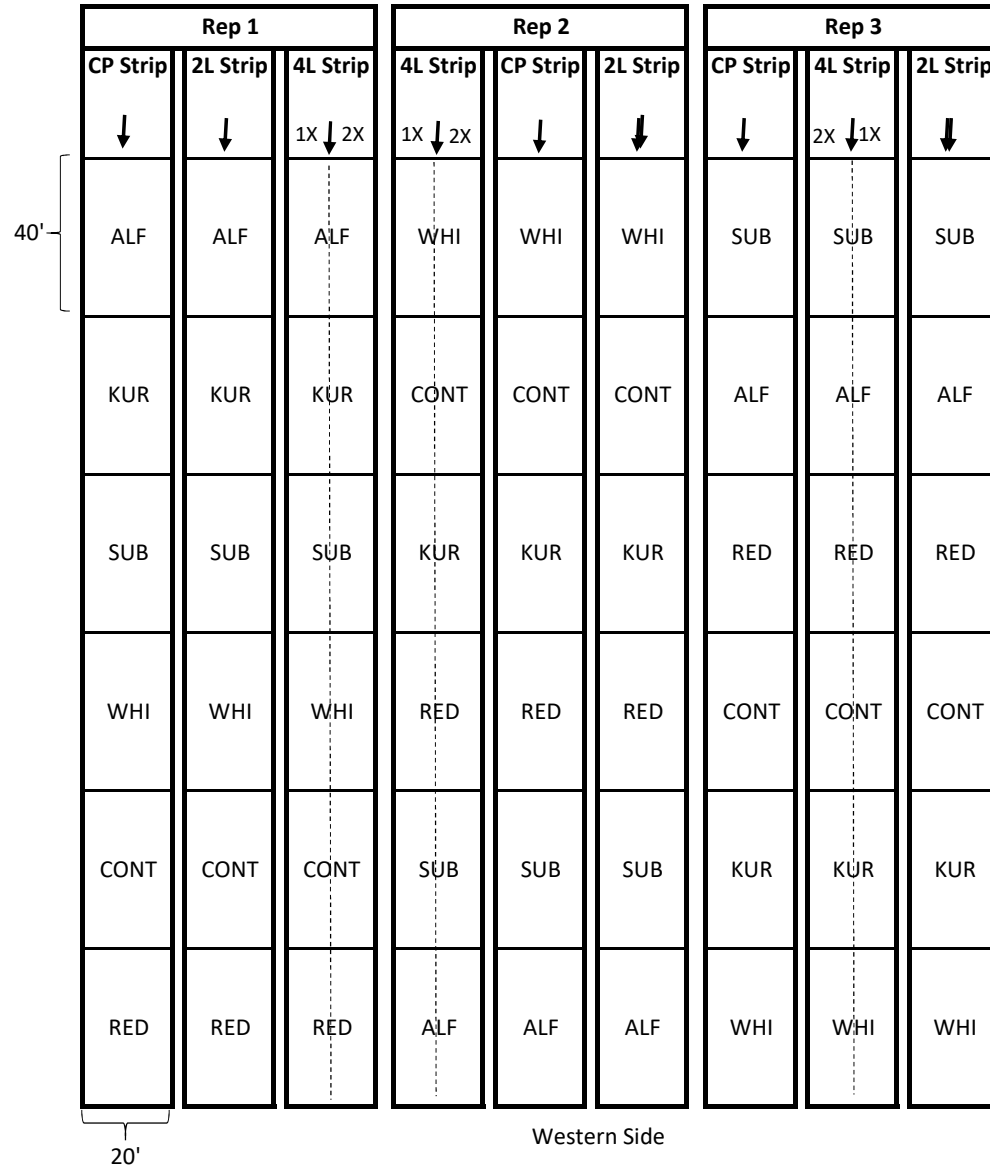
Date
5/15/18

2L Date
(1 to 2 leaf stage)

5/30/18

4L Date
(4 leaf stage)

6/20/18



Treatments Key

I. Seeding time*

CP Corn planting - Legumes seeded at corn planting (no herbicide)

2L 2 Leaf - Legumes planted at 2 leaf corn stage. Glyphosate sprayed at this time

4L-1X Late planting - seeded at 4 leaf stage plus glyphosate sprayed only at EP time (1X)

4L-2X Late planting plus glyphosate sprayed at EP time as well as LP time (2X)

II. Species

ALF Alfalfa

KUR Kura Clover

SUB Subteranian Clover

WHI White Clover

RED Red clover

CONT Control

Seeding Calculations

Plot Length (ft): 40

Plot Width (ft): 20

	lb/a	lb/Plot	g/plot	Total lbs for study
ALF	20	0.367	167	4.4
KUR	15	0.275	125	3.3
SUB	14	0.257	117	3.1
WHI	6	0.110	50	1.3
RED	12	0.220	100	2.6

* Glyphosate was applied just prior to seeding the legumes for 2L and 4L for each respective seeding time using a 10' boom sprayer. Each plot was broadcast seeded at their appropriate rate using a hand held spinner-spreader. A flex tine weeder was used to disturb the soil at broadcast seeding of each legume plot for CP and 2L. An inverted yard rake was used between corn rows to disturb soil for the 4L seedings.

2019 Trial - In 2019, we conducted a four-replication strip-plot trial on a cornfield at the Stocking Farm. **See the next page for a plot map showing details of the treatments.** The corn was grown for silage and planted on May 20th. The study involved a split-split plot design. Main effect treatments included:

- 1) Corn population - two populations of corn (a typical silage population at 33,000 plants per acre versus 27,000 ppa);
- 2) Herbicide timing glyphosate only (1X, once only at 2-leaf corn stage compared to 2X, once at 2-leaf stage and repeated at 4-leaf stage); and
- 3) Cover crop species - a) Annual ryegrass seeded at 50 lbs/a; b) Alfalfa at 30 lbs plus Intermediate ryegrass at 5 lbs; and c) Clover - Red clover at 10 lbs and white clover 5 lbs plus Intermediate ryegrass at 30. All cover crops were broadcast seeded (followed by light raking) on July 3 when corn was at the 4-leaf stage.

Results

Corn population - Counts were made on July 3 when corn was at the 4-leaf stage. Although the target for the high treatment was 33,000 ppa, we measured an average of 30,292 for this treatment (Table 3). It was significantly higher than the low population which averaged 26,542 ppa.

Herbicide timing - By July 23, ten days after the last herbicide treatment had been applied, we did find better weed control with the repeated (2X) treatment compared to the single application (1X) treatment (Table 3). However, there was no significant interactions with the main treatment effects indicating the weed control differences were consistent regardless of corn population or cover crop. Unfortunately, we were not able to evaluate the plots before harvest which occurred in early October. When we made measurements on Oct. 22, most of the annual weeds had died off or died back due to previous frosts, so were unable to conduct weed ratings at that time.

Cover crop germination and cover was better in 2019 compared to 2018. By July 23 (10 days after seeding), annual ryegrass had germinated and had the best cover ratings compared to the alfalfa and clover treatments. The intermediate ryegrass that was mixed with the alfalfa and clover treatments did not germinate well. The seed was older and likely not as viable. On July 23, the alfalfa cover rating was not as high as the annual ryegrass but much better than the clover treatments. This may have been somewhat due to germination times since there was only 10 days between seeding and when the rating was made. At post-harvest on Oct. 22, the annual ryegrass clearly had the best cover. The alfalfa treatment actually dropped in cover between July 23 and Oct 22. This may have been due to the shading of the corn in August and September. We observed this as well the year before. The clover treatment was still low by October and not likely to do much more. Percent cover was not effected by corn population nor herbicide timing and there were not significant cover crop by other main effect interactions.

Table 3. Corn plant population counts, weed control, and percent vegetative cover of inter-seeded cover crops.

Main Effects	Treatments	Corn Population (ppa)	Weed Rating ²	Cover Crop Rating ³	
		(July 3)	(July 23)	(July 23)	(Oct 22)
Corn Population	High	30,292 a	7.1	5.2	5.0
	Low	26,542 b	7.9	5.2	5.3
	Significance	0.003 ⁴	ns ⁵	ns	ns
Herbicide Timing ¹	1X	28,625	6.8 a	5.2	5.2
	2X	28,208	8.1 b	5.2	5.2
	Significance	ns	0.053	ns	ns
Cover Crop	Annual Ryegrass	28,375	7.7	6.6 a	7.9 a
	Alfalfa/ryegrass	28,563	7.3	5.4 b	3.6 b
	Clover/ryegrass	28,313	7.5	3.5 c	4.1 b
	Significance	ns	ns	0.001	0.001

¹ Glyphosate only applied either once at 2-leaf corn stage (1X) or application at 2-leaf and repeated at 4-leaf stage (2X)

² Visual Weed Control Ratings (% control): 1 - 0 to 10%; 2 - 20 to 30%; 3 - 30 to 40%; 4 - 40 to 50%; 5 - 50 to 60%; 6 - 60 to 70%; 7 - 70 to 80%; 8 - 80 to 90%; 9 - 90 to 100%

³ Visual Vegetative Cover Ratings (% cover): 1 - 0 to 10%; 2 - 20 to 30%; 3 - 30 to 40%; 4 - 40 to 50%; 5 - 50 to 60%; 6 - 60 to 70%; 7 - 70 to 80%; 8 - 80 to 90%; 9 - 90 to 100%

⁴ Means with different letters are significant at a P value of 0.10 or less (P values are shown when significant)

⁵ ns - not significant for main effect means comparison. Note - All main effect interactions were not significant

Summary for 2019 –Glyphosate (a non-soil residual herbicide) applied at the 2 to 3 leaf stage followed by a second application at the 4 to 5 leaf stage did provide better weed control compared to a one time application at the 2 leaf stage. However, this had no impact on the final percent cover in the fall. Although alfalfa showed promise early in the season with adequate cover, it had poor cover by late October. Lowering the corn population by 4,000 ppa did not make any difference. Other systems need to be evaluated if interseeding of perennial legumes will be consistently successful.

Stocking Study 2019

Corn Planted on: 5/20/2019

Strip No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Replication	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	
Population	High	High	Low	Low	Low	Low	High	High	High	High	Low	Low	Low	Low	High	High	
Spray:	2X	1X	2X	1X	2X	1X	2X	1X	2X	1X	2X	1X	2X	1X	2X	1X	
Cover Crop	A	AR	AR	AR	AR	ALF	ALF	ALF	ALF	AR	AR	AR	AR	CLV	CLV	CLV	CLV
	B	CLV	CLV	CLV	CLV	AR	AR	AR	AR	CLV	CLV	CLV	CLV	ALF	ALF	ALF	ALF
	C	ALF	ALF	ALF	ALF	CLV	CLV	CLV	CLV	ALF	ALF	ALF	ALF	AR	AR	AR	AR

Key Spray: Glyphosate only sprayed once (1X at 2-leaf stage on 6/10) or twice (2X, at 2-leaf and then repeat at 4-leaf)
 Population: High - target 33,000 ppa ; Low - 27,000 ppa
 Cover Crops all planted on 7/3: AR - Annual ryegrass only (50 lbs/a)
 CLV - Red clover at 10 lbs, white clover 5 lbs, Intermediate ryegrass at 30
 ALF - Alfalfa at 30 lbs and Intermediate ryegrass at 5 lbs