AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2015 – 2017

TITLE: Improving winter cover crop establishment in sweet corn production in the Willamette Valley.

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SUMMARY:

This project is evaluating the potential of interseeding of crop crops to improve cover crop establishment after late harvested sweet corn. Cover crop establishment for producers of processed vegetables in the Willamette Valley is a challenge because sweet corn harvest may occur late into the fall. Soil may already be saturated from fall rains, and the combination of wet soil and crop residue on the soil surface precludes tillage that benefits cover crop establishment. Cover crops were interseeded into sweet corn with a high clearance drill designed specifically for this task. In 2015, the optimum time to interseed a cover crop of oats and crimson clover was the V6 stage of corn. Sweet corn yield was not affected by the cover crop when drilled or sown at V6 and cover crop growth was greater in the interseeded plots through November. Results were very different in 2016. A higher than expected crop stand, good growing conditions during the summer, and nearly 13 in of rain that fell in the month immediately after harvested produced a meager stand of cover crop. In both studies however, we were able to demonstrate that weed control need not be sacrificed when interseeding. The HPPD herbicides topramezone and tembotrione controlled weeds very well when applied immediately after interseeding, and had no effect on oat or crimson clover survival and growth.

OBJECTIVES:

1. Demonstrate the capability of interseeding with a high-clearance direct-seed planter to improve cover crop establishment and growth compared to conventional tillage or direct-seeding of cover crops after sweet corn is harvested.
2. Determine the optimum time to interseed cover crops so that the cover crop does not compete with the sweet corn crop for nutrients and water and reduce yield.
3. Evaluate the compatibility of this interseeding system with late applied postemergence herbicides for weed control and whether typical cover crops will tolerate current postemergence herbicide practices.

PROCEDURES:

Trials were set at the OSU Vegetable research farm in 2015 and 2016. Sweet corn was planted at a density of 32,000 seeds/a with Outlook herbicide (18 oz/A) banded over the corn row on a 10-inch band. A series of interseeding treatments were applied to the corn based on cover crop planting strategy, growth stage of the corn and postemergent (POST) herbicide application timing (see Table 1) to plots that were 10 by 60 ft. Cover crops of crimson clover and Cayuse oats (40 lbs./A) were interseeded with a high clearance direct-seed planter into sweet corn at growth stage V4, V6, (V8). Treatments were replicated 4 times in a randomized complete block design.

Table 1. Treatments applied to field plots in 2015 and 2016.

	Cover crop planting system	Cover crop	Cover Crop Seeding Rate (lb/A)		Timing of interseed -ing	Post herb- icide timing
			2015	2016		
1	Relay	Cr. clover + oat	15+60	15+40	V4	V4
2	Relay	Cr. clover + oat	15+60	15+40	V6	V6
3	Relay	Cr. clover + oat	15+60	15+40	V8	V8
4	Relay	Cr. clover + oat	15+60	15+40	V4	N
5	Relay	Cr. clover + oat	15+60	15+40	V6	N
6	Relay	Cr. clover + oat	15+60	15+40	V8	N
7	Broadcast	Cr. clover + oat	15+60	15+40	V4	V4[1]
8	Broadcast	Cr. clover + oat	15+60	15+40	V6	V6[2]
9	Broadcast	Cr. clover + oat	15+60	15+40	V8	V8[2]
10	Direct-seed	Cr. clover + oat	15+60	15+40	Post har	V6[2]
11	Conv.	Cr. clover + oat	15+60	15+40	Post har	V6[2]
12	Check	None				V6[2]

The herbicides Laudis (2015) or Impact (2016) were tankmixed with Basagran and broadcast applied to control weeds on select treatments after the cover crop was seeded to simulate the application being made with the interseeder. Cover crop emergence was measured at silking, and cover crop and weed biomass samples were harvested from all plots before corn harvest, dried and weighed.

Soil moisture was monitored to 2 feet with gypsum blocks throughout the season to determine if the cover crops were competing for soil water. Penetration of photosynthetically active radiation (PAR) to the cover crop canopy was measured throughout the season to monitor competition of the corn crop for light.

Corn was harvested by hand from 20 ft of row from all plots to assess yield. Following hand harvest, the entire plot was machine harvested to remove all remaining ears and simulate soil cover typical of commercial fields. Following harvest, the direct-drill (Tr 10) and conventional tillage (Tr 11) plots were flailed. Tr 11 plots were disked twice after flailing, then followed two times over with vertical tine tillage. Cover crops were drilled with a John Deere notill grain drill. Snap beans were planted into all plots in the spring of 2015 to assess treatment effects on yield of the following crop, in this case snap beans.

SIGNIFICANT ACCOMPLISHMENTS:

2015 (Table 1 and 2). A cover crop of oat and crimson clover produced the most cover crop biomass when interseeded at V4 compared to V6 and V8 plantings but may have reduced corn yield slightly because of competition for water or nutrients. Soil moisture content was slightly depressed in the V4 treatment compared to other treatments supporting the observation that cover crops planted at V4 may have reduced corn yield. Applying Laudis herbicide immediately after interseeding of the cover crop had no impact on cover crop establishment, even when seeds were broadcast on the soil surface and incorporated lightly. Clover did not emerge well in interseeded plots, possibly because it was planted too deeply. Clover establishment was best when seed was broadcast on the soil surface and incorporated with shallow tillage. Cover crop biomass accumulation in mid-December averaged less in interseeded plots than in fall-planted plots because the oat cover crop began to senesce due to very wet soil conditions. Soil coverage after corn harvest and through November was much greater in interseeded plots than in conventionally tilled or direct-drilled cover crop plots. Snap bean yield in 2016 following interseeded cover crops was depressed slightly because of the high carbon biomass that was incorporated in the spring and significant drymatter that impeded seed to soil contact.

2016 (Table 3). The cover crop of oat and crimson clover produced the most cover crop biomass at corn harvest when interseeded at V4 compared to V6 and V8 plantings. However, drymatter yield was nearly 60% lower than the previous year, in part due a very competitive corn crop in a year of optimal growing conditions. Applying Impact and Basagran herbicide immediately after interseeding of the cover crop may have reduced cover crop drymatter yield when applied at the V6 planting date. Interseeding had little impact on corn yield in 2016, primarily because cover crop growth was much less than in 2015, and soil monitoring equipment indicated no significant differences in soil moisture between treatments. In a few cases corn yield was slightly less than the check plot without a cover crop (not statistically significant given the variability in the plot), but this may have been due more to leaf burning that occurred with the herbicide application at V6 rather than cover competition for nutrients and water.

As mentioned above, cover crop drymatter accumulation was very poor compared to the same trial in 2015. Growing conditions for sweet corn were optimal in 2016, and even though the variety Devotion (white Sh2) was used in the study, growth and yield were exceptional producing nearly 12 t/a of ears. Light readings at the soil surface indicated that the corn crop was extremely competitive, and a significant factor regulating the growth of the interseeded cover crops. Cover crop survival also was very poor after corn harvest. Extremely wet conditions commenced immediately after harvest and lasted through the month of November, and gave little time for the cover crop to establish. Slugs also decimated the cover crop foliage, even after slug bait was applied. Establishing the cover crop by direct-drilling and tillage after corn harvest required tarping of the plots because of the incessant rain in October.

Table 2. Cover growth and drymatter accumulation in interseeded (relay planted) plots, 2015.

	Cover crop planting system	Cover crop	Cover Crop Seeding Rate	Timing	Date	Post herb-icide	Cover crop stand (24-Jul)		Cover crop biomass and N Uptake (14-Sept)				Cover crop biomass (15-Dec)			
							Oat	Clover	Oats	Clover	Weeds	N uptake	Oats	Clover	Weeds	Total
			lb/A				*no/7.5 ft sq*		*lb DM/acre*			*lb/A*	*tons DM/acre*			
1	Relay	Cr. clover + oat	10+60	V4	9-Jul	V4[1]	80	11	803	17	6	19	0.34	0.04	0.00	0.39
2	Relay	Cr. clover + oat	10+60	V6	15-Jul	V6[2]	80	18	368	0	313	10	0.45	0	0	0.45
3	Relay	Cr. clover + oat	10+60	V8	27-Jul	V8[2]	19	10	269	0	0	9	0.39	0	0.01	0.39
4	Relay	Cr. clover + oat	10+60	V4	9-Jul	N	94	10	857	0	525	21	0.22	0.01	0.01	0.24
5	Relay	Cr. clover + oat	10+60	V6	15-Jul	N	81	7	384	0	92	10	0.41	0.01	0	0.43
6	Relay	Cr. clover + oat	10+60	V8	27-Jul	N	22	11	109	0	1171	5	0.34	0.09	0.01	0.44
7	Broadcast	Cr. clover + oat	10+60	V4	9-Jul	V4[1]	148	36	240	19	3	7	0.84	0.06	0.01	0.91
8	Broadcast	Cr. clover + oat	10+60	V6	15-Jul	V6[2]	101	11	115	0	0	3	0.48	0.02	0.01	0.50
9	Broadcast	Cr. clover + oat	10+60	V8	27-Jul	V8[2]	42	45	94	17	6	3	0.39	0.18	0.01	0.58
10	Direct-seed	Cr. clover + oat	10+60	Post har	21-Sept	V6[2]	0	0	0	0	0	0	0.53	0	0.01	0.53
11	Conv.	Cr. clover + oat	10+60	Post har	21-Sept	V6[2]	0	0	0	0	0	0	0.61	0	0	0.61
12	Check	None			-	V6[2]	0	0	0	0	0	0	0	0	0.08	0.08
	FPLSD (0.05)						18	17	209	NS	605	5	0.31	0.10	0.02	0.30

[1] Laudis 3 oz/A
[2] Laudis (3 oz/A) + Basagran (1 pt/A)

Table 3. Effect of interseeded cover crops on corn growth, PAR researching the cover crop on the soil surface, and corn yield, 2015.

	Cover crop planting system	Cover crop	Cover Crop Seeding Rate	Timing	Date	Post herb-icide	Corn hts (8/11, ~800 GDD)	Proportion of Photosynthetically Active Radiation (PAR) reaching cover crop canopy			Corn harvest		
								31-Jul	6-Aug	25-Aug	Ear no.	Fresh wt	Avg ear wt.
			lb/A				*ft*				*ear/A*	*T/A*	*lb*
1	Relay	Cr. clover + oat	10+60	V4	9-Jul	V4[1]	5.3	0.33	0.25	**0.23**	25483	11.6	0.91
2	Relay	Cr. clover + oat	10+60	V6	15-Jul	V6[2]	5.5	0.43	0.20	**0.13**	26136	11.9	0.91
3	Relay	Cr. clover + oat	10+60	V8	27-Jul	V8[2]	5.4	0.44	0.17	**0.12**	27443	12.3	0.90
4	Relay	Cr. clover + oat	10+60	V4	9-Jul	N	5.3	0.25	0.20	**0.18**	27007	12.2	0.90
5	Relay	Cr. clover + oat	10+60	V6	15-Jul	N	5.2	0.33	0.22	**0.11**	27661	12.7	0.91
6	Relay	Cr. clover + oat	10+60	V8	27-Jul	N	5.3	0.37	0.19	0.10	24829	11.2	0.91
7	Broadcast	Cr. clover + oat	10+60	V4	9-Jul	V4[1]	5.4	0.33	0.15	0.09	28314	12.9	0.91
8	Broadcast	Cr. clover + oat	10+60	V6	15-Jul	V6[2]	5.5	0.34	0.17	0.09	28967	13.7	0.95
9	Broadcast	Cr. clover + oat	10+60	V8	27-Jul	V8[2]	5.2	0.35	0.13	0.10	30710	13.7	0.90
10	Direct-seed	Cr. clover + oat	10+60	Post har	21-Sept	V6[2]	5.4	0.36	0.19	0.06	26354	12.4	0.95
11	Conv.	Cr. clover + oat	10+60	Post har	21-Sept	V6[2]	5.4	0.38	0.16	0.09	26572	12.2	0.91
12	Check	None			-	V6[2]	5.3	0.36	0.15	0.06	26789	11.9	0.89
	FPLSD (0.05)						NS	NS	NS	0.04	NS	NS	NS

1 Laudis 3 oz/A
2 Laudis (3 oz/A) + Basagran (1 pt/A)

Table 4. Effect of interseeding method and herbicide on cover crop growth and corn yield, Corvallis, 2016.

	Cover crop planting system	Cover crop	Cover Crop Seeding Rate	Interseed date	POST herbicide	Cover crop drymatter at corn harvest	Corn harvest		
							Ear no.	Fresh wt	Avg. ear wt.
			lb/A			*lb DM/A*	*ear/A*	*T/A*	*lb*
1	Relay V4	Cr. clover + oat	15:40	16-Jul	V4[1]	179	29621	12.0	0.82
2	Relay V6	Cr. clover + oat	15:40	21-Jul	V6[1]	40	27661	10.8	0.78
3	Relay V8	Cr. clover + oat	15:40	27-Jul	V8[1,2]	21	28096	11.4	0.81
4	Relay V4	Cr. clover + oat	15:40	16-Jul	None	14	30056	12.3	0.81
5	Relay V6	Cr. clover + oat	15:40	21-Jul	None	92	30710	12.1	0.79
6	Relay V8	Cr. clover + oat	15:40	27-Jul	None	42	28968	12.0	0.83
7	Broadcast V4	Cr. clover + oat	15:40	16-Jul	V4[1]	57	26790	11.0	0.82
8	Broadcast V6	Cr. clover + oat	15:40	21-Jul	V6[1]	38	27225	11.2	0.82
9	Broadcast V8	Cr. clover + oat	15:40	27-Jul	V8[1,2]	45	29839	11.8	0.79
10	Check	None				0	28532	11.6	0.81
	FPLSD (0.05)					59	NS	NS	NS

[1] Impact (3/4 oz/A) + Basagran (1 pt/A)
[2] Directed application

BENEFITS & IMPACT:

- Demonstrated the potential benefits and risks of interseeding cover crops into sweet corn from V4 thought V8 stages of growth.
- Provided estimates of cover crop drymatter accumulation with interseeding compared to conventional seeding in the fall after corn is harvested.
- There was no effect of the weed control program that was tested on cover crop establishment and growth in 2 years of this study, indicating that POST herbicide programs using Laudis or Impact herbicide are compatible with changes in cropping system to accommodate interseed cover crops of clover and cereals. This is the most significant finding of this study because it paves the way to develop new weed management programs that allow relay planting or interseeding in crops such as sweet corn, with the potential to improve sustainability of the cropping system and reduce cost.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM:

- Myer Memorial Trust provided funding so that we could begin to evaluate the impact of interseeding on the quality of winter runoff in producer fields, particularly the impact of interseeding on sediment and phosphorus loads in runoff in the fall immediately after harvest compared to conventional establishment strategies.
- WSARE provided support for a producer-researcher grant for on-farm demonstration plots.
- The Oregon Processed Vegetable Commission provided support for on-farm research and funds to help with the purchase of the planter

FUTURE FUNDING POSSIBILITIES:

We are discussing the project with NRCS to determine whether the objectives of this project will complement the goals and vision of this NRCS.