Project Number SW11-072
Project Title: Selecting management practices and cover crops for reducing tillage, enhancing soil quality, and managing weeds in western WA organic vegetable farms

Results and Discussion/Milestones Tables and Figures

Table 2. Biomass production by cover crop variety in year 2012 and 2013. Data were pooled over termination times because no difference existed between "early" and "late" termination times (Wayman 2013).

		2012	2013
	Cover Crop	biomass Mg ha $^{-1}$	
Grain	Alba	7.9	-
	Aroostook	9	6.9
	Common	6.4	7.3
	Merced		4
	Strider	8.4	7.9
Mix	Aroostook+Common	-	8.1
	Aroostook+Purple	-	5.3
	Merced+Common	-	5.7
	Merced+Purple	-	5.4
	Strider+Common	-	6.8
	Strider+Purple	6.4	4.6
	Strider+Lana	5.4	-
Vetch	Cahaba	-	4.9
	Common	5.9	4.9
	Hairy	5.5	7.6
	Lana	3.4	4.7
	Purple bounty	5.5	5.8

Table 3. Biomass of winter weeds and their percentage makeup of cover crop biomass at cover crop termination in 2012 and 2013 by variety. There was no difference by "early" or "late" termination thus values were combined. Letters in weed biomass columns indicate HSD test for cover crop variety mean separation within each year (Wayman 2013).

		2012		2013	
Type	Cover crop	Percent of cover crop that is weeds	Weed biomass Mg ha^{-1}	Percent of cover crop that is weeds	Weed biomass Mg ha^{-1}
Grain	Alba barley	6.9	0.6 ab	--	--
	Aroostook rye	3.3	0.3 ab	11.2	0.8 abcd
	Common rye	7.0	0.4 c	3.2	0.2 d
	Merced rye	--	--	33.7	1.8 a
	Strider barley	8.3	0.7 b	14.5	1.2 ab
Vetch	Cahaba	--	--	24.9	1.5 ab
	Common	3.7	0.2 ab	18.7	1.1 abc
	Hairy	8.1	0.5 ab	5.1	0.3 cd
	Lana	38.4	1.6 a	15.1	0.6 bcd
	Purple bounty	11.8	0.7 ab	12.1	0.7 bcd
Mix	Aroostook+Common	--	--	8.1	0.7 abcd
	Aroostook+Purple	--	--	15.4	0.8 abcd
	Merced+Common	--	--	23.5	1.5 ab
	Merced+Purple	--	--	21.8	1.4 ab
	Strider+Common	--	--	13.6	0.9 abc
	Strider+Lana	8.9	0.5 ab	--	--
	Strider+Purple	7.3	0.5 ab	16.75	0.9 abcd

Table 4. Cover crop N concentrations, C:N ratios, and N in kg ha^{-1} pooled over "early"/"late" averaged together in year 2012 only. Significance letters indicate difference of means within type groupings. "ns" indicates no significant differences among varieties within type (Wayman 2013).

Type	Cover crop	% N	C:N ratio	N kg ha^{-1}
Grain	StriderB	0.92 a	48 b	76 a
	AlbaB	0.73 b	61 b	59 ab
	AroostookR	0.53 c	88 a	48 b
	CommonR	0.56 c	84 a	35 b
Vetch	HairyV	2.9 a	15 b	156 ns
	LanaV	3.1 a	14 b	110 ns
	CommonV	2.8 ab	15 b	165 ns
	PurpleBV	2.4 b	19 a	129 ns
Mix	Strider + Purple	2.1 ns	21 ns	133 ns
	Strider + Lana	2.2 ns	20 ns	119 ns

Table 5. Percentage of cover crop mulch upright at 4 weeks by "early" and "late" termination timings for three grain varieties in two years for roller-crimped plots (Wayman 2013).

		Percent of cover crop mulch upright		
Year	Cover crop	"Early"	"Late"	"Early"/"Late" Mean
2012	Aroostook rye	8 b[1]	0 a	--
	Common rye	10 b	10 a	--
	Strider barley	68 a	20 a	--
2013	Aroostook rye	--	--	3 c
	Common rye	--	--	19 b
	Strider barley	--	--	86 a
<0.0001	<0.0001	<0.0001		NA

[1]Values in columns followed by same letter are not significantly different at p=0.05 Tukey's HSD test.

Table 6. Percent weed cover at 4 weeks by cover crop variety for two termination times (Wayman, 2013).

	Percent weed cover	
Cover crop variety	"Early"	"Late"
Aroostook rye	19 b[1]	14 b
Common rye	19 b	62 a
Strider barley	26 b	22 b
Strider + Purple bounty	28 b	34 ab
Common vetch	15 b	13 b
Lana vetch	81 a	59 a
Purple bounty vetch	39 b	38 ab

[1]Values in columns followed by same letter are not significantly different at p=0.05 Tukey's HSD test.

Table 7. Crop yield from on-farm experiments at Kirsop and Let Us Farms 2012-2014

Year	Location	Cover crop	Crop	Reps	Tillage Treatment	Yield	(SE)	
						Fresh wt. t/acre		
2012	Let Us Farm	'Strider'+ peas+red clover	Squash	3	flail + rototill	3.44	(0.14)	a
					roll/crimp + strip till	0.34		b
					flail + strip till	0.17		b
	Kirsop Farm	'Strider' + crimson clover	Squash	3	deck mow + rototill	4.65	(0.55)	a
					deck mow + strip till	1.59		b
2013	Let Us Farm	'Aroostook'	Squash	4	flail + rototill	ND*		
					roll/crimp + strip till	ND		
					flail + strip till	ND		
	Kirsop Farm	'Aroostook'	Squash	4	flail + rototill	3.38	(1.18)	a
					roll/crimp + strip till	3.53		a
					flail + strip till	0.88		a
						Dry biomass lbs/acre		
	Kirsop Farm	Common vetch	Broccoli	2	flail + strip till	3144	(327)	
					flail + rototill	2082	(197)	
			Kale	2	flail + strip till	1204	(164)	
					flail + rototill	1213	(78)	
						Fresh head wt, lbs/acre		
2014	Kirsop Farm	Common vetch	Broccoli	4	flail + strip till	13,349	(2065)	a
					flail + rototill	12,297		a

Means followed by the same letter are not significantly different at $p<0.05$ within each unique on-farm experiment. *Weed pressure was extremely high and there was no harvestable crop in reduced tillage treatments at Let Us Farm in 2013. No yield data was taken. Reps=replications, SE=standard experimental error

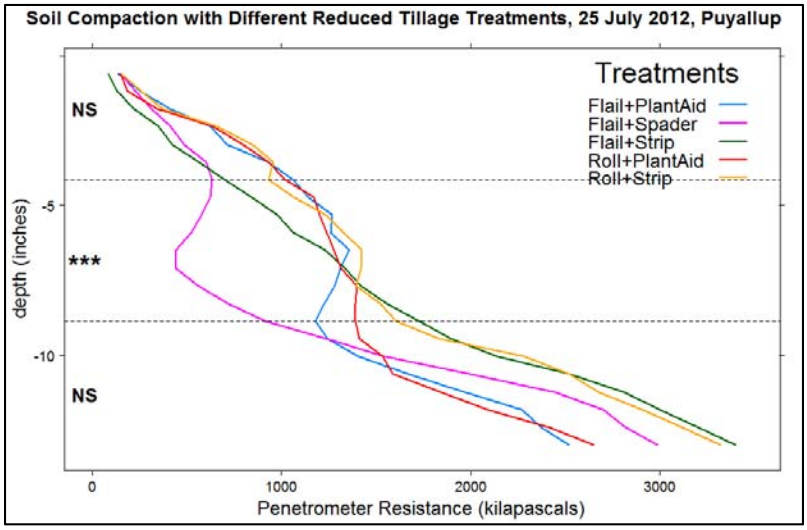

Figure 2. Soil compaction with different reduced tillage treatments, 25 July 2012, WSU Puyallup.

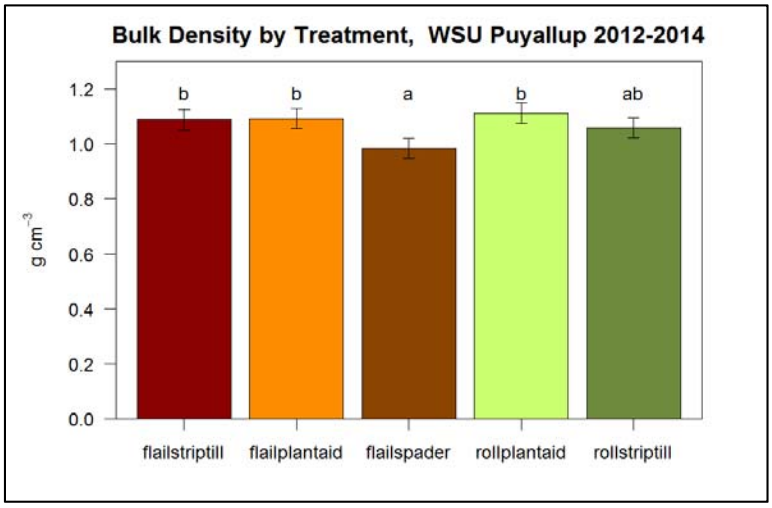

Figure 3. Soil bulk density with different reduced tillage treatments, 2012-2013, WSU Puyallup. Means sharing the same letter are not significantly different at $p<0.05$. Bars are standard error.

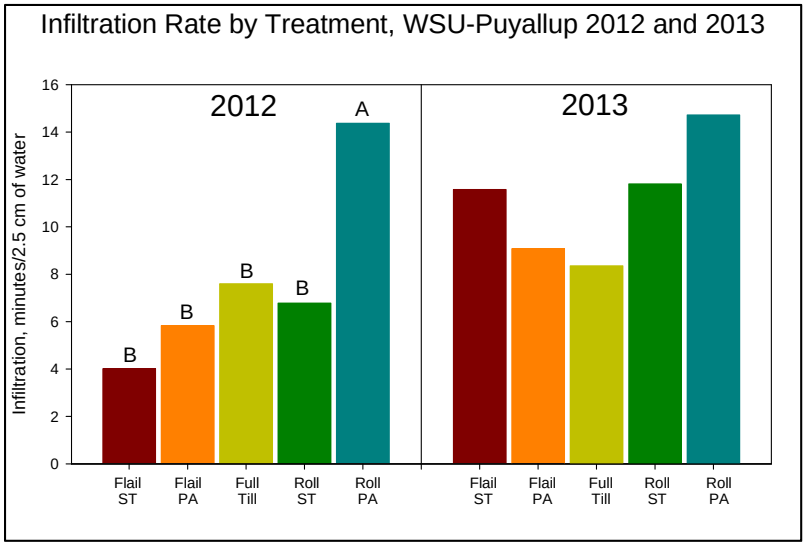

Figure 4. Infiltration with different reduced tillage treatments, 2012-2013, WSU Puyallup. Means sharing the same letter are not significantly different at $p<0.05$. Bars are standard error.

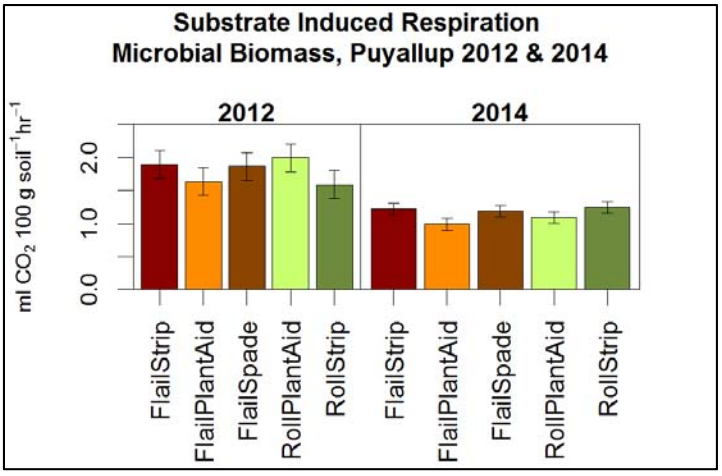

Figure 5. Substrate induced respiration microbial biomass with different reduced tillage treatments, 2012 and 2014 at WSU Puyallup. Bars are standard error.

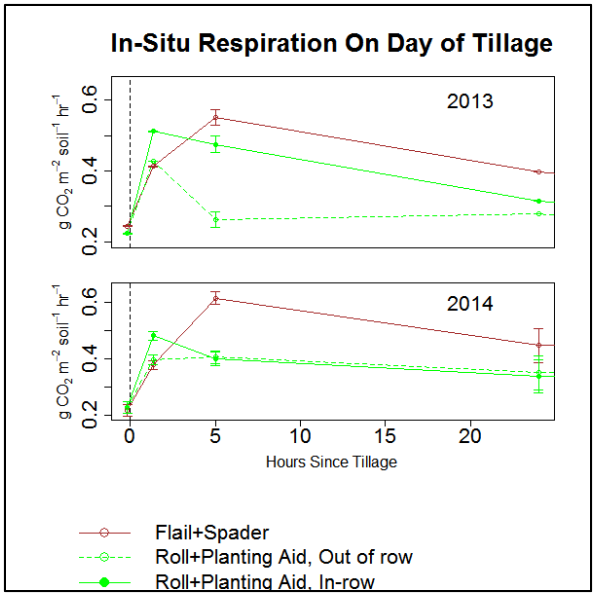

Figure 6. In-situ soil respiration (g CO_2 m^{-2} hr^{-1}) by hours on the day of tillage. Error bars represent standard error of the mean of each day and the dashed gray line is time of tillage.

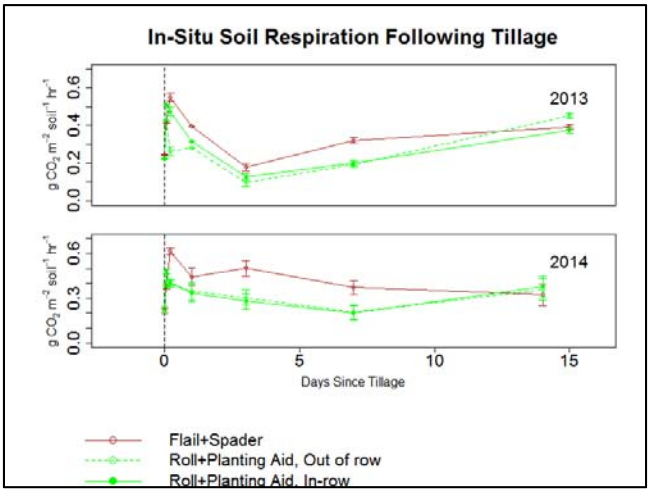

Figure 7. In-situ soil respiration (g CO_2 m^{-2} hr^{-1}) by day following tillage in 2013 and 2014. Error bars represent the standard error of the mean of each day and the dashed gray line is time of tillage.

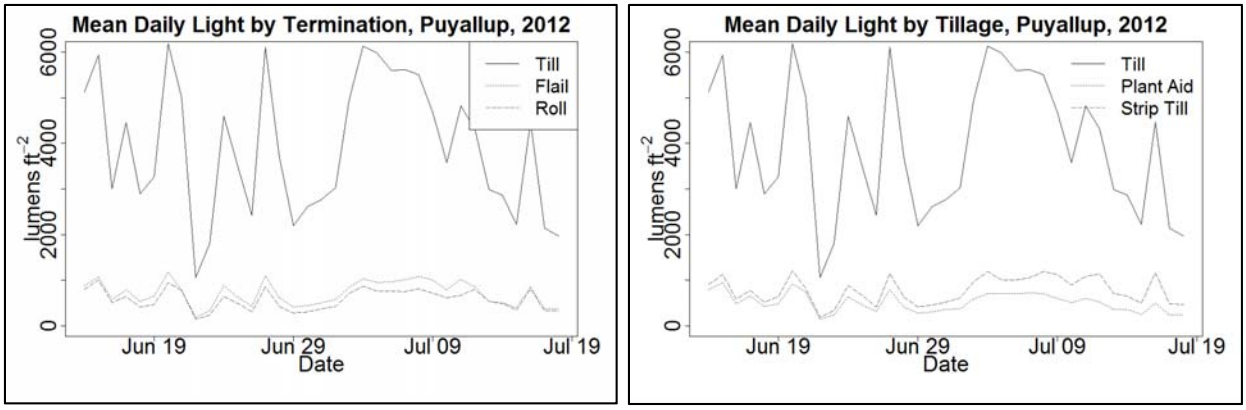

Figure 8. Mean daily light by termination (a) and by tillage (b) at WSU Puyallup in 2012.

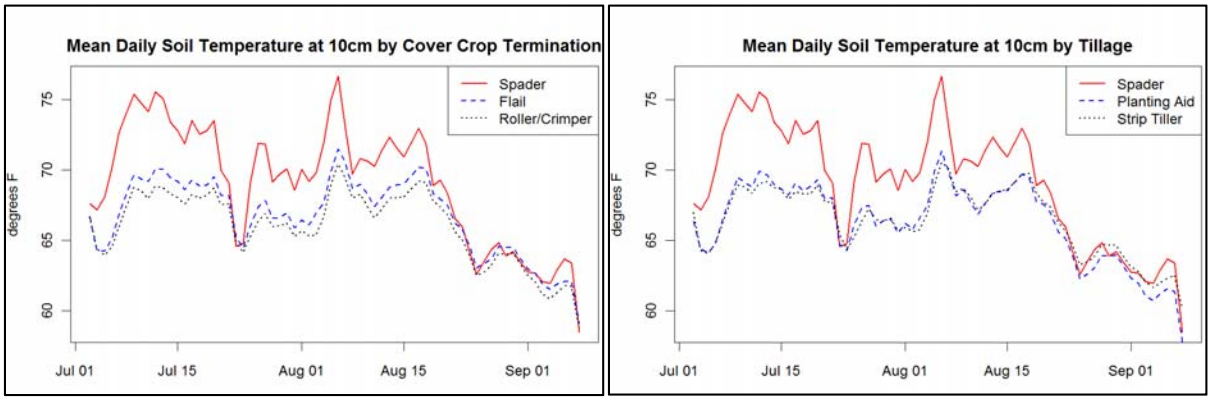

Figure 9. Mean daily soil temperature at 10cm by termination (a) and by tillage (b) at WSU Puyallup in 2012.

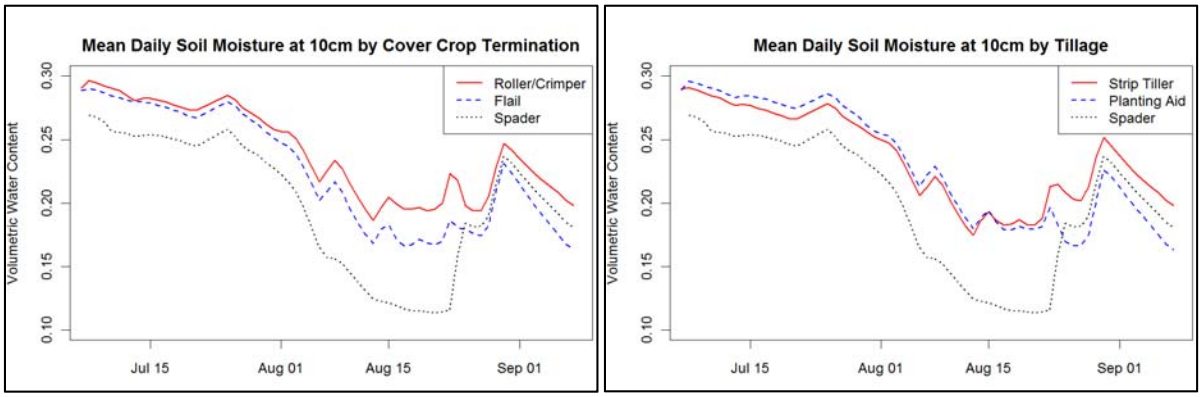

Figure 10. Mean daily soil moisture at 10cm by termination (a) and by tillage (b) at WSU Puyallup in 2012.

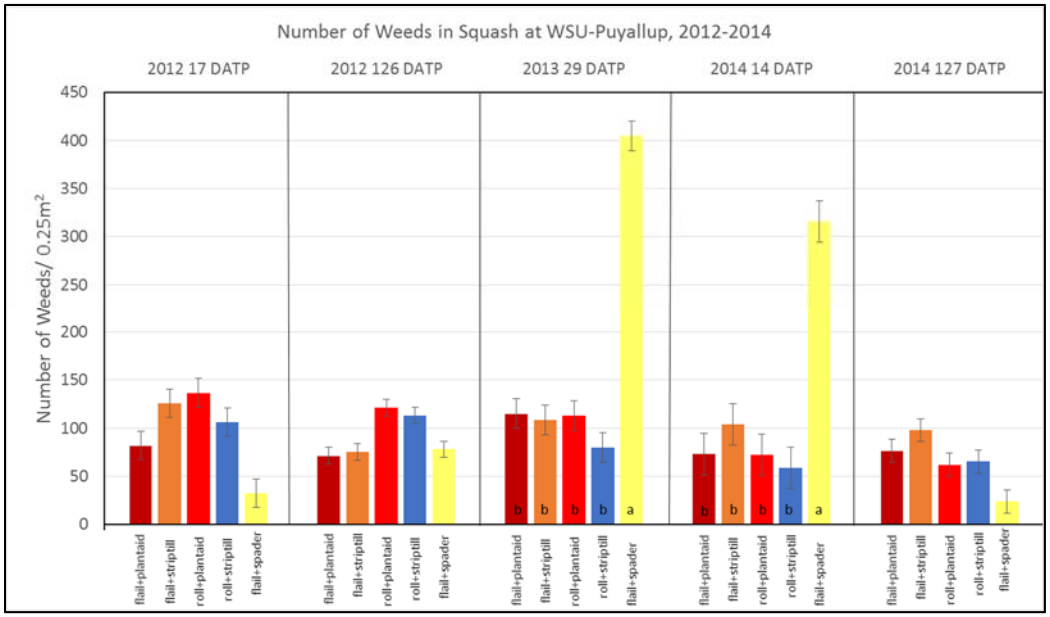

Figure 11. Number of weeds by treatment at WSU Puyallup, 2012-2014. DATP=days after transplanting.

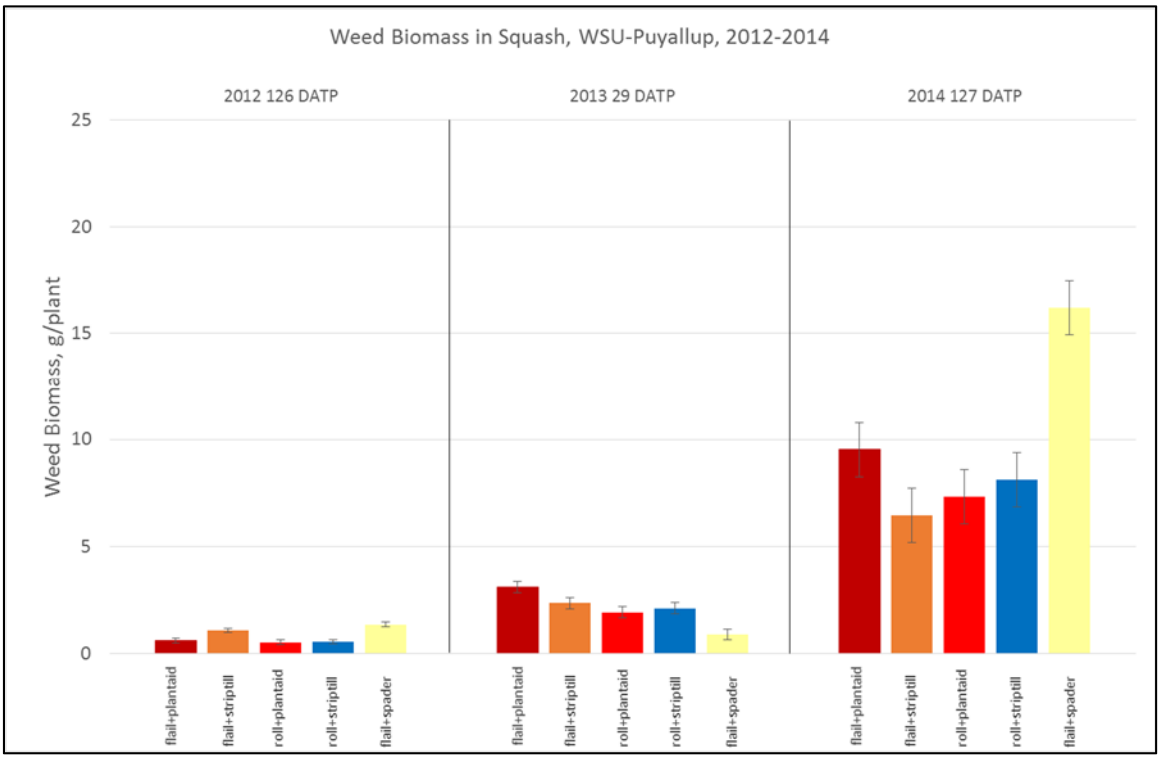

Figure 12. Weed biomass by treatment at WSU Puyallup, 2012-2014. DATP=days after transplanting.

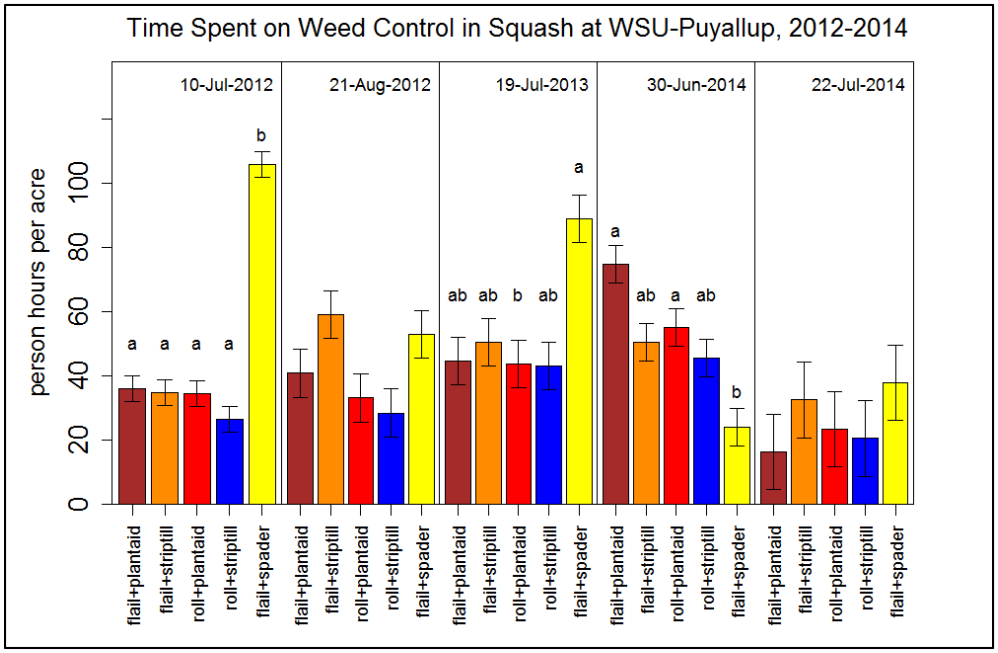

Figure 13. Time spent on weed control in squash at WSU Puyallup, 2012-2014.

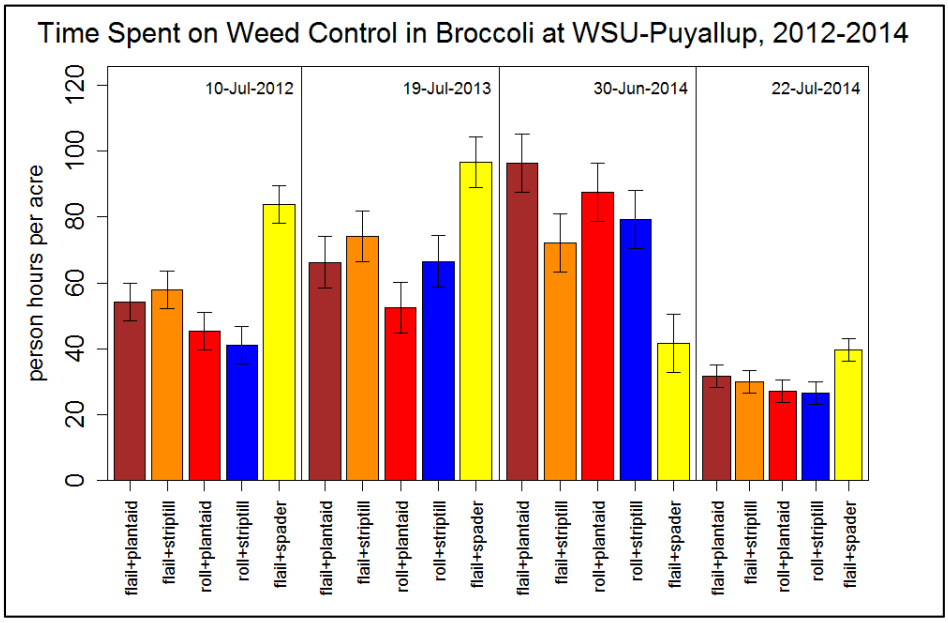

Figure 14. Time spent on weed control in squash at WSU Puyallup, 2012-2014.

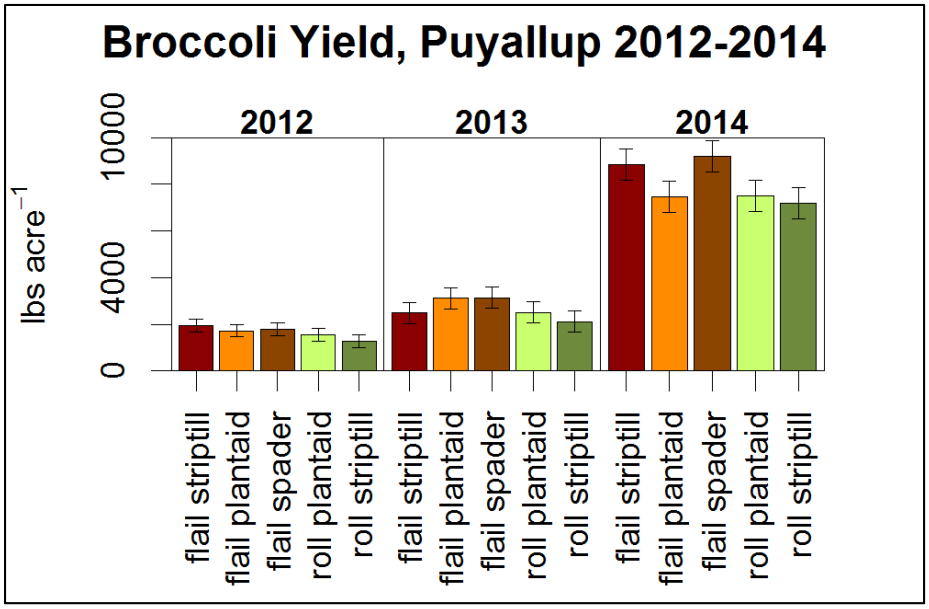

Figure 15. Broccoli yield by treatment at WSU Puyallup, 2012-2014**.** Treatment was not significant in any year. Bars are standard error.

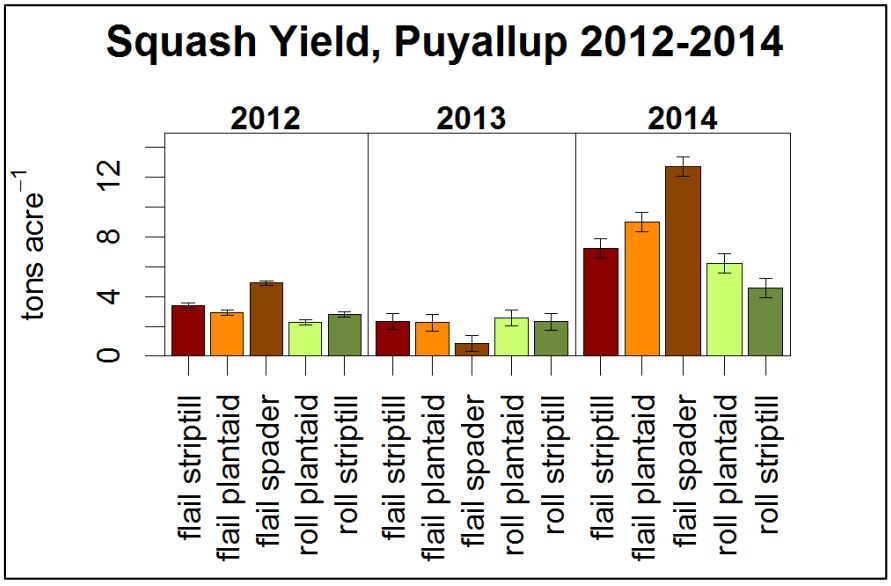

Figure 16. Squash yield by treatment at WSU Puyallup, 2012-2014. Treatment was significant in 2012 and 2014 ($p<0.0001$). Bars are standard error.

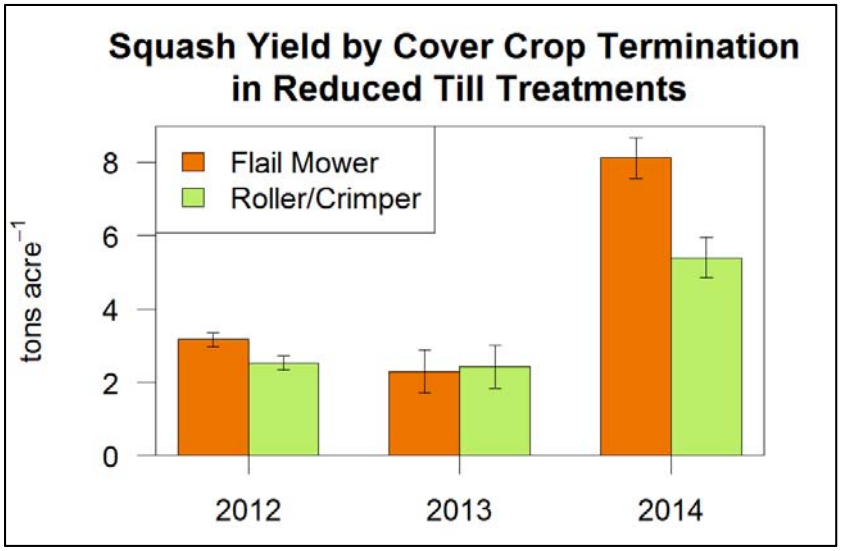

Figure 17. Squash yield at WSU Puyallup by cover crop termination method within reduced tillage treatments in 2012-2014. Termination method was significant in 2012 and 2014 ($p=0.008$, $p<0.001$). Bars are standard error.

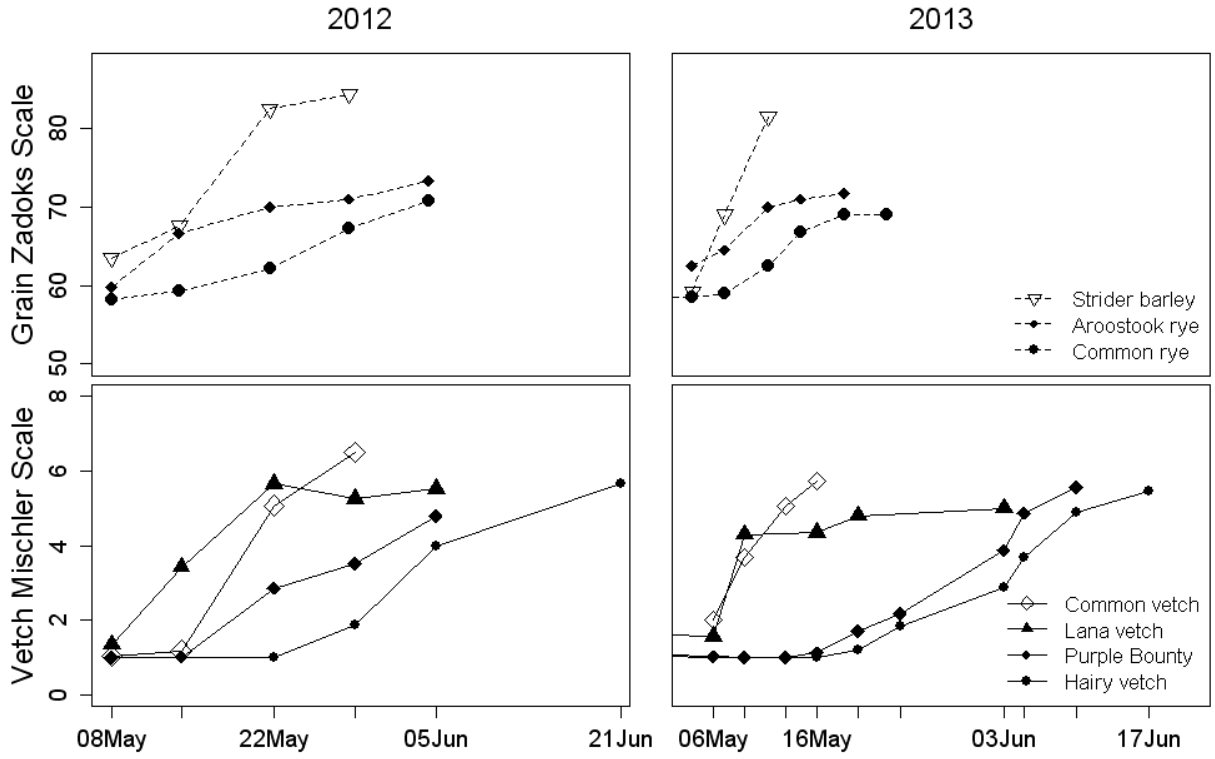

Figure 18. Vetch and grain development May-June in 2012 and 2013 using Zadok's development scale for 3 grains and Mischler's et. al. scale for 4 vetches(2009). Zadok's stages are: 50-60 inflorescence emergence, 60-70, anthesis, 70-80 milk development. Vetch stages are: 4 = 60% flowering, 6 = 100% flowering, 7 = Early pod set (Wayman 2013).

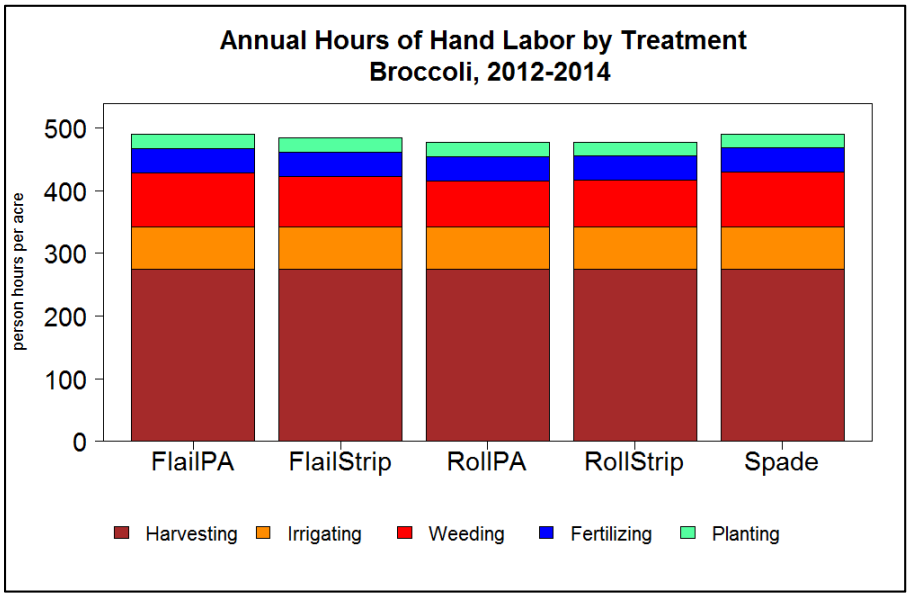

Figure 19. Annual hours of hand labor by treatment in broccoli production, WSU Puyallup, 2012-2014.

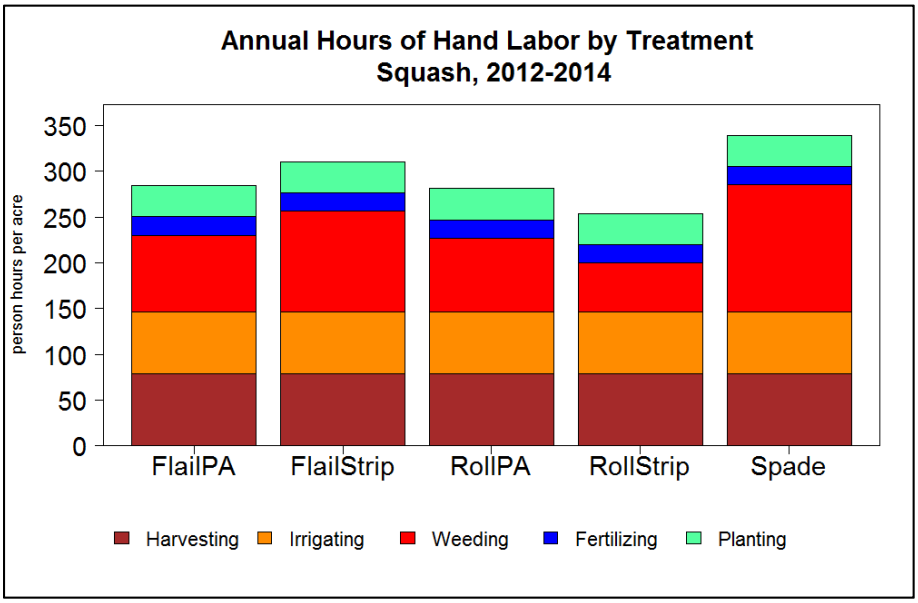

Figure 20. Annual hours of hand labor by treatment in squash production, WSU Puyallup, 2012-2014.

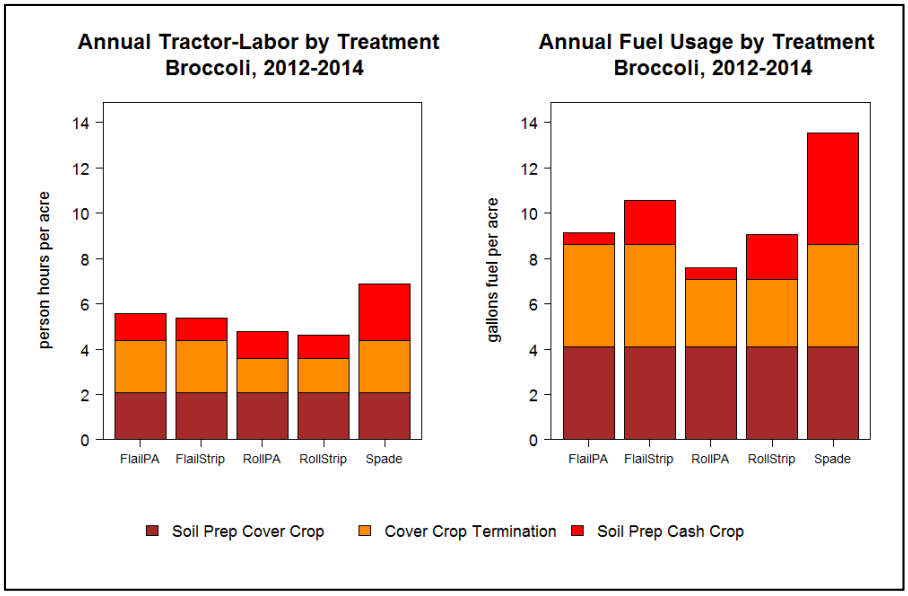

Figure 21. Annual hours of tractor labor and fuel usage by treatment in broccoli production, WSU Puyallup, 2012-2014.

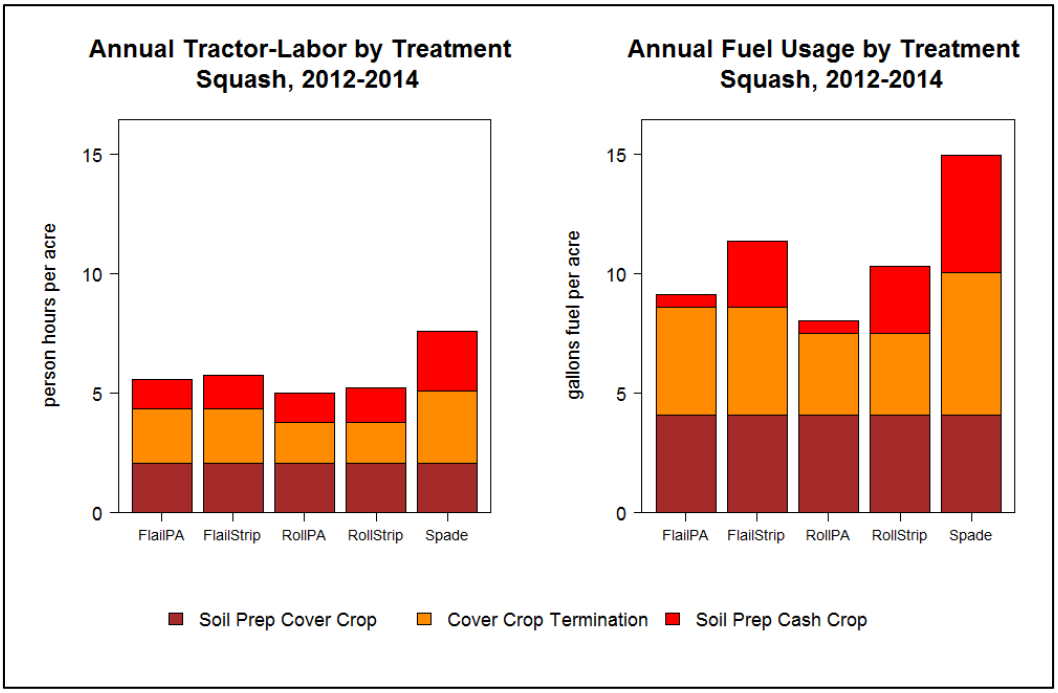

Figure 22. Annual hours of tractor labor and fuel usage by treatment in squash production, WSU Puyallup, 2012-2014.