Evaluation of an Organic Reduced Tillage System in the Pacific Northwest and the Influence on Weed Populations

C.A. Benedict[1], S. Wayman[2], D. Collins[3], C. Cogger[2], A. Bary[2], A. Corbin[4];
[1]Washington State University, Bellingham, WA, [2]Washington State University, Puyallup, WA, [3]Washington State University Extension, Puyallup, WA, [4]Washington State University, Everett, WA.

Project Objectives

- Identify production methods that effectively integrate cover crops and reduced tillage technologies to improve soil quality while reducing in-season weed pressure and seed bank populations on western Washington organic farms;
- Evaluate profitability and life cycle impacts of reduced tillage cropping systems on these farms; and
- Facilitate adoption of reduced tillage technologies and ideas to a wide audience and identify tools and strategies most effective at encouraging behavior change.

Methods

In the fall of 2011, 'Strider' barley was planted (100 lbs/A) as a cover crop at the WSU Puyallup Research and Extension Center in Puyallup, WA. The experimental design is a split-plot including 6 main treatments and 3 sub treatments and is located in an area 290 X 240 feet (1.6 acres). The entire area includes 87 sub-plots (Figure 1) but only 72 will be used for the experiment. Prior to treatment layout, fifty sample sites were located across the experimental area in a geostatistical sampling scheme and soil collected at each site. Soils were assessed for seedbank density by placing samples into a heated (75F°D:60F°N) greenhouse with supplemental lighting (14 hrs.). Emerged weeds were counted, identified to species level and data analyzed. A correlation matrix was developed from all weed data with the R statistical software package. Isopleth maps were generated through kriging with the spatial analyst tool in ArcMap (ESRI). Results from this analysis determined replication placement across available plots (Figure 2).

Once blocking was determined, main plots (30' X 60') and subplots (10' X 60') were setup with four replications consisting of the following six tillage treatments: 1) Flail-mowing + full till, 2) flail-mowing + strip till, 3) flail-mowing + planting aid, 4) rolling/crimping + strip till, 5) rolling/crimping + planting aid, 6) relay cover crop planting + flail-mowing + full till (Table 1). The sixth treatment would not be initiated until the fall of 2012 and as such has been omitted from analysis as reported here. The barley cover crops was terminated at the early milk stage by either a flail-mower or a roller/crimper. Each subplot was planted to either: a) green beans, b) broccoli, or c) winter squash. These cash crops will be rotated over the course of this three-year study through the split-plots, while the main plot tillage treatment remains the same. Plots were hand-weeded as needed (1-2 times) and total weeding time recorded.

Weed populations were assessed at several points throughout the experiment. In the spring of 2012, twelve soil samples (125in^3) were taken from each split-plot (following the winter squash over time) to monitor seedbank density. In season weed counts (1/4m^2) occurred by location (in-row and between-row) and over time (17- and 102-days after planting) at the subplot level (winter squash only). Weed biomass samples were taken on all assessment dates. All hand-weeding times were recorded. All data was analyzed utilizing PROC GLM (SAS Institute, NC) and were considered significant at the p=0.05 level.

Results

- Overwintering cover crop biomass was significantly lower in rolled/crimped + planting aid plots (Figure 3).
- At either assessment date, emerged weed density was not significantly different amongst tillage treatments (Table 2)
- Early season weed counts (17 DATP). were numerically lower in the intra-row region of the winter squash crop across all tillage treatments as compared to the inter-row region.
- Later season weed counts (102 DATP) exhibited a more balanced distribution of emerged weeds within a plot.
- Weed biomass was significantly reduced in flail-mowed + spader plots when compared to flail-mowed + strip tilled plots or rolled/crimped + planting aid at 17 DATP (Figure 4).
- There was no difference in weed biomass amongst treatments prior to harvest (Figure 5).
- Total hand weeding times were not significantly different between tillage treatments.
- Winter squash yields were significantly lower in reduced tilled plots (Figure 6).

Figure 1. Isopleth maps for total weeds (weeds/kilo soil) and experimental area (260' X 240') prior to plot assignment (Spring 2012).

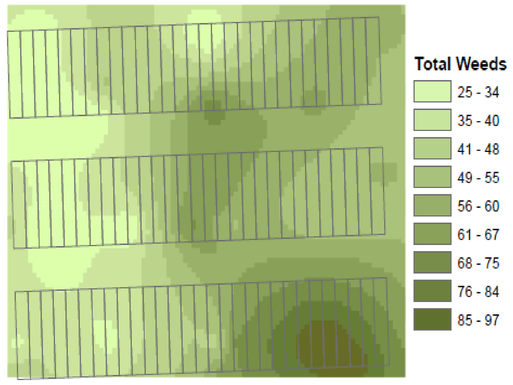


Figure 2. Final block distribution for reduced tillage experiments.

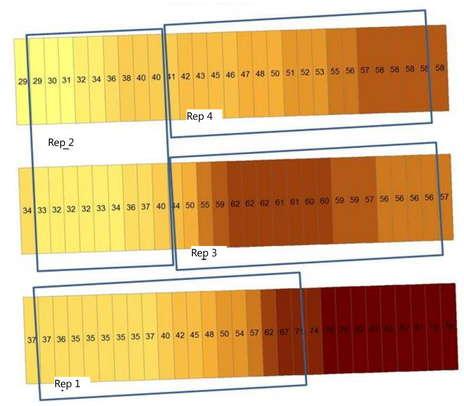


Figure 3. Overwintering 'Strider' Barley Cover Crop Biomass, Reduced Tillage Trial, WSU Puyallup R&E Center.

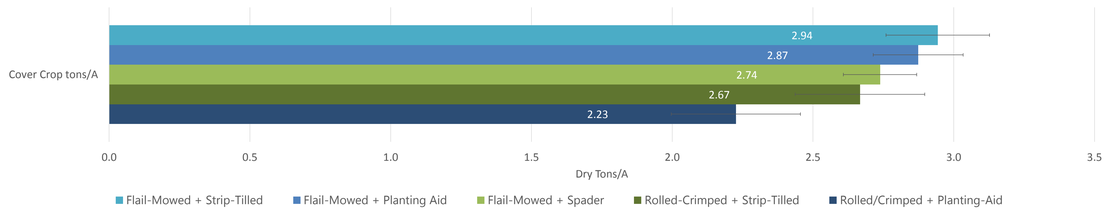


Figure 4. Weed biomass (g/1/4m2) at 17 DATP.

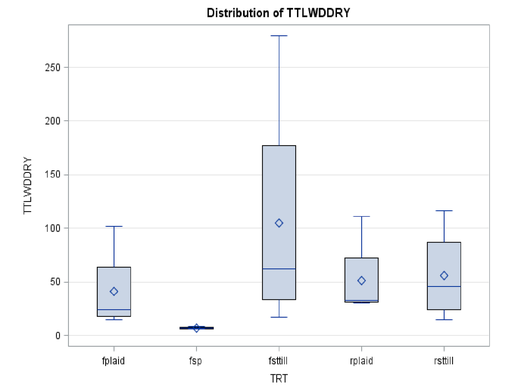
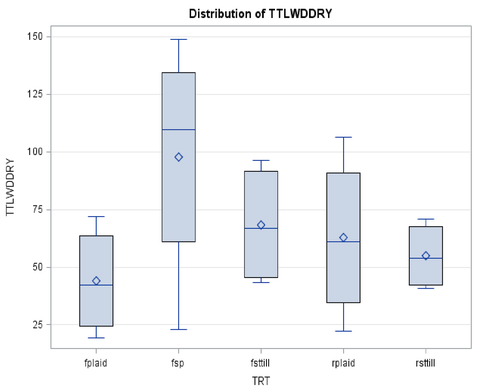


Figure 5. Weed biomass (g/1/4m2) prior to harvest (102 DATP).

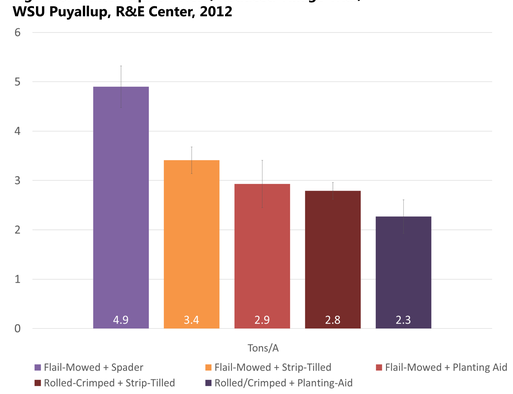


Cover Crop Termination Methods

Flail-Mower

Roller/Crimper Mechanical Termination

Figure 6. Winter Squash Yield, Reduced Tillage Trial, WSU Puyallup, R&E Center, 2012



Subsequent Primary Tillage Tools

Spader

Strip Tiller

Custom Made Planting Aid

Table 1. Treatment List Consisting of Cover Crop Termination Method and Subsequent Primary Tillage Tool Reduced Tillage Trial, WSU Puyallup R&E Center, 2012

Treatment	Cover Crop Termination Method	Primary Tillage	Termination Date	Primary Tillage Date	Transplanting Date
FSP	Flail-Mowed	Spader	5/24/2012	6/6/2012	6/11/2012
FSTTILL	Flail-Mowed	Strip-till	5/24/2012	5/7/2012	6/11/2012
FPLAID	Flail-Mowed	Planting Aid	5/24/2012	6/6/2012	6/11/2012
RSTTILL	Roller/Crimper	Strip-till	5/24/2012	5/7/2012	6/11/2012
RPLAID	Roller/Crimper	Planting Aid	5/24/2012	6/6/2012	6/11/2012

Table 2. Emerged weeds at 17- and 102 DATP and their within-plot location.

			17 DATP			102 DATP		
Treatment	Cover Crop Termination Method	Primary Tillage	In-Row	Between-Row	Total	In-Row	Between-Row	Total
			% Total		Weeds/1/4m^2	% Total		Weeds/1/4m^2
FSP	Flail-Mowed	Spader	34%	66%	32.5a	47%	54%	78.0a
FSTTILL	Flail-Mowed	Strip-till	6%	94%	125.5a	65%	35%	75.5a
FPLAID	Flail-Mowed	Planting Aid	24%	77%	82.0a	63%	37%	71.5a
RSTTILL	Roller/Crimper	Strip-till	12%	88%	106.3a	58%	42%	113.3a
RPLAID	Roller/Crimper	Planting Aid	25%	75%	136.8a	59%	41%	121.3a
					p = 0.3872			p = 0.3270

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