New Tools and Techniques for High Residue Organic Vegetable Strip Tillage in the Maritime Pacific Northwest

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Introduction

Soil health concerns in conventional tillage systems have increased interest in reduced tillage practices to enhance soil. Traditional organic production relies on soil disturbance through field cultivation to manage weeds. High residue mulch created by terminating cover crops in spring can minimize disturbance and suppress annual weeds. Large amounts of cover crop residue can, however, reduce soil temperature and interfere with planting and weeding. Strip tilling is a form of reduced tillage that prepares a planting strip similar to full width tillage and thus has promise for adoption. Three new reduced tillage tools and techniques were trialed in western Washington to increase adoption : 1) powered strip tillage, 2) continuous minimum tillage, and 3) strip-planting cover crops. We hypothesized that:

1. Powered strip tillage would increase soil temperature and vegetable yield relative to no till
2. Continuous reduced tillage would produce similar cover crop and cash crop yields relative to rotational reduced tillage and full till
3. Strip planted cover crops would decrease in-row biomass and improve strip tiller operation

Experimental Design

Sq	Br	Bn	Sq	Br	Bn	Sq	Br	Bn	Sq	Br	Bn	Sq	Br	Bn	Sq	Br	Bn
flailing + no-till			flailing + strip till			roll/crimp + strip till			roll/crimp + no-till.			flailing + complete till			cont. red till flail + strip till		
Fall tillage before cover crop															No fall tillage		

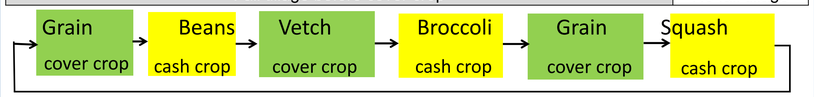

Figure 1. One of four replicates (top) and rotation scheme (bottom) in the WSU Puyallup Long-term Organic Reduced Tillage Systems Experiment. Sq=squash; Br= broccoli; Bn = beans.

- The Long-term Organic Reduced Tillage Systems Experiment compares No Till, Strip Till and Full Till and was initiated fall 2011.
- Cover crops were terminated with a roller crimper or flail mower.
- In fall 2014, a continuous reduced tillage treatment was introduced and strip tillage was transitioned from ground-driven to powered strip tillage.

Powered Strip Tillage

Figure 2. Custom-built powered strip tiller side view (a) and working in heavy flail-mowed rye residue (b)

- The powered strip tiller (Figure 2a-b) combines a coulter and row cleaner (Dawn 1572-RH, Sycamore, IL) inline with a shank and powered multivator (Maschio Model K, Campodarsego, Italy).
- The powered strip tiller was compared with a no-till treatment implemented with a transplanter with no-till attachment (Mech. Transplanter Model 5000WD, Holland, MI) (Figure 3) and a rotary spader (Full Till; not pictured)

Figure 3. Trans-planter with no-till attachment.

Tillage effect on soil temperature

- In 2016, Strip Till resulted in warmer soil temperatures than No Till in mid June, three weeks after transplant. In 2017, Strip Till did not increase soil temperature relative to No Till.
- Following transplant, Full till tended to have higher soil temperatures than the reduced till treatments in 2016 and 2017.

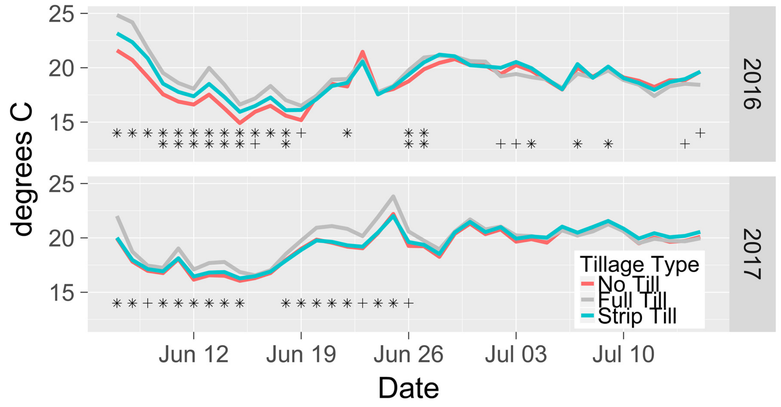

Figure 4. Soil temperature at 10cm in Full Till, No Till, and Strip Till in 2016 and 2017 in squash. Statistical significance was evaluated each day for the mean daily temperature with contrasts between reduced till treatments and full till (top line) and between Strip Till and No Till (bottom line). * indicates $p<0.05$, $^+$ indicates $p<0.1$. There was no significant difference between Strip Till and No Till in 2017. Squash was transplanted 25 May in 2016 and 2017.

Continuous Reduced Tillage

- Eliminates inversion tillage frequently used in fall to prepare soil for cover crop planting.
- Soils were disturbed with an undercutter (Figure 4a) to reduce weed pressure then cover crop was sown with a minimum till drill (Landpride 3P500, Salina KS; Figure 4b.)

Figure 5. Undercutting before seeding fall cover crops (a) and planting cover crops with minimum till drill (b). In continuous reduced tillage treatment.

Cover crop yield with different fall tillage

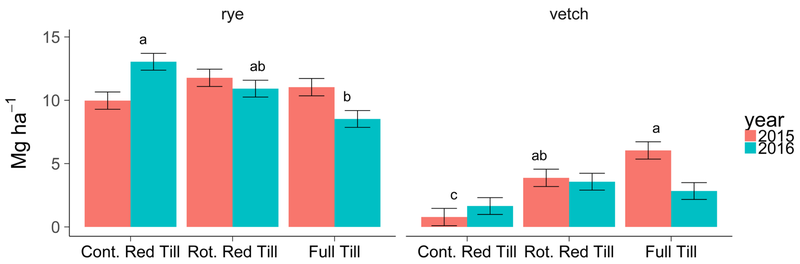

Figure 6. Biomass of Aroostook rye and common vetch cover crop with continuous reduced tillage, rotational reduced tillage, and full tillage. Rotational reduced tillage treatments are tilled in the fall prior to cover crop planting (Figure 1).

- Removing fall tillage yielded equal or greater rye cover crop biomass compared to Full Till. Vetch biomass was larger in full till and rotational reduced till in 2015 (Figure 6).

Vegetable crop yield

- Squash yield was significantly reduced by the no-till treatment compared to strip tillage (Figure 7).
- Reduced tillage treatments where flail mowing was used to terminate cover crop also yielded greater squash than treatments where cover crop was terminated with a roller crimper.
- Continuous reduced tillage, with strip tilling preceding the cash crop, was equal to rotational reduced tillage with strip tillage and full tillage.
- There was a significant year by treatment effect for broccoli.
- In 2016, continuous reduced tillage yielded significantly more broccoli than all other treatments (Figure 7).
- In 2017, the No Till treatment yielded less broccoli.

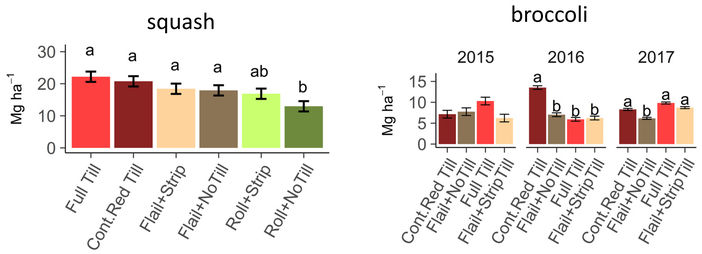

Figure 7. Squash and broccoli yield in the WSU Puyallup Long-term Organic Reduced Tillage Systems Experiment. Squash was preceded by Aroostook rye that was terminated with either a roller crimper or flail mower. Broccoli was preceded by common vetch and terminated with a flail mower in all treatments.

Strip Planting Cover Crops

- Cover crop strip planting, where different cover crops can be planted in the in-row and between row regions, is a promising technique to pair with strip tilling (Figure 8).
- Rye may be desirable between rows for weed suppression, but the high residue ischallenging for strip tillage and may lower soil temperatures. Strip tillage proceeds more easily with lower biomass cover crops.
- Vetch, clover, and radish produce lower biomass than rye and, in the case of legumes, can contribute additional N.

Figure 8. Hairy vetch, daikon radish, and crimson clover planted alone or in strips with Aroostook rye.

- Vetch strip planted with rye is currently being trialed with strip tilled sweet corn. Strip planting lower biomass cover crops, coupled with powered strip tillage, may increase soil temperature and favor warm-season crops such as squash and corn.

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