Strip Tillage and Cover Crop Effects on Tomato and Pepper Yield

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Introduction

Vegetable crops, including pepper and tomato, are typically grown using raised beds topped with drip tape and covered with plastic mulch. Plastic mulch enhances yield by warming soils, and reducing evaporation and weed pressure. However, bed establishment also requires intense tillage, which degrades soil structure, contributes to runoff and erosion, and intensifies reliance on non-renewable resources. Reduced tillage systems lack these negatives but, so far, have been less productive than standard plastic-based systems. The crop grown, and type and condition of cover crop and its residue strongly affect crop performance in reduced tillage systems. Vegetable production systems with less tillage but cover crops are under-tested and, possibly, under-utilized in Ohio. We set out two paired studies in 2015 at the OARDC in Wooster, Ohio to document the yield of tomato and pepper plants grown in plots representing different seedbed (tillage) and mulch combinations.

Materials and Methods

Plot Establishment

Each study (pepper, tomato) used a split-plot design with four replications; system (raised bed and plastic mulch vs. flat strip-till) was the main plot and cover crop (living vs. dead) was the sub-plot. The field was sown to winter wheat in Fall-2014. In Spring-2015, standard beds (raised, topped with plastic and drip tape) were established in selected plots by plowing, applying herbicide, and broadcasting pre-plant fertilizer at a rate of 90 Kg·ha^{-1} of N. Then, annual ryegrass seed was broadcast over the top and into the furrows of half of all standard plots as living mulch; wind moved ryegrass seed to bed edges (Fig. 1A). Strip-till plots were not plowed; instead, wheat was mowed to promote tillering. Two weeks later, wheat was either sprayed (strip-till dead mulch plots) or mowed again (strip-till living mulch plots). Then, a PTO-driven roto-tiller with one pair of tines was used to create 25-cm wide by 15-cm deep strips in the living and dead wheat plots (Fig. 1B-D). Different from the standard system, pre-plant fertilizer was spread directly into tilled strips but at a same rate.

Transplanting and Plot Management

'Mountain Fresh' tomato and 'Aristotle' pepper were transplanted into standard and strip-till plots in single rows. All plots were drip irrigated. Ryegrass and wheat living mulches were mowed several times to limit their height but remained alive. Herbicides were used to limit weed growth in dead mulch plots.

Both crops received a total of 4.35, 0.63, 3.61, 1.16, and 0.58 kg of supplemental elemental N, P, K, Ca, and Mg, resp., through weekly fertigation 7/20-9/9, regardless of tillage-mulch treatment.

Broadcast-seeding of annual ryegrass in half of all standard plots (Fig 1A); Using PTO-driven roto-tiller with single tine to create 25-cm wide x 15 cm deep seedbeds in strip-till plots (Fig 1B-D).

Harvest and Statistical Analysis

Fruit were harvested 6 (pepper) or 7 (tomato) times 7/28-9/30. Yield and fruit number data from both studies were: a) transformed based on a 1000-plant population and b) analyzed separately using SAS 9.4. ANOVA tested tillage, mulch, and interaction effects. Main effect means were compared using Fisher's LSD test ($P \leq 0.05$). Tillage-mulch interaction effects were tested using PROC GLM and LSMEANS ($P \leq 0.05$).

Results

1) For both crops, total irrigation hours for the two tillage methods were the same due to excessive rainfall in June and July and equal hours of fertilizer injection from July to September.

2) In general, tomato and pepper yields were greater in the standard versus strip-till system, but the effect was more pronounced in pepper.

3) Tillage significantly affected six of seven yield variables in pepper (Table 1) but only two variables in tomato (Table 2).

4) Using dead versus living mulch resulted in greater tomato, but not pepper, yield (Tables 1 and 2).

5) For both crops, the harvest at which yield was greatest occurred later in strip-till than standard plots.

Pepper

Table 1. Main effects of tillage and mulch on pepper yield based on 1000 plants grown in Wooster, OH in 2015.

	No. of Fruit	Total Yield (Kg)	Avg. Fruit Wt (g)	# Marketable Fruit	Marketable Yield (Kg)	Avg. Marketable Fruit Wt (g)	% of Marketable Yield in Total Yield
Seedbed/Tillage							
Raised-Plastic	18000*	3235*	175*	16525*	3010*	180*	93.05
Flat-Strip	5175	765	140	4940	730	140	95.40
Mulch							
Dead	12815	2270	165	11715	2105	165	92.75
Living	10365	1725	155	9750	1635	155	94.75

Tomato

Table 2. Main effects of tillage and mulch on tomato yield based on 1000 plants grown in Wooster, OH in 2015.

	No. of Fruit	Total Yield (Kg)	Avg. Fruit Wt (g)	# Marketable Fruit	Marketable Yield (Kg)	Avg. Marketable Fruit Wt (g)	% of Marketable Yield in Total Yield
Seedbed/Tillage							
Raised-Plastic	26040*	5580*	215	9485	2180	230*	39.05
Flat-Strip	20040	4160	205	7360	1605	205	38.60
Mulch							
Dead	25815*	5510*	215	9625*	2175*	225	39.50
Living	20265	4230	205	7225	1605	220	38.00

Yield by Date

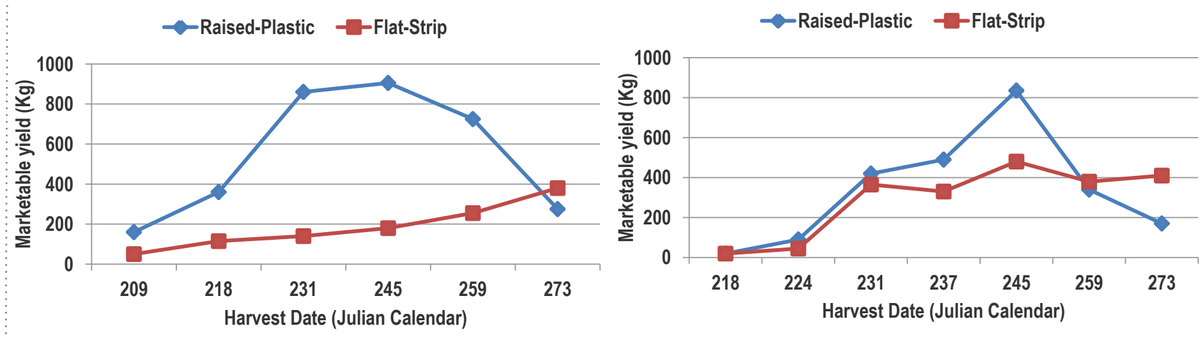

Fig. 2. Marketable yield distributions of pepper (left) and tomato (right) grown in plastic raised-bed and flat strip-till systems in Wooster, OH in 2015.

Conclusions

This study compared pepper and tomato yields in standard, plastic-covered raised bed and flat strip-till systems. As in related tests completed elsewhere, the standard was more productive than the strip-till system. Understanding the underlying causes of reduced productivity in reduced-till systems and developing tools and strategies to limit these effects remains important.

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