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John Krzton-Presson
Iowa State University, johnkp@iastate.edu

Ajay Nair
Iowa State University, nairajay@iastate.edu

Angela Shaw
Iowa State University, angelaml@iastate.edu

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Effects of Tillage and Cover Crops on Muskmelon Production and Food Safety

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John Krzton-Presson, graduate student
Ajay Nair, assistant professor
Department of Horticulture
Angela Shaw, assistant professor
Department of Food Science and Human
Nutrition

Introduction

Reduced tillage has been widely adopted in production of agronomic crops for its potential to improve soil health and reduce input costs. Despite this, vegetable growers largely rely on conventional tillage to incorporate crop residue, control weeds, and to prepare a seed bed for planting. Conventional tillage (CT) may cause declines in water infiltration and soil biodiversity, and increases in nitrate leaching, erosion, and weed germination. Strip tillage (ST) is a form of reduced tillage in which a crop is planted into narrow, tilled strips. The area between strips is left undisturbed. The non-tilled area between the strips might contain residue from the previous season's main crop, or a living or dead cover crop. When compared with CT, ST can provide environmental benefits such as better soil quality and health, reduced erosion, weed suppression, reduced use of herbicides, and improved soil organic matter. However, more research is needed to understand how ST affects crop yield and soil properties. In addition, practicing ST in conjunction with cover crops requires use of additional equipment, including a roller-crimper. A roller-crimper is a tractor mounted implement that knocks over a mature cover crop, killing it mechanically by crimping the stalks, thereby stopping the flow of nutrients. This project explored the feasibility of using the strip-till/roller-crimper system in muskmelon

production. Additionally, the project investigated whether the rolled cover crop ST system would prevent the spread of *Listeria innocua* from contaminated soil to the surface of the fruit. *Listeria innocua* is a harmless bacteria, but related to the pathogenic *Listeria monocytogenes*. *Listeria monocytogenes* is a food-borne pathogen that has a high rate of lethality. In 2011, an outbreak of *L. monocytogenes* originated at a farm in Colorado causing 147 illnesses, 37 fatalities, and one miscarriage.

Materials and Methods

This experiment was a split-plot design with cover crop as the whole plot factor. There were three cover crop treatments: cereal rye (110 lb/ac), cereal rye + hairy vetch, (90 lb/ac and 25 lb/ac, respectively), or no cover crop. The subplot comprised of CT or ST treatment. On September 18, 2014, within each subplot, half of the soil was inoculated with *L. innocua*. This was followed by tillage of the entire field. Cover crops were seeded the same day using a drop seeder followed by shallow tillage to incorporate seeds. In ST plots, the first pass with the strip tiller was made on November 14, 2014 using a Hiniker 6000 strip tiller. Remaining half of the subplot received a second inoculation of *L. innocua* on May 19, 2015. Cover crops in the CT plots were mowed on May 22, 2015, then incorporated with a rototiller. The cover crop in ST plots was roller-crimped on June 1, 2015 when rye was at anthesis using a roller-crimper (I&J Manufacturing, Gap, PA). In the ST plot, a second pass of strip tiller, over the previously tilled strip, was made on June 2, 2015. In CT plots, plastic mulch was laid on June 12, 2015. Aphrodite muskmelons were hand transplanted on June 16, 2015 at 24-in. spacing in all treatments.

Weed biomass was collected on July 8, 2015 from the between-row areas of ST and CT plots. Weeds were described as either grass or broadleaf, counted, dried and weighed. Melons were harvested and graded for marketable yield. Subsamples of two melons were collected from the September 8, 2015 harvest for analysis to detect presence of *L.innocua*.

Results and Discussion

Weed biomass and density. Conventional tillage led to greater dry weight and density of weeds regardless of cover crop, as compared with ST (Table 1). Conventional tillage greatly disturbs the soil bringing weed seeds to the surface, and promoting their germination. By using the roller-crimper and ST system, the soil was minimally disturbed, and where present, the cover crop mulch prevented germination of new weed seeds. However, the weeds present in the ST plots require more labor to remove because of the mulch residue. Over time, fields in reduced tillage tend to see a shift in weed populations toward perennial weeds, which are more difficult to control without herbicide.

Marketable yield. In the first year of this study across all cover crop treatments, CT produced, on average, greater yields than ST (Figure 1). Cereal rye CT produced the greatest yield, and no cover ST produced the lowest, on average. Cereal rye ST and cereal rye + hairy vetch ST produced higher yields than no cover ST. Cereal rye CT and cereal rye + hairy vetch CT produced higher yields than no cover CT. This increase in yield as a result of cover crops is likely due to the increase in soil organic matter, soil health, and the decrease in nutrient leaching during the winter months. ST plots with either a cereal rye or cereal rye + hairy vetch cover crops produced yields that were

comparable to the CT plots with no cover crop. The fact that the yield benefit of CT in the no cover plots did not exceed yields of the ST plots with cereal rye or cereal rye + hairy vetch further highlights the benefits of a cover crop in muskmelon production.

L. innocua Presence. Of the 48 samples analyzed for the presence of *L. innocuai*, seven were positive. There was no apparent effect of tillage or cover crop on the presence of *L. innocua*. Some fruits grown in plots that had been inoculated in the fall tested positive for the presence of *L. innocua*, indicating the bacteria was able to overwinter in the soil and persist for more than 10 months.

Leaving a field fallow through the winter to rid the field of a pathogen (human or plant) after it has been contaminated may not hold true.

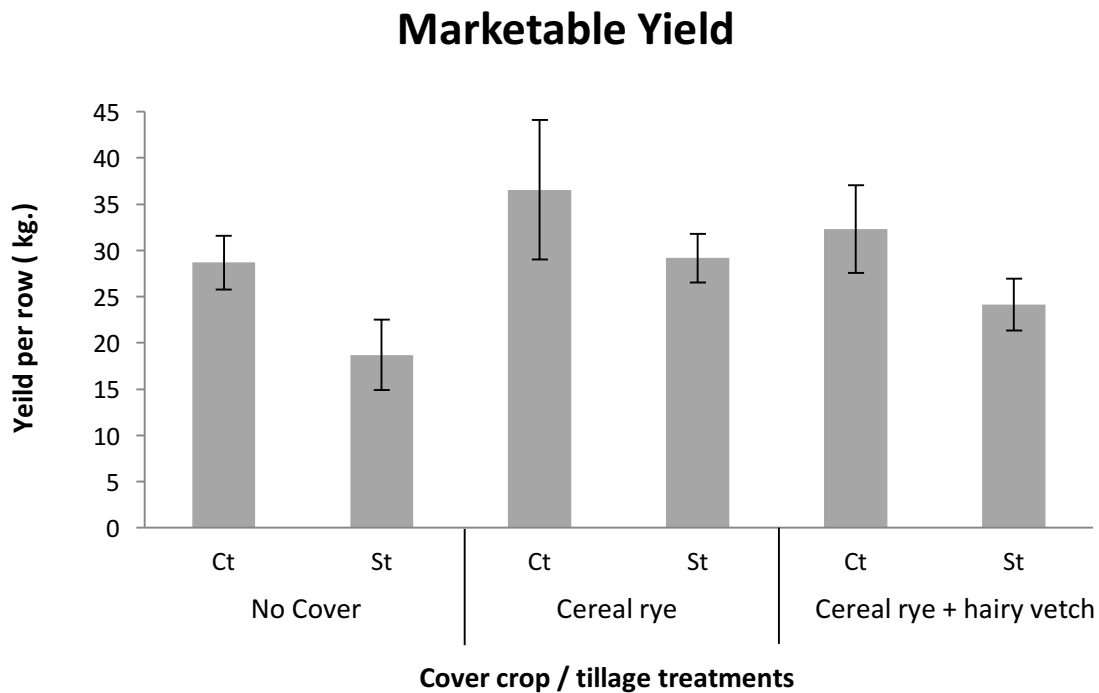
In coming years, growers will be challenged to provide a consistently safe food product. The agricultural sector as a whole currently faces issues of soil health, water quality, and overall sustainability. Through the continuation of this research we will be able to better understand benefits and challenges of reduced tillage systems and their possible influence/interaction in reducing foodborne pathogens on fresh produce.

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Table 1. Mean weed biomass and density as affected by tillage treatments in muskmelon production on July 8, 2015 at the Horticulture Research Station, Ames, IA.

Treatment	Grass		Broadleaf	
	Biomass (g/m ²)	Density (number of weeds/m ²)	Biomass (g/m ²)	Density (number of weeds/m ²)
Conventional tillage	26.95	75	60.04	331
Strip tillage	0.43	4	15.49	36

**Figure 1. Means of total yield (kg) of marketable muskmelon as affected by cover crop and tillage treatment per row (1 row = 7.5 m). Ct = conventional tillage; St = strip tillage. Error bars represent standard error of the mean.**