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

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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 (CT) to incorporate crop residue, control weeds, and prepare a loose seed bed for planting. Conventional tillage may cause reduced water infiltration, lessen soil biodiversity, and increase nitrate leaching, erosion and weed germination. Strip-tillage (ST) only disturbs the soil in a 12-in. strip where the cash crop will be planted, leaving the rest of the field untilled. A roller-crimper is a tractor mounted implement that crushes a cover crop in place, forming a thick biodegradable mulch to protect the soil and suppress weeds between rows. This project explored the feasibility of using the strip-till/roller-crimper system in muskmelon production. Additionally, to determine if rolled cover crop mulch would prevent the spread of *Listeria innocua* from contaminated soil to the surface of the fruit. *L. innocua* is a harmless species of bacteria used as a surrogate for the human pathogen *Listeria monocytogenes*. *L. 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 1 miscarriage.

Materials and Methods

This study was conducted over the course of two growing seasons (2014-15 and 2015-16) at the Iowa State University Horticulture Research Station in Ames, Iowa. The experimental design was a split-plot design, cover crop was the whole plot factor, and tillage was the split plot factor. There were three cover crop levels: no cover crop, cereal rye (110 lb/acre), and cereal rye + hairy vetch, (90 lb/acre and 25 lb/acre, respectively). There were two tillage treatments—CT and ST. Cover crops were established in September of both years using a Gandy drop seeder before lightly tilling in seed. In ST plots, strips were tilled in November using a Hiniker 6000 strip tiller. In CT plots, the cover crop was mowed in late May, then incorporated with a rototiller in early June. Raised beds with black plastic mulch were established for all CT plots. The cover crop in ST plots was roller-crimped in early June when rye was at anthesis using an I&J roller crimper. The seedbed was prepared for ST plots in early June with a Hiniker 6000 strip tiller. Aphrodite muskmelon plants were hand transplanted in mid-June at 24-in. spacing. Conventional production methods were used, and commonly used fertilizers, herbicide, and pesticides were utilized where appropriate and always in accordance with the label. Half of all plots received a soil inoculation with *L. innocua* in the fall and half in the spring.

Melons were harvested and graded for marketable yield. Weed biomass was collected in early July from the between row (BR) areas of ST and CT plots. Weeds were dried until constant weight and weighted. In mid-September, at peak harvest, melons were analyzed for the presence of *L.innocua*.

Results and Discussion

Weed biomass. In 2015, CT led to greater dry weight of weeds regardless of cover crop, as compared with ST (Figure 1). CT greatly disturbs the soil, possibly bringing weed seeds to the surface and promoting their germination. In 2016, No Cover plots had the greatest weed biomass. The greater weed biomass in ST plots compared with CT, though not significant, was likely due to the heavy weed pressure in No Cover ST plots. Because there was no cover crop, overwintering weeds were not suppressed or terminated by tillage. Shortly before planting weeds in the No Cover ST, plots were controlled with herbicide and then mowed. Because some of these weeds had already dispersed seeds, in 2016 the highest weed biomass was observed in No Cover ST plots. By using the roller crimper/ST system, the soil was minimally disturbed, and where present, the cover crop mulch prevented weed growth. However, the weeds that are 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 can be difficult to control without herbicide.

Marketable yield. Significantly higher yields were observed for CT plots in both 2015 ($P = 0.0250$), and 2016 ($P = 0.0341$) (Fig. 2). Though not statistically significant, the highest yielding plots in both years were CT with either Rye (2015), or Rye + Vetch (2016). Higher yield as a result of cover crops is likely due to the improved soil health and the decrease in nutrient leaching during the winter months. The fact that the yield benefit of CT in the No Cover plots did not exceed yields on the ST plots with either Rye or Rye/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. innocua,* seven were positive in 2015, and two were positive in 2016. 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 did test 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 over the winter is not an effective means to eliminating human pathogens. Understanding how human pathogens can survive in the soil will be crucial in growing safe and healthy produce.

In coming years, growers will be challenged with providing 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 and other projects we hope to fulfill our extension obligations to Iowa's farmers by helping them solve today's problems and prepare for the future.

Acknowledgements

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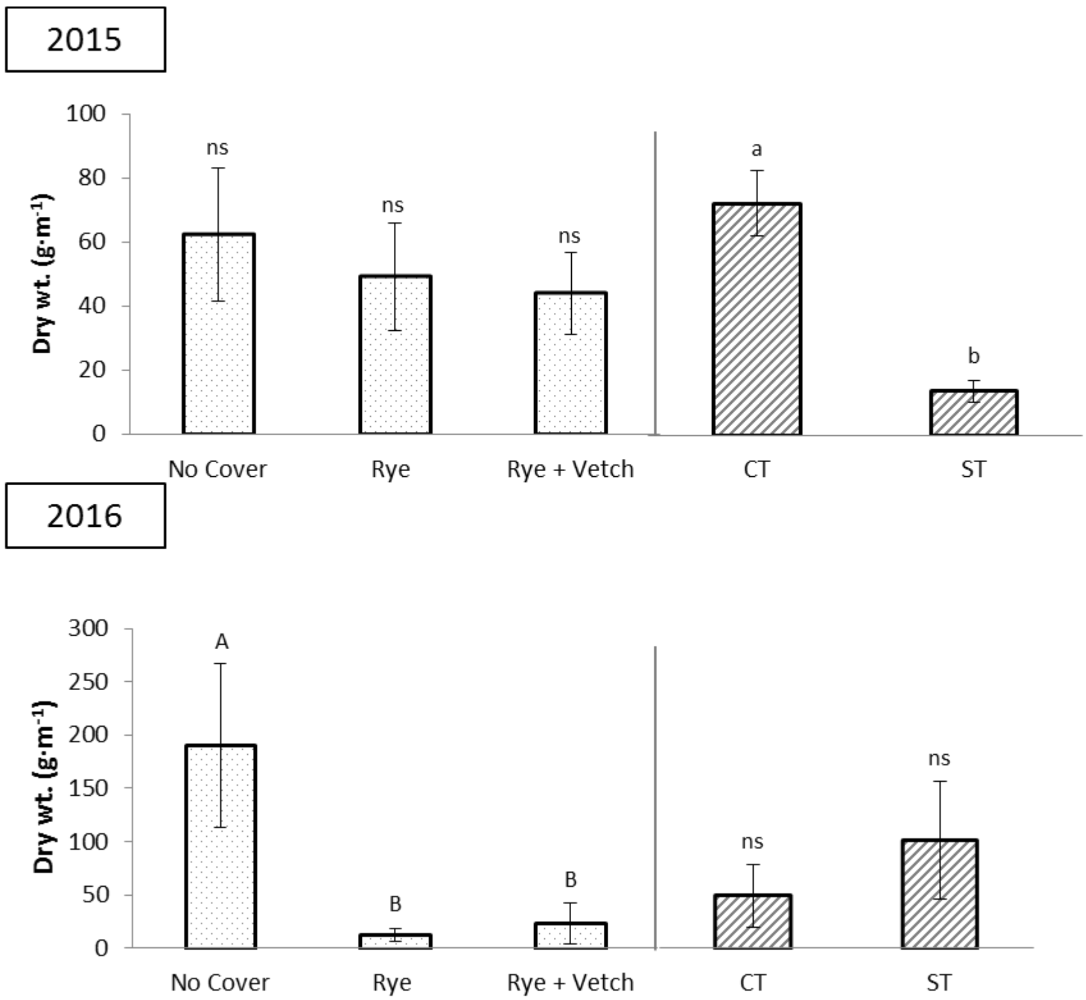

Figure 1. Dry weight weed biomass of the between row area of a muskmelon crop as affected by cover and tillage (CT = conventional tillage, ST = strip tillage) in 2015 and 2016 at the Iowa State University Horticulture Research Station, Ames, IA. Mean separation of cover crop (uppercase letters) and tillage (lowercase letters) within based on least significant difference at $P \leq 0.05$. Error bars indicate standard error of the mean.

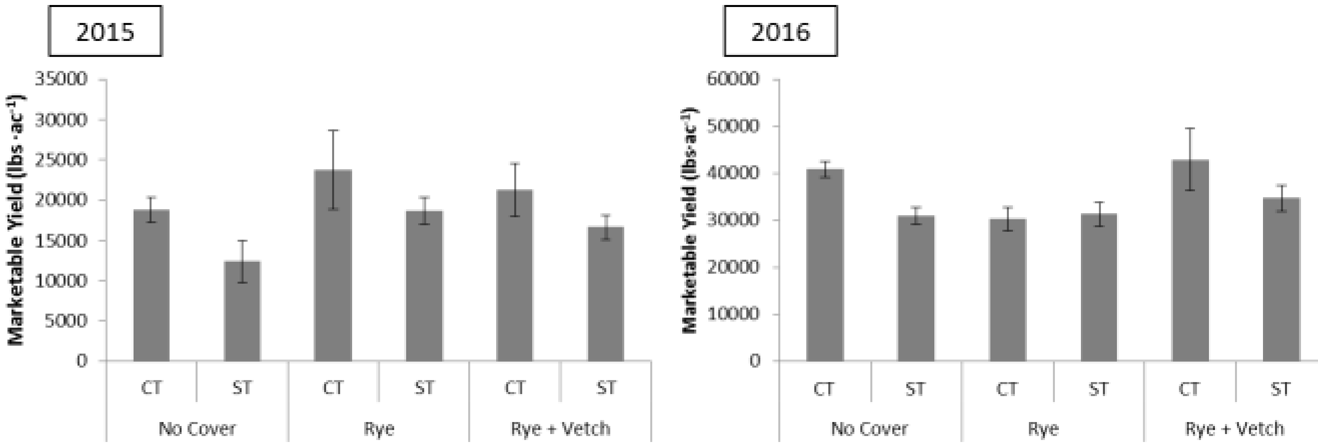

Figure 2. Marketable yield of muskmelons as affected by cover and tillage (CT = conventional tillage, ST = strip tillage) in 2015 and 2016 at the Iowa State University Horticulture Research Station, Ames, IA. Error bars indicate standard error of the mean.