Cover Cropping and Strip Tillage to Improve Crop Performance and Food Safety in Muskmelon Production

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Introduction

There is a growing interest among growers to utilize production techniques that reduce soil erosion, minimize nutrient leaching, suppress weed emergence, and build soil quality and organic matter. Cover crops are now being widely used by both conventional and organic growers to accomplish these tasks and also to maintain high soil fertility. Cover crops have a profound impact on soil quality by adding to the soil organic matter pool, enhancing soil structure and fertility, improving soil water holding capacity, reducing the loss of nutrients and sediments in surface run-off, and suppressing weed populations. Additional benefits from cover crops include reduction of insect and disease spread, enhanced microbiological attack of soil pathogens, increase in soil microbial biomass, and biological activity.

Cereal rye (*Secale cereale* L.) and hairy vetch (*Vicia villosa* Roth.) are among the most common cover crops used in regions with temperate climate because of winter hardiness and the ability to produce considerable biomass. Vetch also has the capacity to fix atmospheric nitrogen. Legume cover crops, such as hairy vetch, can supply N to succeeding crops and increase crop yields compared with non-legume or no-cover crops. A non-legume cover crop can significantly increase soil organic matter by increased biomass production compared with legumes or no-cover crops.

This study investigated whether sustainable production systems involving cover crops and strip tillage can be used to improve muskmelon crop production and also reduce contamination of produce from food-borne pathogens. Our hypothesis was that cover crops will form a barrier between the fruit and the soil thereby reducing chances of contamination. Specific objectives of this study were to: 1) determine the effect of cover crops and strip tillage on weed suppression, 2) study the effect of cover crops on muskmelon crop performance, and 3) evaluate cover crop effects on muskmelon quality and safety.

Materials and Methods

The study was conducted at the Muscatine Island Research and Demonstration Farm, Fruitland, Iowa. Soil type was Fruitfield coarse sand with 0 to 2 percent slope and less than 1.5 percent soil organic matter. The study was comprised of eight treatments, a combination of cover crop (no-cover crop, cereal rye, hairy vetch, or cereal rye + hairy vetch), and nutrient management (compost or synthetic fertilizer). The plot was chisel plowed and disked on September 20, 2011 and drilled with cover crops. Experimental design was a split-plot randomized complete block design with four replications. Cover crop was the main plot and nutrient management was the sub plot. Cereal rye was drilled at 90 and 54 lb/acre in cereal rye and cereal rye + hairy vetch treatments, respectively. Hairy vetch was drilled at 40 and 27 lb/acre in hairy vetch and cereal rye + hairy vetch treatment, respectively. Four cover crop biomass samples were collected from each treatment on May 21, 2012 using 50 cm × 50 cm quadrats. Samples were oven-dried and weighed to quantify cover crop biomass. In the field, cover crops were later crushed with a JD 7000 planter and dual wheels followed by chisel plowing (14 in. deep) to establish planting strips 7 ft apart. Each sub plot had two rows of muskmelons (cv. Grand Slam). Spacing between plants within rows was 2.3 ft. Each row consisted of 10 plants with eight data plants and two plants on each side as guard plants.

In compost treatment, compost was applied at the rate of 10 tons/acre. Compost was applied in planting strips. Synthetic fertilizer treatments received 200 lb/acre of 0-0-60, 400 lb/acre 13-13-13, and 50 lb/acre urea (48-0-0). Four weed biomass samples were collected from each treatment on June 22, 2012 using 50 cm × 50 cm quadrats. Weeds were categorized as broadleaf or grass, and were oven-dried and weighed to quantify biomass. Once harvest of melons was conducted on August 7, 2012, fruit number and marketable weight was collected. In addition, two fruits from each replication of synthetic fertilizer treatment was collected and transported to the laboratory for food safety analysis. A composite sample of each rind was taken from each treatment/rep and blended for 30 seconds. The blended sample was placed into a sterile sampling bag for the designated time and temperature combination.

Calculation of most probable number (MPN) per gram of sample was done on coliform, fecal coliform, and *E. coli* bacteria. Based on lab assays, presence or absence of *Listeria monocytogenes* and *Salmonella spp. w*as also confirmed.

Results and Discussion

Successful cover crop establishment and biomass accumulation is critical for implementing strip tillage. Cereal rye and hairy vetch established well and produced sufficient biomass (Figure 1). Cover crop biomass was 2.1, 3.2, and 3.9 tons/acre in hairy vetch, cereal rye + hairy vetch, and cereal rye treatment plots, respectively. Weed biomass collected in June clearly reflected weed suppression capability of cover crops. Weed density in no-cover crop treatment plots was severe compared with cover crop plots (Table 1). The cover crop treatment plots had the highest biomass of broadleaf weed compared with the other cover crop treatments. There was no difference between cereal rye or hairy vetch treatments. However, when comparing cereal rye and cereal rye + hairy vetch treatments, the latter exhibited better weed suppression. Hairy vetch when used alone and in combination with cereal rye provided better suppression of grass weed species when compared to no-cover crop or cereal rye treatments. When accounting for total (broadleaf and grasses) weed species, hairy vetch and cereal rye + hairy vetch produced better results than cereal rye or no-cover crop treatment. Both cereal rye and hairy vetch are known to produce allelochemicals that are toxic to weed seeds and prevent their germination.

Cover crops and nutrient management treatments affected muskmelon yield characteristics. No-cover crop synthetic fertilizer treatment had higher number of fruits when compared with any compost treatment regardless of cover crop. Synthetic fertilizer treatments of cereal rye or hairy vetch had similar results when compared with no-cover crop synthetic fertilizer treatment. Within main plots (i.e. cover crop treatment) compost treatments produced a lower number of fruits and yielded lower marketable weight. This could possibly be explained by the compost application method. Compost was applied in a band within the strip tilled area very close to the plant causing injury to young melon transplants. Evaluation of plants at the middle and end of the growing season showed small and less robust plants in compost treatments.

Lab analysis of fruit rind to identify the presence of pathogens, especially *Listeria monocytogenes,* were negative. It was expected that all samples would be negative for *Listeria monocytogenes* because these bacteria are not typically associated with in-field conditions as they prefer cool and moist environments. The cover crop treatment had higher numbers for fecal coliform, and *E. coli* bacteria but due to huge variability in data there were no statistically significant differences (Table 3).

Coliform bacteria are naturally found in the soil and vegetation, and are generally harmless. Therefore the presence of coliforms within these samples was expected. Fecal coliforms are a subset of total coliform bacteria that are more fecal-specific in origin. The presence of fecal coliforms and *E.coli* provides evidence that fecal contamination from humans and/or animals is present within the fields. All samples tested positive for *Salmonella*. The presence of *Salmonella* is a concern with contamination from outside sources. *Salmonella* has been recognized as a foodborne pathogen of concern with produce. The need for soil management and exclusion of animals within the fields is emphasized when outbreaks occur. In this study, fruits from cover crop treatments had lower fecal coliform and *E. coli* bacterial counts on fruit rind suggesting potential benefits of using cover crops as a barrier between the fruit and the soil.

Table 1. Effect of cover crop on weed biomass.

Treatment	Broadleaf† (g)	Grass (g)	Total (g)
No cover crop	9.63 a	3.01 ab	12.64 a
Hairy vetch	0.88 bc	0.57 bc	1.44 b
Cereal rye	1.58 c	5.10 a	6.69 a
Cereal rye + hairy vetch	0.23 b	0.45 c	0.68 b

†Mean separation within columns; means followed by same letter(s) are not statistically different (P ≤ 0.05).

Table 2. Muskmelon yield characteristics as affected by cover crop and fertilizer treatments.

Treatment	Marketable	
	Number†	Weight (kg)
NC-synthetic fertilizer	33 a	103.9 ab
NC-crop-compost	23 b	56.4 a
R-synthetic	31 ab	68.1 bc
R-compost	9 c	22.4 d
HV-synthetic	26 ab	74.3 bc
HV-compost	10 c	24.1 d
RHV-synthetic	23 b	85.3 ab
RHV-compost	10 c	16.7 d

†Mean separation within columns; means followed by same letter(s) are not statistically different (P ≤ 0.05).
*NC = No cover crop, R = Rye cover crop, HV = Hairy Vetch cover crop, RHV = Rye + Hairy Vetch cover crop

Table 3. Most probable numbers (MPN) for coliform, fecal coliform, and *E. Coli* on fruit rind at the time of muskmelon harvest.

Treatment	Coliform^NS	Fecal coliform^NS	*E. coli*^NS
No cover crop	7.9	553.0	550.0
Hairy Vetch	4.6	0.75	0.75
Cereal rye	11.5	88.3	13.0
Cereal rye + hairy vetch	119.2	163.8	62.3

^NS Non-significant (P ≤ 0.05).

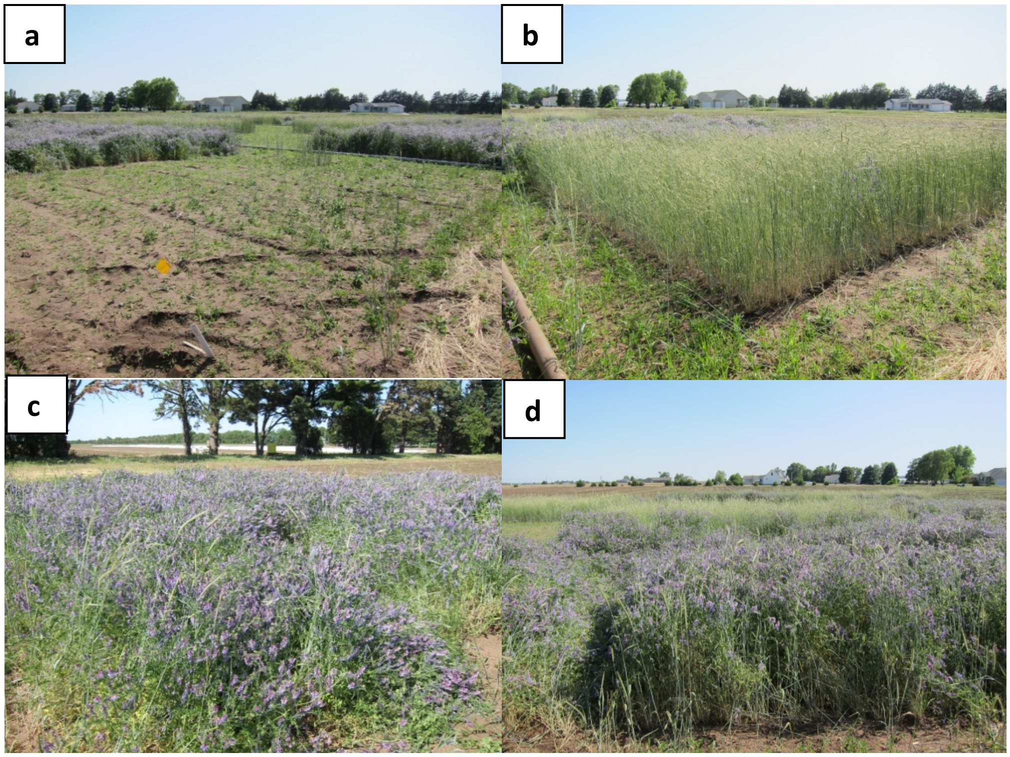

Figure 1. Cover crop plots on May 21, 2012. a) No-cover crop; b) Cereal rye; c) Rye+Hairy vetch, and d) Hairy vetch.