Living mulch suppresses weeds and yields in organic vegetable plots

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Researchers studied the effects of living mulches in three organic vegetable crops. They found that vegetable yields were reduced because of competition in the living mulch plots.

Healthy, productive soils are of prime importance to small-scale organic vegetable growers. Cover crops are a proven way to improve soil quality, reduce erosion and suppress weeds; however, they can be difficult to incorporate on farms with a limited land base and cash crop rotations that span the growing season. Living mulches—cover crops interplanted or undersown with main crops—allow opportunities for farmers to plant cover crops without taking the land out of cash crop production. Researchers at the UW-Madison tested living mulches for use in the production of three organic vegetable crops to evaluate their impact on weed suppression, labor needs and crop yield and quality. The results demonstrated that, while the living mulches did appear to suppress weed populations, they also resulted in lower vegetable yields. The living mulch plots in this study also had higher labor requirements than the control plots.

Setting up plots

UW-Madison researchers Anne Pfeiffer and Erin Silva from Plant Pathology and Jed Colquhoun from Horticulture received a grant from the USDA National Institute of Food and Agriculture program to carry out this research. The researchers grew the crops in accordance with USDA National Organic Program standards on certified organic experimental plots at the West Madison Agricultural Research Station in 2012 and 2013. The experiment was established as a strip-plot design, with living mulch species as one whole-plot factor and vegetable crops as another factor. Living mulch treatments included four species—buckwheat, field pea, crimson clover and medium red clover—and a cultivated control without living mulch. Vegetable crops included snap beans, broccoli and bell peppers in four replicates. All field management practices were carried out by equipment and protocols easily replicable on a typical small-scale vegetable farm.

Living mulch grows between rows of vegetables.

Living mulches were planted in the spring in strips that were 15 feet wide by 20 feet long, as soon as soil conditions were dry enough to allow mechanical tillage. Cover crop seed was hand broadcasted after tillage and incorporated with a rake. Researchers recorded the living mulch stand density four weeks after seeding and clipped the mulches prior to vegetable planting in early June. There was no clean cultivation around the vegetable plants in the living mulch. Every 10 to 14 days throughout the growing season, the mulches were mowed with a standard walk-behind lawn mower, control plots were hoed, and all plots were weeded in-row. Prior to each mowing, the researchers recorded the living mulch height, biomass of both weeds and living mulch, and weed species counts. Following mowing or cultivation, both control and living mulch plots were hand weeded within vegetable rows. Labor time for mechanical and hand cultivation was recorded for each plot.

The researchers planted snap beans and transplanted bell peppers into plots immediately after the living mulch was clipped in early June. Broccoli was transplanted into plots in late July. Snap beans were direct seeded. Broccoli and bell pepper transplants were punch-planted by digging a small hole in the living mulch with a trowel and inserting the transplant. About 10 days after transplanting or after the first true leaves developed, researchers side-dressed the plants with granulated composted chicken manure. Early-season irrigation in 2012 was provided by garden hose and watering wand. Drip irrigation was installed in mid-July 2012 and used for the remainder of 2012 and all of 2013. Extremely hot and dry conditions in 2012 resulted in water stress in all of the plants despite regular water application.

Weed growth and living mulches

Weed biomass and density in the living mulch systems varied throughout the growing season. In both 2012 and 2013, buckwheat and field peas mostly died out at the first mowing. The biomass from these mulches degraded quickly and provided little weed control for the rest of the growing season. Medium red clover and crimson clover were resilient to mowing and survived for the rest of the season. In 2012, buckwheat, crimson clover and field peas had greater biomass at the first mowing compared to later mowings. Buckwheat biomass was significantly higher at the first mowing than that of the other living mulches, followed by field pea in 2012. Field pea had the highest biomass at first mowing in 2013. Crimson clover produced the most biomass mid-season, and medium red clover in late season in both 2012 and 2013.

Prior to early June in all of the treatments, pre-mowing weed density and weed biomass were inversely related to living mulch biomass. But after the first mowing and subsequent hand cultivation, weed biomass was lower in the cultivated control plots for the remainder of the season as compared to the living mulch plots. This was true for all living mulch treatments, including the ones where clover survived after mowing.

Field pea (foreground) and buckwheat (background) had high biomass at the first mowing, but then died out and provided little weed control.

Yield results by crop

The researchers measured marketable yield for each of the three crops. In order to determine marketability, they evaluated the crops in terms of size, uniformity of appearance, and level of pest damage. Snap beans were harvested once per season when most pods were mature, and marketable beans were counted, weighed and 20 were randomly measured for length.

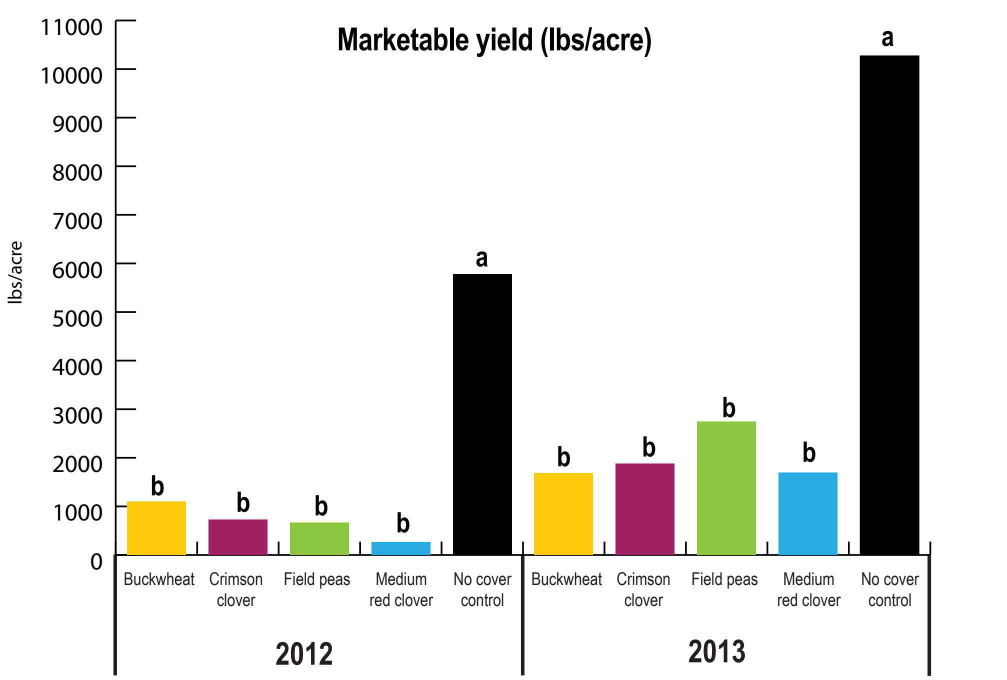
Bell peppers were harvested at the green-ripe stage on three dates each year. Researchers counted the number of pepper plants in each plot, and harvested all ripe and damaged bell peppers. After sorting out the non-marketable peppers, researchers weighed and counted the remaining fruit. Ten randomly selected peppers were graded on shape and measured for length, width and wall thickness. Broccoli was harvested once per season. In each broccoli plot, researchers obtained stand counts and harvested all heads. All marketable heads were weighed and counted, and 10 randomly selected heads were measured. Non-marketable crops were counted and weighed with notes taken on the reasons for non-marketability.

For all three of the vegetables, yields were lower in living mulch treatments than the cultivated control treatment. The competition for light, water and nutrients from weeds and living mulches impacted crop productivity.

Head development of broccoli was delayed in all plots and resulted in no marketable yields in the living mulch plots. Although all of the broccoli heads in the living mulch plots were less than the designated minimum size of 4 inches, the heads were otherwise of high quality. In the cultivated control treatments, 2012 broccoli yield was 1,837 lbs. per acre and 2013 broccoli yield was 3,719 lbs. per acre.

In 2012, the bell pepper yield was the highest in the cultivated control (see Figure 1 below). The other living mulch treatments were statistically similar. In 2013, bell pepper yield was again the highest in the cultivated control and statistically similar in all of the living mulch treatments. The primary reason for bell pepper non-marketability was rot, including blossom end rot and sun scald. Mowing

Figure 1. Bell pepper yield under four living mulch treatments and one control treatment, 2012 and 2013

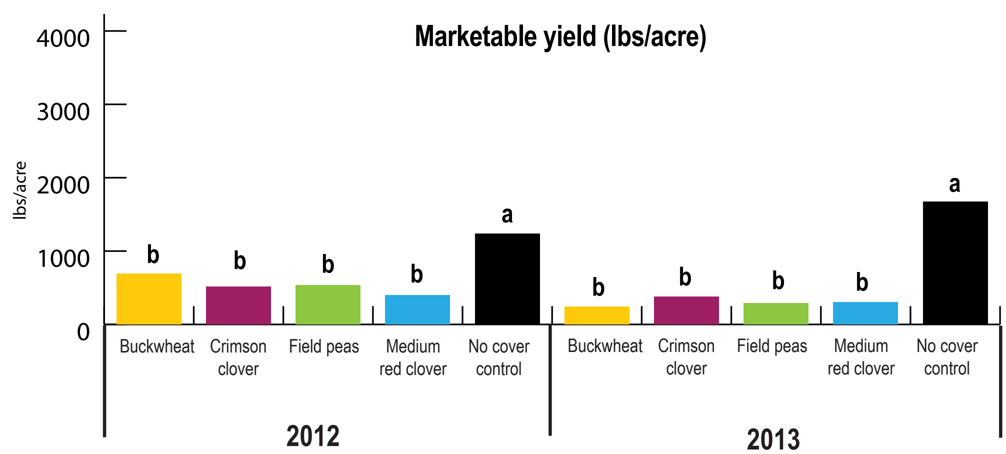


Column means with the same letter were not significantly different across treatments, within the same year and crop, at P<0.05.

the mulches when the plants were fruiting was challenging and resulted in injury of 10 percent of the non-marketable peppers. In 2012, bell pepper diameter, length, wall width and grade were greater for those in the cultivated control and buckwheat plots compared to the red clover treatment. In 2013, bell pepper diameter in the cultivated control treatment was greater than those from the crimson clover and medium red clover treatments, but not different from the field pea or buckwheat treatments. No differences in wall width, length or grade between treatments were observed in 2013.

Snap bean yield was lower in the living mulch treatments than the cultivated control in both 2012 and 2013 (see Figure 2 below). Snap bean length did not differ by treatment in either year. In both 2012 and 2013, about one-third of the snap beans that had been classified as unmarketable were immature at harvest. In 2012, bean rust accounted for an additional 21 percent of non-marketable snap beans. Other reasons for non-marketability included general surface marring and mower damage. There were no differences between treatments in the reasons for non-marketability of snap beans.

Figure 2. Snap bean yield under four living mulch treatments and one control treatment, 2012 and 2013

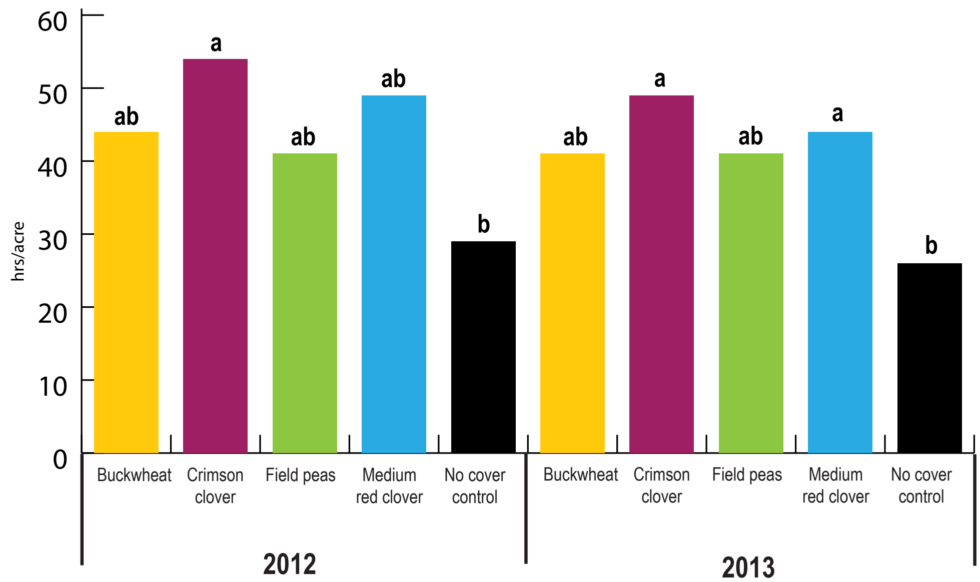


Column means with the same letter were not significantly different across treatments, within the same year and crop, at P<0.05.

Labor time required

The living mulch systems had greater labor needs compared to the cultivated control (see Figure 3 on page 5). Time required for mowing and in-row hand weeding varied by living mulch treatment and time of year. The drought conditions in 2012 slowed all plant growth, so less mowing was needed that year. All living mulch plots (including died down buckwheat and peas) were mowed all summer for consistency — four times in 2012 and six times in 2013. Crimson clover required significantly more management time than the cultivated control in 2012; in 2013 both crimson clover and medium red clover required significantly more management time than the cultivated control. Higher cover crop biomass in the clover plots meant more time was required for mowing than in the buckwheat and field pea plots.

Figure 3. Labor time required for cover crops and weed control from vegetable crop planting to harvest (hours/acre), 2012 and 2013



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Factors limiting living mulch success

Several factors contributed to the limited success of living mulches in this study. First, relatively high prior weed pressure on this field site may have reduced vegetable yields. A living mulch system in a plot with less of a weed seedbank and weed competition may result in vegetable yield and management requirements that are closer to the tilled control.

Second, drought stress in 2012 likely significantly impacted crop yield results that year. While living mulch germination in 2012 was successful, cover establishment was slow, most likely due to limited water availability. Drought conditions probably also exacerbated the competition between vegetables and living mulches for water and nutrients.

Labor time requirements for the living mulch plots were higher than the cultivated control plots. In particular,

Labor requirements were higher in the living mulch plots than the cultivated control.

the punch planting technique that was used for bell pepper and broccoli transplants meant that hand weeding was necessary around individual plants. Bare soil in control plots allowed for quicker and easier weed control.

Can living mulches suppress weeds but not yields?

Reduced vegetable yields in the living mulch treatments as compared to the cultivated control demonstrate that competition for resources from both weeds and living mulches impacted overall crop productivity. Certain modifications to the production systems in this study could lead to more comparable vegetable yields and labor requirements. A strip tillage system, into which vegetables are planted in a strip of bare soil with living mulch planted between the rows, would minimize the impact of competition between the cash crop and living mulch cover crop. In-row weed management could then be achieved with the use of straw or plastic mulches, which would limit competition for water and fertility resources immediately adjacent to the vegetable plant. In addition, the researchers suggest using cover crops that establish quickly for early weed control, but also tolerate mowing. The identification or breeding of a mulch crop that stays low to the ground and grows more slowly later in the season will help minimize competition with vegetable plants and be more ideally adapted to these systems.

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