Cover Crops can Improve Soil Quality and Suppress Weeds

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Vegetable growers who want to reduce their chemical inputs and field disturbance may turn to cover crops to help manage crop pests and improve soil quality. Winter cover crops are seeded in the fall and killed off in the spring prior to planting the main crop. There are several advantages to using winter cover crops as living plants or as surface mulch. Cover crops compete with weeds for space and resources and prevent weed seed germination. Some types of cover crops fix nitrogen, increasing available soil nutrients for the main crop and reducing the need for fertilizer application. Cover crops also give structure above and below the soil, reducing soil erosion and providing shelter or food sources for natural enemies of arthropod pests and for weed seed predators.

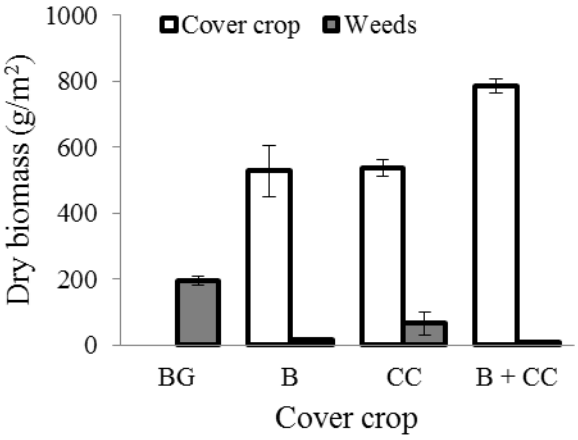
Flowering crimson clover (left) and early barley grown with crimson clover (right)

The type of cover crop used can have a big influence on potential benefits. Legumes are a popular cover because they can produce large amounts of aboveground biomass, creating a dense habitat for beneficial arthropods and suppressing weed growth, while at the same time fixing nitrogen in the soil. Grasses can provide a dense cover, but their higher carbon content means the plants break down more slowly, providing longer-lasting surface mulch after the cover crop is killed off. Growing cover crop mixtures, like legumes and grasses together, may provide complementary benefits beyond what each type of cover can provide alone. In a four-year research project, we addressed how cover crops grown in monocultures or as a mixture influenced soil fertility and health, weed germination and growth, abundance of beneficial and pest arthropods, and crop yield. We grew organic vegetable crops planted into one of four treatments: no cover crop (bare ground, BG), barley (*Hordeum vulgare*, B), crimson clover (*Trifolium incarnatum*, CC), or a barley and crimson clover mixture (B + CC). Winter cover crops were seeded each fall at approximately 25 lbs/acre (CC), 100 lbs/acre (B), and 60 + 40 lbs/acre (B + CC). All plots were flail mowed and then strip tilled 4 weeks prior to planting the main crop. Early tilling can allow weed seeds to germinate; killing weed seedlings with herbicide or a second till before planting can reduce weed pressure (stale seedbed technique). Crookneck squash were direct-seeded into the tilled strips at 4' plant spacing, 3' row spacing. Each treatment was replicated four times, in 36' x 39' plots, at the Central Maryland Research and Education Center in Upper Marlboro, MD.

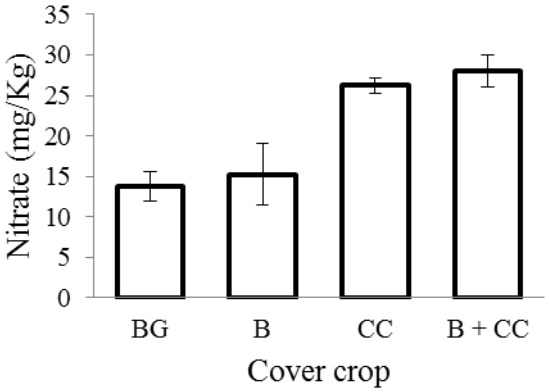
Research facility and study field at CMREC, Upper Marlboro (upper left). Flail mowing crimson clover (bottom left) and strip tilling cover crop residue (bottom right). A large cover crop biomass will provide good surface coverage through the summer.

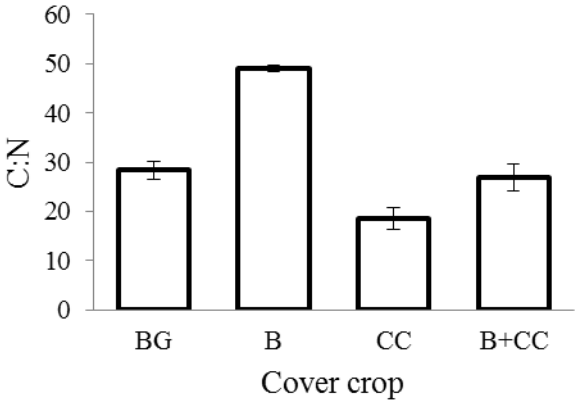
Cover crop treatments remained the same through all four years of the study. In 2011 and 2012 the main crops were organic broccoli-snap bean double crop. In 2013 and 2014, the main crop was organic crookneck squash. We collected and analyzed soil samples for nutrients, nematodes, and microbes. We measured beneficial and pest arthropods by recording plant damage and arthropod numbers on crop plants, and by sampling ground-dwelling arthropods with pitfall traps. We assessed weed abundance by counting and identifying individual weeds, and collected weed samples to measure biomass. To assess amount of weed seeds present in the soil, we collected soil from each of the plots, placed the soil in plastic flats within the greenhouse and allowed seeds to germinate. Weed seedlings that germinated were counted and identified. For an economic assessment of weed suppression, we recorded time spent weeding each plot. We measured crop quality through plant size measurements, plant tissue nutrient analysis, and crop yield.

Here we report preliminary results based on the 2013 season. Aboveground cover crop biomass was highest in the cover crop mixture (B + CC), but both crimson clover and barley grown alone produced enough biomass to reduce weed biomass relative to the no-cover crop treatment. Soil nitrate levels were highest in treatment plots containing crimson clover, and aboveground plant material in the barley plots had the greatest carbon content.

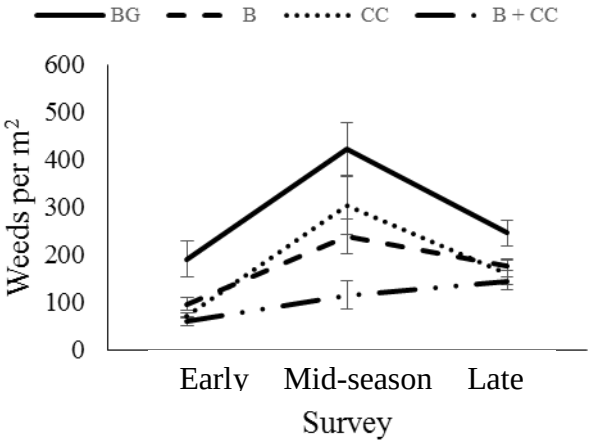


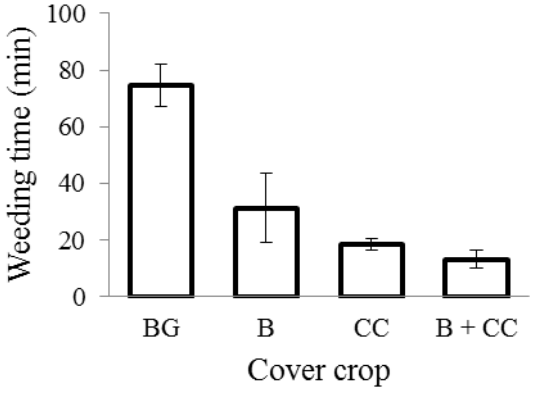
Initial conditions of the cover crop treatments prior to planting the main crop show high biomass in mixture plots and more soil nitrate in plots with crimson clover.

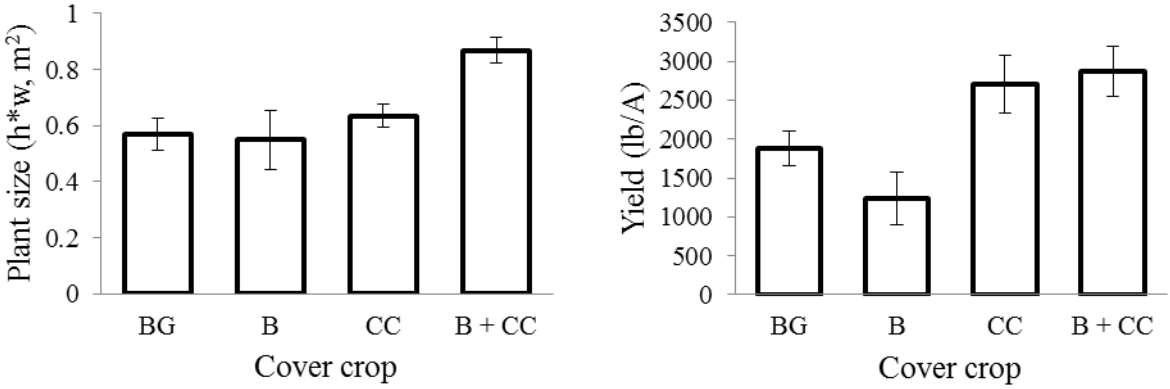




Weed surveys showed that weed presence was greatest in bare ground plots throughout the growing season, but cover crop type had no effect on the number of weed seeds present in the soil. Treatments also influenced weeding effort. It took longer to hand weed bare ground plots than any other treatments. None of the treatments influenced abundances of the most common insect pests (squash bugs (*Anasa tristis*) and cucumber beetles (*Diabrotica undecimpunctata*) and (*Acalymma vittatum*) found on squash plants. Squash plants were largest in the cover crop mixture plots, and yield was highest in plots containing crimson clover.







Weed surveys and weeding time reflect greater weed suppression from cover crop mixtures. Plant size and crop yield reflect the influence of crimson clover, likely through improvements in soil quality.

Results from the 2013 season show that cover crops were effective for weed suppression. Greater aboveground biomass especially in the cover crop mixture led to fewer weeds and reduced weeding effort. Plots with crimson clover in particular had the highest soil nitrate levels, the largest plants, and the greatest yield. In this study season, cover crops did not influence beneficial or pest arthropod abundances. Further analysis of all four years of this study will give a more complete picture of which cover crops can be most effectively used to influence crop pests and soil quality.

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Economic Optimization of Cover Crops and Sterile Seedbed Techniques for Eggplant Production

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Winter cover crops are planted in the fall and terminated in the spring, leaving residues in the field until they break down. Cover crops are versatile tools for farmers because the remaining residue may have a variety of effects on soil health and quality, arthropod and weed abundance, and crop quality, fertility, and ultimately performance. We have started a three year project to investigate the effects of winter cover crops and stale seed bed techniques on soil quality, insect and weed communities, and crop production in eggplant fields, and to conduct an economic analysis comparing their effectiveness and cost.

Previous work by our group has shown that eggplant yields poorly when planted in no-till fields. Thus, experimental fields were strip tilled prior to planting the eggplant. Strip tillage provides a narrow tilled area for crop growth while leaving most of the surface undisturbed. We compared crimson clover (23 lbs/acre) and a rye-crimson clover mix (65 and 13 lbs/acre) to a no-cover crop control treatment. Each treatment was replicated four times and arranged in a randomized block design at the University of Maryland Research and Education Center, Upper Marlboro Facility (CMREC).

Cover crops were terminated with a flail mower and the field was tilled in 10" wide strips with 4' spacing between tilled strips. Weeds grew in the strips for three weeks and then we killed them (the stale seed bed technique) either by "shallow tilling" with a garden tiller, or with Avenger herbicide. We transplanted eggplant seedlings (*Solanum melongena* 'Nubia') at 3' intrarow spacing into the weed-free strips the following day. We recorded labor and cost associated with the three whole plot (cover crop) treatments and two sub-plot (stale seedbed technique) treatments for economic comparison.

The Colorado potato beetle, *Leptinotarsa decemlineata* (CPB) and the flea beetle complex, Alticini, can cause severe defoliation resulting in yield loss, and at high densities can kill plants. Cover crop residue can slow pest movement into a field, and support more predators than bare-ground soil surfaces. We recorded eggplant defoliation, numbers of CPB egg masses, larvae, and adults, and numbers of adult flea beetles weekly. To estimate treatment effects on CPB egg predation, we deployed sentinel (field collected) CPB egg masses on three occasions and then monitored their fate.