OCIA R&E Micro Grant 2017 Year-End Report

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Weed control with cover crops in organic soybean systems

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Background and research objectives

Soybeans are planted in mid-to late May on organic farms in Nebraska, and frequent pre-plant mechanical weed control is necessary to keep fields clean. Better weed control increases crop yields and thus farm profitability. In our OCIA-funded project "Weed control with cover crops in organic soybean systems", we compared the weed suppressing potential of spring-sown grass and brassica cover crops before soybean to mechanical weed control before soybean. Our particular research questions were:

1. Can cover cropping prior to soybean planting suppress weed emergence and weed biomass compared to standard weed control?
2. What are the effects of cover crop species and termination methods on weed growth after cover crop termination?
3. Do cover crops affect soybean yields?

Experimental design and implementation

This experiment was carried out at the Agroforestry research farm at the Eastern Nebraska Research and Extension Center (formerly ARDC) near Mead, NE. We used an organically certified field that was in a soybean-winter wheat-corn rotation and had corn as its previous crop. This field had high pre-existing weed pressure. Plots were layed out in a randomized complete block design with four replications. Cover crop species were oats, barley, yellow mustard and brown mustard. Cover crops were terminated either by disking or by undercutting with a sweep-plow (undercutter), which has blades that sever plants approximately 3" below the soil surface. There were also two treatments without cover crops: a no-cover crop treatment with standard weed control and a no-cover crop treatment without any weed control. Standard weed control consisted of disking and field cultivation before soybean planting; and rotary hoeing and cultivation after soybean planting until approximately June 20.

On March 21, 2017 oats were drilled at a rate of 200 lb/a and barley was drilled at a rate of 120 lb/a in the plots. On March 22, brown mustard and yellow mustard were broadcast seeded at a rate of 14 lb/a each, and lightly packed with a multipacker. Biomass samples of weeds and cover crops were taken May 18 by cutting all above-ground biomass, drying and weighing it to

determine cover crop dry matter production. All cover crops were killed May 26 (either with a disk or undercutter) and soybean was planted June 2. Weed biomass in all plots was sampled July 14, just before the soybean canopy closed.

Cover crop and weed biomass at cover crop termination

Emerged weeds were counted May 5 and most weeds were small with just cotyledons visible. At that time, there were slightly more weeds in the no-cover crop plots (42 weeds per square foot) than in the grass cover crops (31 weeds per square foot) and mustard cover crops (27 weeds per square foot). Mechanical weed control in the previous years has been difficult at this site due to very wet springs, and weeds were able to reproduce and spread seed, thus the high number of weed seedling.

On May 18, when cover crop and weed biomass was sampled, the most productive cover crop were oats (3,100 lb/a) and barley (2,700 lb/a). Yellow mustard (2,500 lb/a) and brown mustard (2,200 lb/a) had intermediate biomass production. Weed biomass was very high in the no-cover plots that had no weed control (900 lb/a) and was very low in the cover crop plots (20 lb/a) and no-cover standard weed control plots (5 lb/a) (figure 1).

On May 25, just before cover crops were terminated, oats and barley were about 1.5' tall and jointing (figure 2), brown mustard was about 1.5 and yellow mustard 3 feet tall and flowering (figure 3). The no-cover crop plots without weed control had dense stands of mostly pennycress (figure 4).

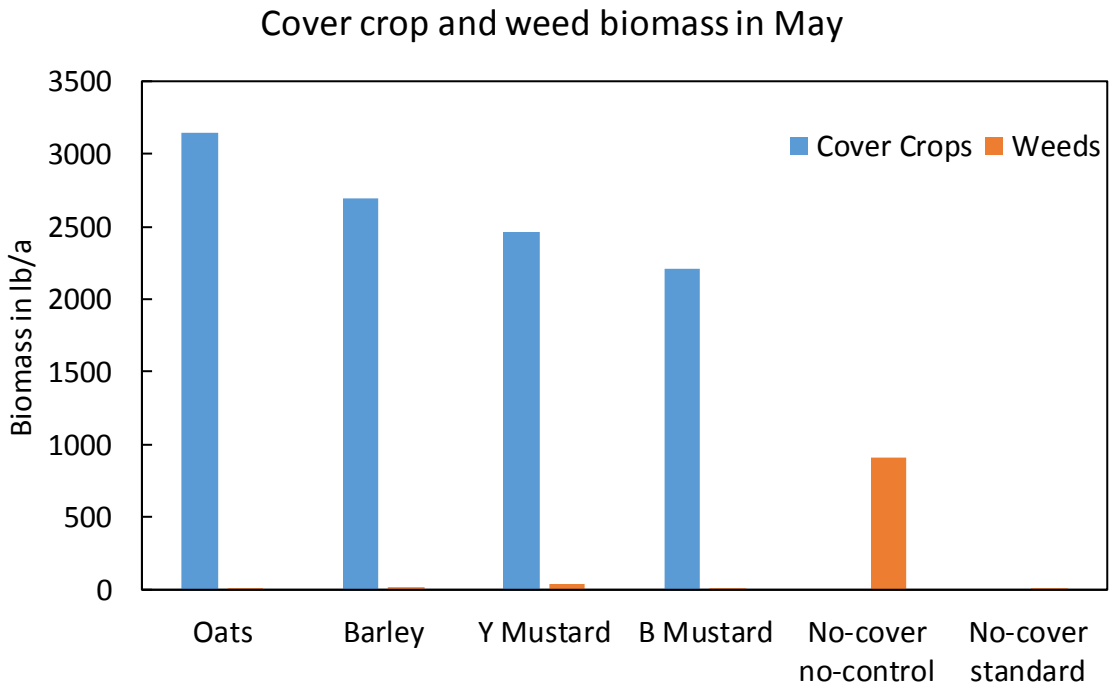

Figure 1. Average cover crop and weed biomass May 18, 2017, nine weeks after planting of cover crops. There were four species of cover crops: oats, barley, yellow mustard (Y Mustard), brown mustard (B Mustard); a no-cover crop with standard weed control (No-cover standard) and a no-cover crop without weed control (No-cover no-control). The blue bar is cover crop biomass and the red bar is weed biomass (in lb/a).

Figure 2. Oats (left) and barley (right) on May 25, 2017.

Figure 3. Yellow mustard (left) and brown mustard (right) on May 25, 2017

Figure 4. No-cover crop without weed control (left), no-cover crop with standard weed control (right). Pennycress is the predominant weed species.

Figure 5. Height of vegetation in different treatments on May 25, 2017: No-cover without weed control (left), oats (center), yellow mustard (right).

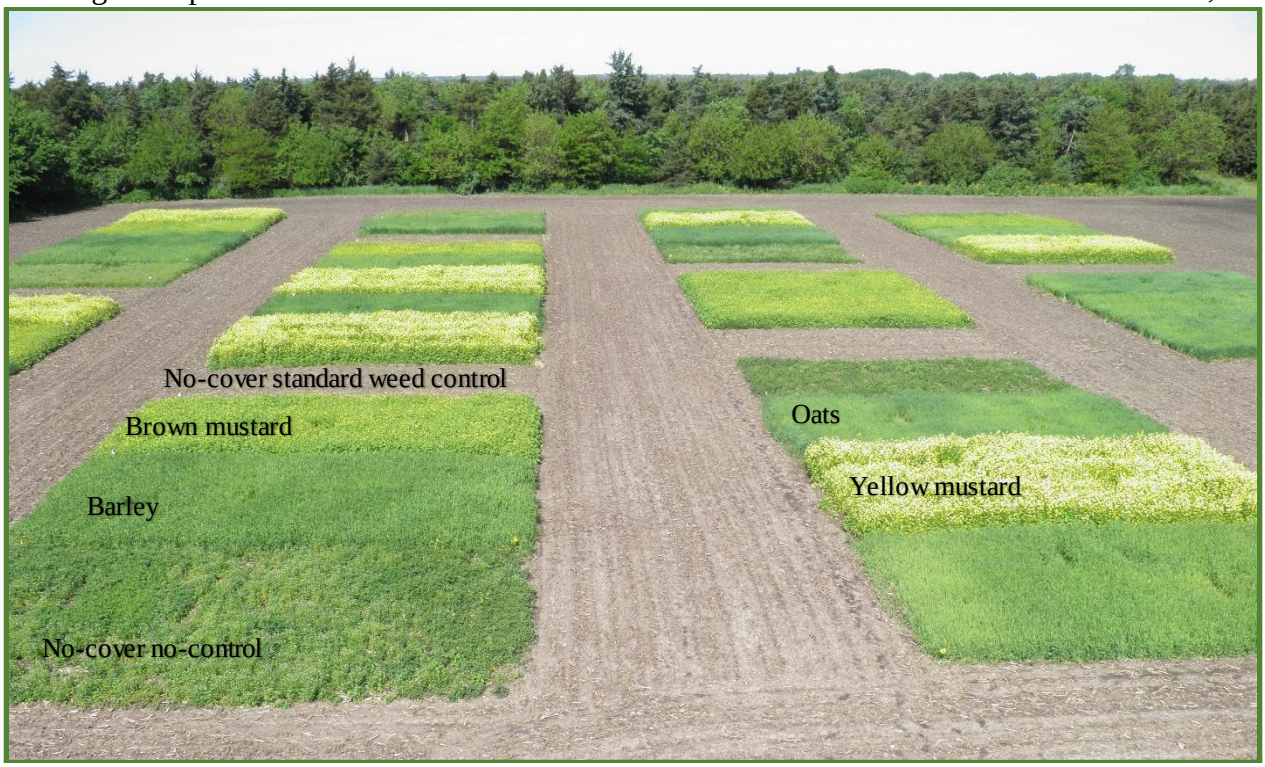

Figure 6. Aerial view of the experiment on May 25, 2017. Treatment names are listed in the bottom left corner of the plots.

Soybean and weed growth after cover crops

Cover crops were terminated May 26 and soybean planted within one week. On July 14, when weed biomass was sampled for the last time, weed pressure was very high in all but the oats (500 lb/a) and barley plots (1,000 lb/a) (figure 7). Their thick layer of residue was decomposing slowly, and suppressed weeds (figure 8). On the other hand, yellow and brown mustard residue was mostly decomposed, and the plots were overtaken by weeds (figure 9). Cultivation had been carried out in the no-cover standard weed control treatment between the time soybeans emerged and late June when soybean became too tall. The cover crop plots and the no-cover no-control treatment were not cultivated. Once cultivation stopped, summer annual weeds emerged and grew, leading to similarly high weed biomass in the no-cover standard weed control plots (2,500 lb/a) as in the no-cover no-control plots (2,200 lb/a) (figure 10).

Using an undercutter versus a disk may have reduced weed emergence early on, as the undercutter preserves the cover crop mulch better than a disk. However, by mid-July, the effect had dissipated, and the plots terminated with the undercutter had similar weed biomass as those terminated with a disk.

While oats and barley had fewer weeds than the standard no-cover mechanical weed control, soybean growing in oats and barley plots had uneven emergence and slower growth than soybean in the other plots (figure 8, 9, 10). Unfortunately, weed pressure in the whole field was so high that soybean could not be harvested.

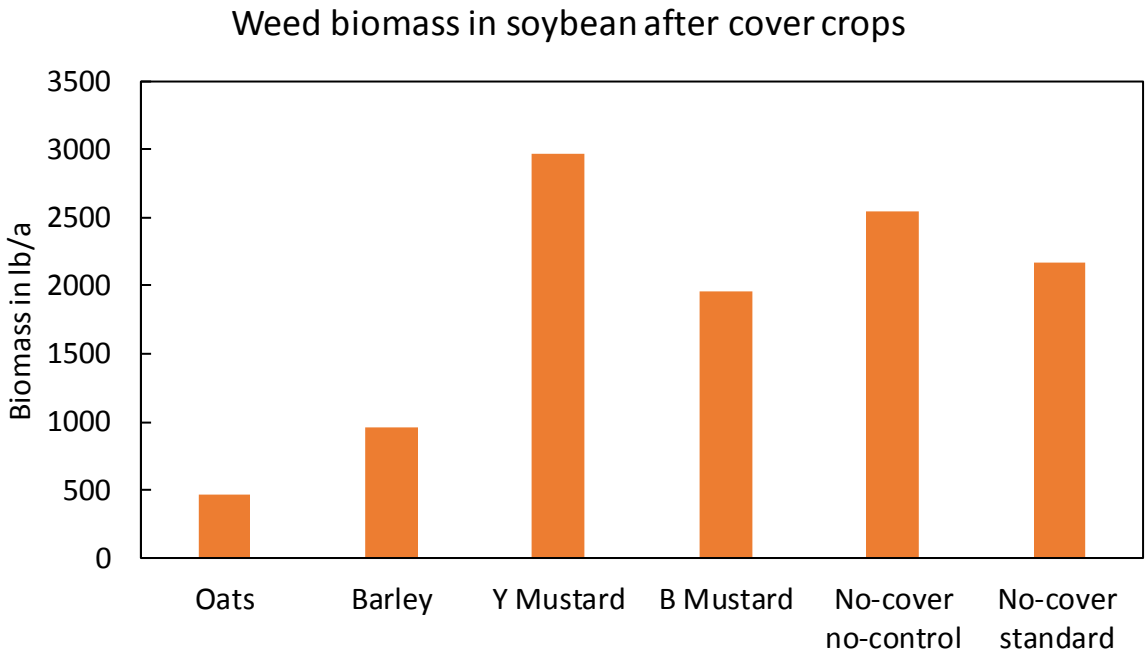

Figure 7. Average weed biomass July 14, 2017, seven weeks after terminating cover crops. There were four species of cover crops: oats, barley, yellow mustard (Y Mustard), brown mustard (B Mustard), a no-cover crop with standard weed control (No-cover standard) and a no-cover crop without weed control (No-cover no-control).

Figure 8. Soybean in oat mulch, July 7, 2017. Few weeds, but soybean emerged unevenly and is small. Soybean rows are 30" apart.

Figure 9. Soybean after yellow mustard, July 7, 2017. More weeds, but soybean are bigger than in oat cover crop plots (figure 8). Soybean rows are 30" apart.

Figure 10. Soybean after no-cover crop standard weed control, July 7, 2017. More weeds, but soybean are bigger than in oat cover crop plots (figure 8). Soybean rows are 30" apart.

Take-home message

Spring-sown cover crops had between 2,000 and 3,000 lb/a of biomass, with oats and barley being more productive then yellow and brown mustard. While in the field, they suppressed the emergence and growth of winter annual weeds. In oats and barley, this weed-suppressing effect continued after they were terminated, as their residue created a thick mulch that was a barrier to weed germination and growth. The mustards on the other hand, while taller than the grasses, decomposed quickly, and did not suppress weeds in the soybean. Oats and barley reduced weed biomass compared to standard no-cover mechanical weed control, but it should be noted that weed pressure was high in the entire field. The grass cover crops seemed to negatively affect soybean growth, but due to the weed contamination, soybean yield was not measured.

Future research needs

More research is necessary to discern the effects of cover crop species on subsequent soybean yields and to test whether spring-sown oats and barley cover crops can be used reliably as a tool in organic weed management. For example, how is cover crop biomass quantity and quality (such as the carbon and nitrogen content or C:N ratio) related to the emergence and growth of certain weed species? How do these cover crops affect soybean emergence, yields and profitability? We were not able to determine soybean yields in this experiment, but yield data is essential for examining profitability. In addition, are there other cover crop termination methods, such as roller-crimping cover crops, that may improve weed control in organic soybean?