Progress Report for Maryland Soybean Board, August 2023

"Spring management of cover crops - how termination timing affects soybean growth and yield."

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Many farmers terminate their cover crops as early as possible to get this task out of the way well before planting, to ensure that the cover crop residue will be completely dead and dry and easy to cut through without causing hair pinning, and to avoid having to plan through thick residues. In the Mid-Atlantic, this often means terminating cover crops in late March or early April 2 to 4 weeks before cash crop planting. But for cool-season species like those used for winter cover crops, April represents ideal growing conditions during which they may be able to double or even quadruple or biomass. Many of the benefits derived from cover crops are directly related to the amount of biomass produced. This includes the water and serving mulch, nutrient cycling, carbon sequestration, weed suppression, and soil structure improvement. On the other hand, many farmers fear that allowing cover crops to grow large will make the planting process difficult and is likely to provide conditions favorable to pests such as slugs. This research project compares three times of cover crop termination: early (several weeks prior to cash crop planting), mid termination simultaneous with planting green into the living cover crop at the normal crop planting time), and late (1 to 2 weeks after planting green when the cash crop has already emerged).

The field experiments applied these three termination dates to three cover crop treatments: 1) no cover crop control containing only winter weeds; 2) a pure stand of rye established in the fall, and 3) a 3-way mixed species cover crop established in the fall with radish + rye + crimson clover. The latter cover crop normally would have only two species in the spring (plus any weeds that might be present) since the radish normally freeze-kills during the winter. We studied a factorial combination of three termination times and these three cover crops against the background of either corn residue or soybean residue from the previous cropping season.

Preliminary results on the cover crop aboveground biomass dry matter achieved.

In spring 2023 there was a significant interaction between the cover crop species or treatment and the timing of determination. Termination time had little effect on clover biomass or weeds, but later termination significantly increased the dry matter of the cereal Rye in the mixture (Figure 1). This three-species mixture when planted early enough by interseeding into the cash crop in late summer, is usually dominated by radish in the fall and by clover in the early spring.

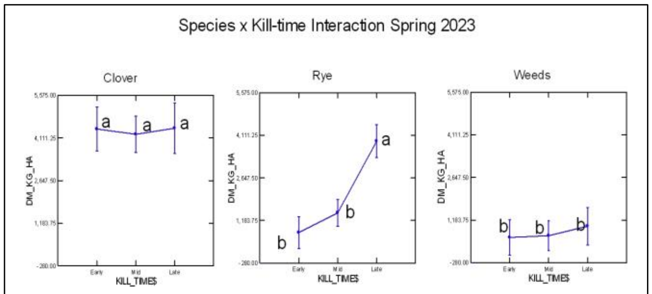

Figure 1 Cover crop above ground dry matter accumulation for three termination times and three components in a mixed species cover crop. Only the rye gain significant dry matter by late termination.

Figure 2 shows that the same cover crop will behave differently depending on which cash crop it is following. The corn crop and its residues tend to create a low nitrogen environment which gives the nitrogen-fixing crimson clover an advantage over the nitrogen required and radish in the fall. The spring biomass for the mid-kill date simultaneous with planting green is shown in Figure 2. The rye and weed biomass produced was similar whether in corn or soybean residue. However, the Clover biomass was more than twice as great in corn residue as in soybean residue. This pattern has been observed in previous sight years and highlights the fact that various management factors can affect the cover crop performance just as much as the seeding rate.

Results from the slug study in the cover crop trial.

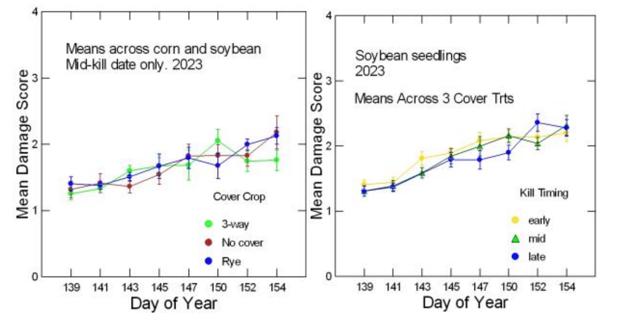

Figure 2 Neither cover crop type (rye, 3-species rye-radish-clover mix, or no cover control) nor termination timing (early, mid, or late) affected the amount of slug damage to the crops.

The results in the spring of 2023 regarding slug populations and damage to corn and soybean plantings or similar to what we observed in previous years. Figure 2 (left) shows that there was increasing slug damage observable on crop seedlings during the first two weeks after emergence, but that the extent of the damage was the same for Rye cover crop three-way cover crop or no cover crop. The right panel in Figure 2 shows that the timing of cover crop termination also had no effect on the degree of damage to soybean seedlings during the first two weeks after emergence. The number of slugs counted in the plots did occasionally vary with cover crop treatment, but this was not reflected in the damage done. In the treatments where the soybeans were planted green and the cover crops terminated nearly two weeks afterward, we observed slugs feeding on the still living cover crop species, both the Clover and the Rye. On the other hand, in the early terminated cover crop the soil was covered by a thin layer of dead Brown residue and the young soybean plants emerging were the only green living tissue available for the slugs to feed on. Figure 3 shows that there were no cover crop type or termination timing effects on the final stands of either corn or soybean. However, shading by the heavy crimson clover growth did reduce soil temperature near the surface somewhat, and this delayed and slowed soybean emergence in early growth. But even in the Clover heavy three-way mix within 2 weeks after emergence, the soybeans plant density had cut up with the other treatments. It remains to be seen whether this slow start will affect the final yields.

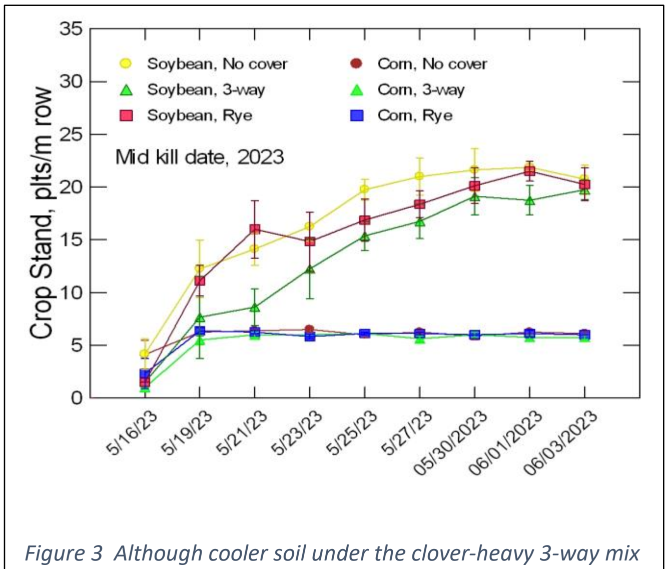

Figure 3 Although cooler soil under the clover-heavy 3-way mix slowed soybean emergence, final plant populations were not affected by the cover crop treatments in a slug-infested clayey field in 2023.

These results should help alleviate fears farmers have that by planting green and allowing cover crops to produce high biomass they may be increasing the risk of severe crop damage by slugs. As a side observation, it should be mentioned that from late April through mid-May in the late termination plots the Clover was in bloom and the plots were humming with pollinating insects. So the provision of pollinator resources is a secondary benefit of late cover crop termination.

Preliminary results on cover crop root growth measurements and root-to-shoot ratio

One of the objectives of this research was to determine how termination timing affects the below-ground contribution of carbon to the soil to better understand how cover crops affect soil health and carbon sequestration. Most models that describe the amount of carbon added to the soil by crops and cover crops are based almost entirely on above-ground growth patterns and make oversimplified assumptions about root growth by using a simple shoot-to-root ratio for a given species. There's very little research on the shoot-to-root ratio of different cover crop species and so the carbon models often rely on very limited data in this regard.

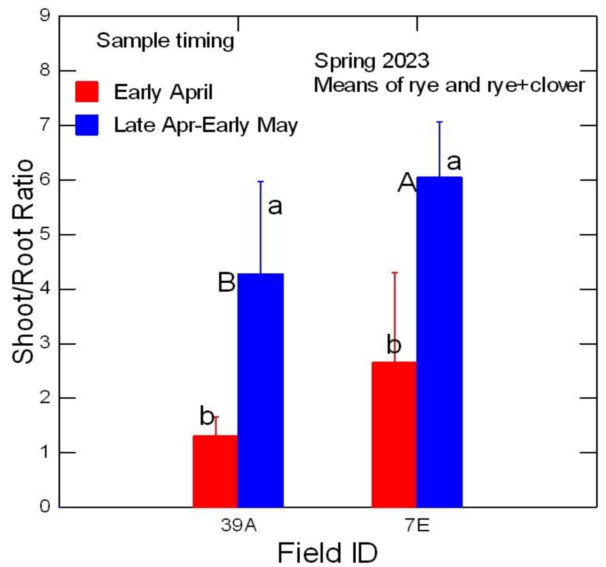

Figure 4 The shoot-to-root dry matter ratios for rye and rye + clover cover crops were significantly higher in a clayey field (7E) than in a sandy field (39A) and increased significantly during the 4 weeks between early April and around the 1st of May.

We, therefore, hope to contribute more detailed data on how different cover crop species may have changing shoot-to-root ratios over time. Figure 4 shows the shoot-to-root ratios averaged across the rye and the 3-way cover crop (which in spring consisted of rye + crimson clover) as grown on two contrasting soils (field 39a is very sandy and field 7e is a silty clay). The two cover crops, rye and rye + clover, were averaged together because there were no significant differences between them in the shoot-to-root ratio. On the other hand, the fine-textured soil consistently produced cover crops with a significantly higher shoot-to-root ratio than the cover crops grown on the sandy soil. As a general principle, when plant growth is restricted by conditions in the root zone the plant will send more energy to the roots to try to alleviate the compaction, water shortage, or low access to nutrients that may be present, and this will create greater root biomass at the expense of shoot growth and thus a lower shoot to root ratio. Therefore, it's not surprising that the lower fertility, lower water-holding capacity sandy soil would produce plants with lower shoot-to-root ratios. The graph also shows the difference between ratios measured in early April and those measured about 4 weeks later just before planting corn and soybeans in early May. On both soils, the shoot-to-root ratio increased significantly. This was largely due to increased shoot biomass with little change or even a decrease in the root biomass (data not shown). It can be seen from Figure 4 that the shoot-to-root ratio under the same weather conditions varied fourfold (between 6.1 and 1.4). It is therefore obvious that any plant growth or carbon sequestration model that assumes a particular shoot-to-root ratio is likely to be highly inaccurate in predicting dry matter and carbon fixation for any particular circumstance.