Eastern Soybean Board Project Progress Report

Title: Developing soybean cover cropping strategies that maximize yield and enhance environmental conservation

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Due to continued economic and climatic pressures, farmers in the Northeast are looking for ways to increase on-farm feed production and diversity their operations to increase resilience and profitability. Soybeans could be grown for human consumption, animal feed, and biodiesel in Vermont. However, farmers face challenges due to the relatively short growing season and limited research-based information available in our area. The purpose of our trials is to evaluate soybean yield and quality under conventional growing conditions, and to determine cover cropping management practices that are successful, enhance soil health, and support high soybean yields. Understanding how soybeans perform under various cropping systems can help producers make important management decisions that lead to better crop success. With a growing concern of agriculturally related water quality implications in Vermont waterways, farmers are now required in some instances to cover crop their annually cropped fields. However, with this increase in cover cropping there is a need to investigate potential impacts on following cash crops and best practices for establishing cover crops into and following soybeans. Similarly, with the concerted effort to reduce nutrient loading in waterways due to soil erosion, farmers are becoming more interested in adoption reduced and no-till practices. Understanding how to best combine these two practices into soybean cropping systems specifically for the Northeast is critical to the success of soybean crops in Vermont.

This year we initiated several soybean trials at Borderview Research Farm in Alburgh, VT. These trials include a conventional variety trial, a cover crop trial in which soybeans follow fall planted cover crops under varying seeding rates and tillage regimes, and a soybean interseeding trial. This report will summarize our research and outreach activities around these trials thus far this season.

Variety Trial

The conventional variety trial includes 31 varieties from four different seed companies spanning maturity groups 0.70 to 2.0. The trial was planted on 23-May 2022 into a Benson rocky silt loam at a rate of 185,000 seeds ac^{-1} treated with soybean inoculant and with 5-gal ac^{-1} 9-18-9 liquid starter fertilizer. Throughout the season the trials were inspected for insect and disease issues. Some aphids have been present; however, they have not been abundant. Some instances of downy mildew (Figure 1) and other leaf diseases (Figure 2) are developing. We will continue to monitor the trial and will conduct additional assessments to capture differences between varieties if warranted. The trial will also be evaluated for populations, yield, and quality upon harvest.

Figure 1. Soybean leaf infected with downy mildew

Figure 2. Soybean leaf infected with bacterial disease

Cover Crop Trials

In Sep-29 2021, four winter rye seeding rate treatments, summarized in table 1 below, were planted at Borderview Research Farm in Alburgh, VT on 29-Sep. Rates ranging from 50 to 150 lbs ac^{-1} of winter rye and a no cover crop control were used to produce varying levels of cover crop biomass. The objective was to evaluate the impact of cover crop biomass/residue on soybean yield. These four treatments were replicated four times each within three cover crop termination systems: conventional tillage, pre-plant herbicide application with no tillage, and post-plant herbicide application with no tillage.

Table 1. Winter rye seeding rate treatments, 2021-2022.

Treatment	**Seeding rate (lbs ac^{-1})**
No residue (control)	0
Low residue	50
Moderate residue	100
High residue	150

In the spring of 2022, soil health samples were taken from four replicates of two seeding rate treatments (0 and 100 lbs ac^{-1}). Samples were collected according to the Cornell Soil Health Laboratory protocol and were submitted to that laboratory for analysis. Biomass was collected in each plot within a 0.25m^2 quadrat on 6-May in the plow and pre-plant herbicide blocks, and on 23-May in the post-plant herbicide block. Ground cover was also captured at these times using the Canopeo® smartphone application. Soil moisture and temperature were measured in each plot at a 6-inch depth prior to planting and every other week following planting. Table 2 summarizes the cover crop ground cover and biomass prior to termination and soil conditions at planting of soybeans.

Table 2. Biomass and ground cover prior to termination; soil conditions at planting.

Cover Crop Treatment	Dry matter yield tons ac^{-1}	Ground cover %	Soil moisture %	Soil temperature ◦F
No cover/residue (control)	0	15.7	23.8	55.7
50 lbs ac^{-1}	2753	52.2	24.3	60.6
100 lbs ac^{-1}	2804	60.3	22.4	60.8

150 lbs ac^{-1}	3224	68.4	22.0	61.0
Trial mean	2931	49.2	23.1	59.5

At this time these data have not been statistically analyzed nor have quality analyses (nutrient content) performed.

Ground cover and biomass increased with seeding rate as expected, however statistical analysis has not yet been performed to determine if these differences are significant. Biomass in the post-plant herbicide treatment was approximately three times greater than in the plow or pre-plant herbicide treatments. This also was expected as the termination occurred about two weeks later in that treatment, allowing the rye to grow considerably. Soil moisture at planting decreased with increasing cover crop biomass. This suggests that, in years with wet springs cover crops can help absorb and utilize excess soil moisture which may allow for earlier field preparation. However, it is also possible that, in dry years, this could be detrimental to crop establishment. To investigate this, we continued to take soil moisture readings every other week to track changes across treatments throughout the growing season. In addition to moisture, soil temperatures were also recorded as levels of residue may impact soil temperatures. Interestingly, at planting the control plots were approximately 5 degrees cooler than plots with a cover crop. The plow and pre-plant herbicide treatments yielded similar at planting soil temperatures and were approximately 3 degrees warmer than the post-plant herbicide treatment. The additional and living biomass in the post-plant herbicide treatment kept the soil cooler as it was shaded and not disturbed via tillage. Soil temperature data are still being collected and the full data sets will be analyzed for the final report.

Cover crop residue was incorporated into the soil in the plow block with a Pottinger TerraDisc on 9-May. In the pre-plant herbicide treatment, cover crops were terminated using an application of Roundup® PowerMax herbicide at a rate of 1 qt. ac^{-1} on 8-May. Finally, cover crops were terminated with a post-planting application of Roundup® PowerMax at a rate of 1 qt. ac^{-1} on 25-May. Soybeans were planted in all plots on 24-May at a rate of 180,000 seeds ac^{-1}, treated with soybean inoculant, and planted with 5 gal ac^{-1} 9-18-9 liquid starter fertilizer. To understand the nutrient release rates of the various levels of cover crop biomass and how this is impacted by termination method, soil nitrate content was assessed in each plot prior to termination and biweekly following termination and planting. At this time these analyses have not all been completed. The soybeans were also scouted for slug damage in early June to investigate differences between residue levels and potential slug harboring habitat between termination methods and cover crop treatments. However, despite wet and cool conditions no slug damage was observed in any treatment. Soybeans will continue to be monitored for insect and disease pressure and will be evaluated for populations, yield, and quality at the time of harvest.

We also plan to implement a soybean interseeding trial this fall. On 25-May, strips of two soybean varieties, one of maturity group 0.7 and the other 2.0, were planted at 180,000 seeds ac^{-1}. Specific details surrounding treatments and experimental design have yet to be solidified, however, a topic of interest to farmers in our region is interseed timing. Soybeans typically reach maturity and are harvested beyond the optimal times for establishing cover crops, even the most hardy and vigorous species like winter cereal rye. Therefore, looking towards other establishment strategies that can be utilized pre-harvest, such as interseeding, could provide farmers opportunities to be able to implement cover cropping to aid their conservation and soil health promoting efforts (Figure 3). Compared to post-harvest seeding, interseeding presents additional challenges related to equipment and timing seeding with crop growth stage to avoid damage while getting good establishment. Soybean plants that are too young and bushy may be damaged by equipment pushing them over if interseeding occurs too early. Conversely, if done too late, shattering damage may occur. We plan to investigate the efficacy of interseeding cover crops at various growth stages prior to and following harvest in order to identify practices that support both high soybean yields and successful cover crop

establishment. With the two differing maturities we can better understand the impact soybean cropping management, i.e. varietal selection and maturity group selection, has on interseeding and cover cropping success.

Figure 3. Mature soybeans interseeded with winter rye.

Outreach

Outreach this year has finally begun to return to normal. While all of our winter conferences and meetings, which attract hundreds of farmers and technical service providers, were still unable to occur in-person, outdoor field days and workshops have resumed. This includes our annual field day at Borderview Research Farm which attracted 225 attendees. During this event, attendees toured the soybean research trials and were presented with the most current data from the trials and details on the trials underway. The plots were individually labelled with treatment information in each trial so attendees could walk through the trial with the treatment and management information handy. Reports summarizing our research were made available in a printed booklet for that event and have been posted to our website (links below) and shared through our blog and social media networks. At the conclusion of our season, we will still create research reports which will be made available through our website and in-print in our office. In lieu of conferences if we cannot hold them this winter, we will continue to prioritize performing cover cropping, no-till, and soybean production outreach to our farmer and agricultural professional stakeholders to the best of our abilities.

2021 Reports that are distributed at events and online

https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/2021%20Research%20Rpts/2021_Conventional_Soybean_VT_Report_Final.pdf

https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/2021%20Research%20Rpts/2021_Conv_Soybean_Performance_Trials_Summary.pdf

https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/2021%20Research%20Rpts/2021_Soybean_Interseed_Cover_Crop_ReportFinal.pdf

https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/2021%20Research%20Rpts/2021_Soybean_Cover_Crop_Termination_Report.pdf