## Soybean Cover Crop Trial

NORTHWEST CROPS & SOILS PROGRAM

# 2018 Soybean Cover Crop Trial

Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, John Bruce, Abha Gupta, and Lindsey Ruhl
UVM Extension Crops and Soils Technicians
(802) 524-6501

Visit us on the web at: http://www.uvm.edu/nwcrops



THE UNIVERSITY OF VERMONT EXTENSION

**2018 SOYBEAN COVER CROP TRIAL**

**Dr. Heather Darby, University of Vermont Extension**
**heather.darby[at]uvm.edu**

In 2018, the University of Vermont Extension Northwest Crops and Soils Program investigated the impact of various cover crop mixtures on a subsequent soybean crop's yield and quality at Borderview Research Farm in Alburgh, VT. Soybeans are grown for human consumption, animal feed, and biodiesel and can be a useful rotational crop in corn silage and grass production systems. As cover cropping expands throughout Vermont, it is important to understand the potential benefits, consequences, and risks associated with growing cover crops in various cropping systems. In an effort to support the local soybean market and to gain a better understanding of cover cropping in soybean production systems, the University of Vermont Extension Northwest Crop and Soils (NWCS) Program, as part of a grant from the Eastern Soybean Board, established a trial in 2018 to investigate the impacts on soybean yield and quality following annual cover crop mixtures with a soybean crop.

## MATERIALS AND METHODS

The trial was established at Borderview Research Farm, Alburgh, VT in the fall of 2017. The experimental design was a complete randomized block design with four replications (Table 1). The treatments were 18 cover crop mixtures planted on 24-Aug 2017. Treatments consisted of mixtures that would both be over-wintered and some that would be winter-killed. Cover crop treatments and seeding rates are listed in Table 2. Biomass was collected on 17-Oct 2017 from a 0.25m$^2$ area in each plot. Samples were weighed prior to and after drying to determine dry matter content and calculate yield. Cover crop biomass was measured again in the spring just prior to soybean planting (9-May 2018) using this same method. All cover crop treatments were terminated just prior to soybean planting using a moldboard plow and disc harrow.

**Table 1. Trial management details, 2017-2018.**

| | **Borderview Research Farm-Alburgh, VT** |
|---|---|
| Soil types | Benson rocky silt loam 8-15% slope |
| Previous crop | Annual cover crop mixtures |
| Tillage operations | Moldboard plow and disc |
| Plot size (feet) | 5 x 20 |
| Row spacing (inches) | 30 |
| Replicates | 4 |
| Starter fertilizer (lbs ac$^{-1}$) | 5 gal ac$^{-1}$ 9-18-9 |
| Planting dates | Cover crops: 24-Aug 2017<br>Soybeans: 22-May 2018 |
| Weed control | 1 qt. ac$^{-1}$ Roundup® applied 22-Jun 2018 |
| Harvest date | 10-Oct 2018 |

On 22-May, the soybeans were planted into the terminated cover crop treatments using a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA) at 185,000 seeds ac$^{-1}$ with 5 gal ac$^{-1}$ starter fertilizer (9-18-9). The variety SW1055 (maturity group 1.0, Genuity® RoundUp Ready 2 Yield) soybean was obtained from Seedway, LLC (Hall, NY) for the trial. Soybeans were sprayed

with Roundup herbicide on 22-Jun to control weeds. On 10-Oct, the soybeans were harvested using an Almaco SPC50 small plot combine. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). They were then weighed for plot yield and tested for harvest moisture and test weight using a DICKEY-John Mini-GAC Plus moisture/test weight meter.

**Table 2. Annual cover crop mixture treatments grown in 2017 prior to soybean in 2018.**

| Mix | Species | Variety | Over-winters? | Seeding rate lbs ac$^{-1}$ |
|---|---|---|---|---|
| 1 | Annual ryegrass | unknown | No | 24 (NRCS mix) |
| | Crimson clover | unknown | | |
| | Tillage radish | Arifi | | |
| 2 | Winter triticale | Fridge | Yes | 40 |
| | Tillage radish | Eco-till | | 2 |
| | Red clover | Freedom | | 5 |
| | Winter pea | Lynx | | 20 |
| 3 | Winter rye | unknown | Yes | 40 |
| | Red clover | Dynamite | | 1 |
| | Forage turnip | Appin | | 2 |
| 4 | Winter triticale | Hyoctane | Yes | 60 |
| | Red clover | Dynamite | | 3 |
| | Forage turnip | Appin | | 2 |
| 5 | Forage oats | Everleaf | No | 60 |
| | Tillage radish | Groundhog | | 3 |
| 6 | Winter triticale | Trical815 | Yes | 60 |
| | Rape | Dwarf Essex | | 3 |
| 7 | Forage oats | Everleaf | Yes | 40 |
| | Red clover | Duration | | 5 |
| | Forage turnip | Appin | | 2 |
| 8 | Annual ryegrass | Bruiser | No | 15.2 |
| | Forage turnip | Appin | | 2.11 |
| 9 | Annual ryegrass | Fria | No | 22 |
| | Tillage radish | Eco-till | | 3 |
| 10 | Forage oats | Everleaf | No | 70 |
| 11 | Tillage radish | Eco-till | No | 8 |
| 12 | Crimson clover | Dixie | No | 10 |
| 13 | Forage oats | Everleaf | No | 70 |
| | Tillage radish | Eco-till | | 3 |
| | Crimson clover | unknown | | 10 |
| 14 | Winter rye | unknown | Yes | 75 |
| 15 | Winter rye | unknown | Yes | 70 (farm mix) |
| | Hairy vetch | unknown | | |
| 16 | Annual ryegrass | Fria | No | 30 |
| 17 | Hairy vetch | | Yes | 24 |
| 18 | No cover | | No | N/A |

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and hybrids were treated as fixed. Hybrid mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. In this example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5,

| Hybrid | Yield |
|---|---|
| A | 6.0 |
| B | 7.5* |
| C | **9.0*** |
| LSD | 2.0 |

which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another.

## RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 3). Overall, the season was hotter and dryer than normal. A total of 15" of rain fell during the soybean growing season. Precipitation was approximately 60% of normal. During the growing season, there were only six rain events that resulted in greater than 0.75 inches of accumulation. These six events constituted approximately 36% of the total rainfall. Consequently, there were several extended periods with very little to no rainfall. The longest period was approximately 25 days with less than 0.25 inches of accumulated rainfall. Temperatures were above normal Jul-Sep. Overall, 2731 growing degree days (GDDs) were accumulated May-October, 520 above the 30-year normal.

**Table 3. Weather data for Alburgh, VT, 2018.**

| **Alburgh, VT** | May | June | July | August | September | October |
|---|---|---|---|---|---|---|
| Average temperature (°F) | 59.5 | 64.4 | 74.1 | 72.8 | 63.4 | 45.8 |
| Departure from normal | 3.10 | -1.38 | 3.51 | 3.96 | 2.76 | -2.36 |
| | | | | | | |
| Precipitation (inches) | 1.94 | 3.74 | 2.43 | 2.96 | 3.48 | 3.53 |
| Departure from normal | -1.51 | 0.05 | -1.72 | -0.95 | -0.16 | -0.07 |
| | | | | | | |
| Growing Degree Days (base 50°F) | 352 | 447 | 728 | 696 | 427 | 81 |
| Departure from normal | 154 | -27 | 88 | 115 | 109 | 81 |

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

The top yielding cover crop treatment in the fall was mixture 7 (forage oat/red clover/turnip) which produced approximately 2 tons $ac^{-1}$ (Table 4). This treatment performed statistically similar to mixture 3 (winter rye/red clover/turnip) and mixture 8 (annual ryegrass/turnip). As many of the treatments consisted of species that do not overwinter, the top yielding treatments in the spring, producing just under 1.5 ton $ac^{-1}$, were mixtures 14 and 15, which included winter rye and winter rye/vetch respectively. None of the top treatments in the fall were top yielding in the following spring. This was true even for the treatments that included overwintering species. Soybean yield and test weight did not differ significantly by the preceding cover crop treatments. Yields averaged 3758 lbs $ac^{-1}$ or 62.6 bu $ac^{-1}$ and test weight averaged 55.2 lbs $bu^{-1}$. These were consistent with the averages observed in our other soybean trials in 2018.

**Table 4. Cover crop and soybean harvest characteristics, 2017-2018.**

| Mix | Overwinters? | Fall 2017 | Spring 2018 | Soybean harvest 2018 | |
|---|---|---|---|---|---|
| | | Dry matter yield lbs ac$^{-1}$ | | Yield at 13% moisture lbs ac$^{-1}$ | Test weight lbs bu$^{-1}$ |
| 1 | No | 3126 | 490 | 3695 | 55.0 |
| 2 | Yes | 2992 | 1075 | 3702 | 55.0 |
| 3 | Yes | 3562* | 720 | 3573 | 55.1 |
| 4 | Yes | 3297 | 768 | 3820 | 55.4 |
| 5 | No | 2808 | 1383 | 4058 | 55.1 |
| 6 | Yes | 2221 | 1378 | 3847 | 55.4 |
| 7 | Yes | **4388** | 1229 | 3886 | **55.9** |
| 8 | No | 3438* | 805 | **4150** | 55.3 |
| 9 | No | 3165 | 486 | 4028 | 55.1 |
| 10 | No | 2961 | 1288 | 3703 | 55.3 |
| 11 | No | 2890 | 323 | 3670 | 55.6 |
| 12 | No | 1590 | 796 | 3531 | 55.1 |
| 13 | No | 2964 | 1463 | 4074 | 55.2 |
| 14 | Yes | 2076 | 2720* | 3325 | 55.1 |
| 15 | Yes | 1088 | **2862** | 3512 | 55.4 |
| 16 | No | 3122 | 1557 | 4140 | 55.6 |
| 17 | Yes | 1104 | 1714 | 3662 | 55.4 |
| Control | No | 643 | 1488 | 3269 | 55.1 |
| LSD ($p$ = 0.10) | N/A | 984 | 583 | NS | NS |
| Trial mean | N/A | 2635 | 1252 | 3758 | 55.2 |

*Varieties that did not perform significantly lower than the top performing variety in **bold** are indicated with an asterisk.
NS, no significant difference. N/A, not applicable.

In 2017, we saw a significant decrease in soybean yields when following an overwintering cover crop. This year, the trend was much less pronounced (Table 5). Soils were analyzed for nitrate ($NO_3$) content multiple times between the fall biomass harvest and soybean harvest (Figure 1). In the fall, soil nitrate levels were approximately the same in overwinter vs winterkilled cover crop treatments. The following spring when biomass was collected again, the soil nitrate level was approximately 1.54 ppm lower in the overwinter treatments.

**Table 5. Soybean yields by cover crop type.**

| **Overwinter** | **Soybean yield** (bu ac$^{-1}$) 2017 | 2018 |
|---|---|---|
| Yes | 60.4 | 60.0 |
| No | **67.9** | **62.6** |
| $p$ value | 0.007 | 0.132 |
| Trial mean | 64.2 | 55.2 |

The top performing treatment is indicated in **bold**.

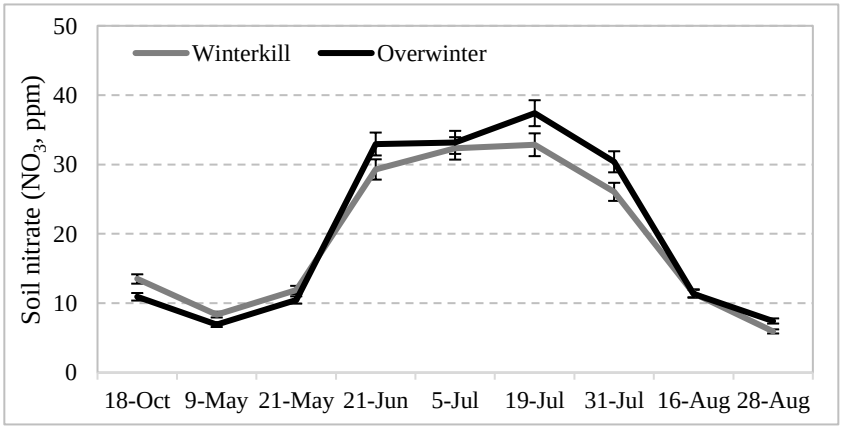


**Figure 1. Soil $NO_3$ content by cover crop treatment type, 2017-2018.**

This trend continues through the end of May at which point the soybeans are planted. It is not until the end of June when soil nitrate levels in the overwinter plots exceed that of the winterkill plots. This trend holds through the end of July. This suggests that the nitrogen in the living cover crop material that was incorporated into the soil prior to planting soybeans was mineralized in mid-July. The extra nitrogen released from the overwintered cover crops did not appear to impact soybean yield. It is important to recognize that starter fertilizer was applied at planting to all soybean plots. A greater impact may have been seen, had starter not been used. We plan to continue to investigate nitrogen cycling in these cover crop treatments and its potential impacts on subsequent soybean productivity.

## DISCUSSION

In 2018, soybean establishment and ultimate yields were not significantly impacted by previous cover crop treatments (Figure 2). These data suggest that soybeans can successfully follow high yielding cover crop mixtures without experiencing yield depressions. As this is contrary to our observations in 2017, we will continue to investigate cover cropping practices in soybeans in this region to gain a better understanding of successful cover cropping practices and their impacts on soybean performance.

## ACKNOWLEDGEMENTS

UVM Extension Northwest Crops and Soils Program would like to thank Eastern Soybean Region Board for the funding for this trial. We would also like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial. We would like to acknowledge Erica Cummings, Catherine Davidson, Hillary Emick, Amanda Gervais, and Haley Jean for their assistance with data collection and entry. We would also like to thank the seed companies for their seed and cooperation in this study. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

*UVM Extension helps individuals and communities put research-based knowledge to work.*

THE UNIVERSITY OF VERMONT EXTENSION

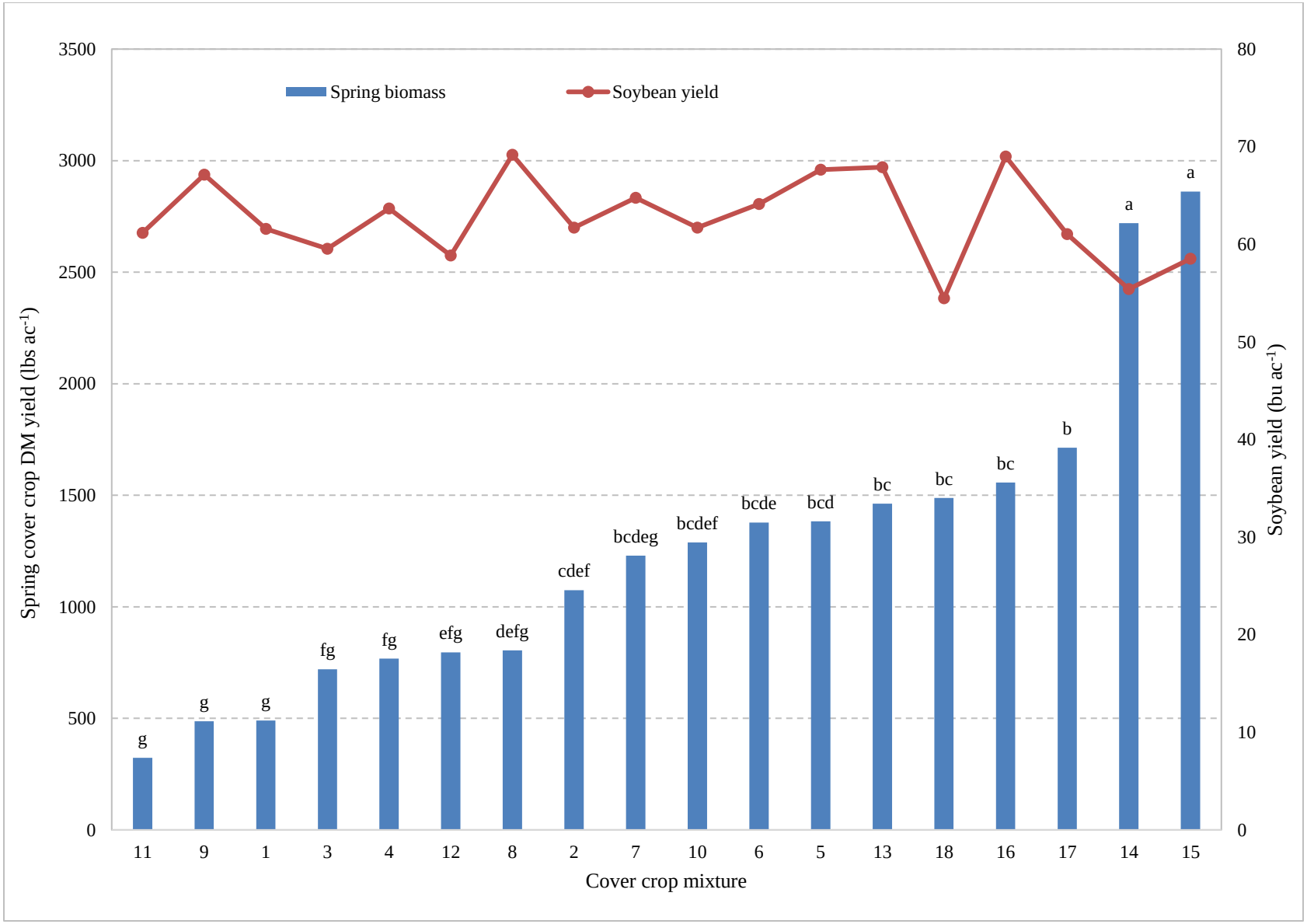


**Figure 2. Soybean and spring cover crop biomass by cover crop mixture treatment, 2018.**
Treatments that share a letter performed statistically similarly to one another. Soybean yields did not differ statistically across treatment.