NORTHWEST CROPS & SOILS PROGRAM

# 2017 Barley Weed Control Trial


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CULTIVATING HEALTHY COMMUNITIES

# 2017 BARLEY WEED CONTROL TRIAL

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Demand for local, organic grains has been increasing in recent years as businesses such as flour mills, malt houses, and bakeries have grown and developed business models to include a higher proportion of local ingredients in their products. The organic grains industry requires the use of innovative strategies to control weeds and address disease issues to grow grains in the most efficient manner. In 2017, the University of Vermont Extension Northwest Crops and Soils Program conducted the second year of a trial to evaluate the impact of row spacing and cultivation on weed pressure and barley yield and quality.

## MATERIALS AND METHODS

The soil type at the Alburgh location was a Covington silty clay loam (Table 1). The plots were 10' x 40' and the treatments were variable row spacing and cultivation (Table 2). Barley was seeded on 27-Apr at a rate of 155 lbs ac$^{-1}$. Ida Gold mustard (surrogate weed) was hand broadcasted on 28-Apr at a rate of 3.38 lbs ac$^{-1}$ to ensure weed presence in the trial. Barley was harvested on 1-Aug. The previous crop was corn.

**Table 1. Barley weed control trial specifications, Alburgh, VT, 2017.**

| | Borderview Research Farm<br>Alburgh, VT |
|---|---|
| Soil type | Covington silty clay loam, 0-3% slope |
| Previous crops | Corn |
| Plot size (feet) | 10 x 40 |
| Tillage type | Spring plow, disk, and spike tooth harrow |
| Barley planting date | 27-Apr |
| Barley seeding rate (lbs ac$^{-1}$) | 155 |
| Mustard planting date | 28-Apr |
| Mustard seeding rate (lbs ac$^{-1}$) | 3.38 |
| Barley harvest date | 1-Aug |

Five treatments were used in this experiment: band sowing, band sowing with cultivation, narrow rows, standard width rows, and wide rows with cultivation. The band sowing treatments had a five-inch-wide seeded area with 6-inch row spacing. The band sowing treatments were planted with a custom made air seeder, mounted with precision Dutch openers, (Gandy Company, Owatonna, MN). The narrow, standard, and wide had a one-inch-wide seeded area with 4.5-inch, 6.5-inch, and 9.1-inch row spacing, respectively. The narrow and wide seeded treatments were seeded with a Kverneland grain drill (Kverneland Group, Klepp stasjon, Norway), and the standard seeded treatments were seeded with a Sunflower 9412 grain drill (Sunflower Manufacturing, Beloit, KS). The band sowing with cultivation treatments and wide sown treatments were cultivated with a schmotzer hoe cultivator (Schmotzer manufacturing, Bayern, Germany).

**Table 2. Barley seeding methods, Alburgh, VT, 2016.**

| Treatment | Row Spacing | Planter |
|---|---|---|
| Band | 6” | Gandy air seeder |
| Band with cultivation | 6” | Gandy air seeder |
| Narrow | 4.5” | Kverneland grain drill |
| Standard | 6.5” | Sunflower grain drill |
| Wide with cultivation | 9.1” | Kverneland grain drill |

Three metal pigtails were placed in the ground in each plot to ensure measurements were taken from the same locations through the season. Measurements were taken using a 2.69 $ft^2$ quadrat, with the pigtail placed in the bottom right corner of the quadrat. Insect and disease scouting was conducted on 3-Jul. Twenty-five plants in each plot were examined for disease and pest damage. The top two leaves from each plant were examined and the percent of each leaf affected by disease and arthropod damage was recorded. On 1-Aug, biomass was sampled from three locations in each plot using a 2.69 $ft^2$ quadrat. The biomass was sorted into four categories: barley, mustard, grasses, and broadleaf weeds. Biomass for each category is presented on a per-acre-dry-matter basis. Heights were taken on 1-Aug in each of the plots; ten measurements were taken for each barley and mustard. Lodging was also assessed on 1-Aug by a visual estimate of the percent of each plot that was lodged.

On 1-Aug, the barley was 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, tested for harvest moisture using a DICKEY-John M20P moisture meter, and evaluated for test weight using a Berckes Test Weight Scale. Once test weight was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill, and were evaluated for crude protein content using the Perten Inframatic 8600 Flour Analyzer. In addition, falling number for the barley was determined using the AACC Method 56-81B, AACC Intl., 2000, on a Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Falling numbers greater than 350 indicate low enzymatic activity and sound quality sample. A falling number lower than 200 indicated high enzymatic activity and poor quality. Deoxynivalenol (DON) analysis was analyzed using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. Percent germination was determined by incubating 100 seeds in 4.0 mL of water for 72 hours and counting the number of seeds that did not germinate. Each plot was done in duplicate. Grain assortment, or plumpness was determined using the Pfeuffer Sortimat using 100g of clean seed, and was determined by combining the amount of seed remaining on the 2.78 mm and 2.38 mm sieves (Kitzingen, Germany). Barley yields are presented at 13.5% moisture on a per acre basis.

Data was analyzed using general linear model (GLM) procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. 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, 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.

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

## 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). While April was warm, promoting good germination and establishment of the barley crop, the rest of the growing season was colder and wetter than normal. April through August experienced 7.39 more inches of precipitation than the 30-year average. From April through August, there were an accumulated 4440 Growing Degree Days (GDDs) this season, approximately 51 less than the historical 30-year average.

**Table 3. 2017 weather data for Alburgh, VT.**

| **Alburgh, VT** | April | May | June | July | August |
|---|---|---|---|---|---|
| Average temperature (°F) | 47.2 | 55.7 | 65.4 | 68.7 | 67.7 |
| Departure from normal | 2.37 | -0.75 | -0.39 | -1.90 | -1.07 |
| | | | | | |
| Precipitation (inches) | 5.20 | 4.10 | 5.60 | 4.90 | 5.50 |
| Departure from normal | 2.40 | 0.68 | 1.95 | 0.73 | 1.63 |
| | | | | | |
| Growing Degree Days (32°F-95°F) | 459 | 733 | 1002 | 1138 | 1108 |
| Departure from normal | 75 | -23 | -12 | -60 | -31 |

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.

Measurements and assessments through the growing season included barley height, mustard height, lodging, and pest and disease scouting (Table 4). The average barley height was 64.4 cm and the average mustard height was 57.8 cm. The wide seeded treatment had the tallest barley, while the narrow seeded barley was significantly shorter than all other treatments. There was no significant difference in mustard heights. Only the narrow seeded treatment had mustard that was taller on average than the barley crop.

The wet weather led to lodging in all treatments. An average 20% of the plot lodged and there was no significant difference in lodging between treatments.

Twenty-five plants in each plot were examined for disease and arthropod pest damage, and results are shown in Table 4 as the average percent of each leaf that was affected by arthropod damage and foliar disease. Overall, pest and disease pressure was low in the trial. Treatments displayed between 1.25% and 2.00% of leaf surface affected by pests and disease, and there was no significant difference between treatments.

The most common arthropods affecting the barley weed control trial were cereal leaf beetles, affecting 44% of plants scouted (data not shown). Cereal leaf beetles overwinter in crop stubble or leaf litter in wooded areas and emerge in the spring to raise a single generation of young per year. The larval stage of the beetle generally causes more damage than the mature insect. Thrips were also observed in the barley weed control trial at lower prevalence than cereal leaf beetle. Thrips are small insects with fringed wings that feed on a variety of plants by puncturing the cells and sucking up the contents. Damage caused by thrips includes discoloration and leaf scarring, reduced growth of the plant, and they can also act as a disease vector. Thrips damage was observed in 18% of plants scouted.

Several foliar diseases were observed during wheat development, including powdery mildew, leaf rust, and several diseases causing lesions and spotting to the leaf, including septoria and tan spot (data not shown). Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased plant typically exhibits reduced vigor, growth and seed fill. The earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. Leaf spots, caused by several bacterial and/or fungal infections, were very prevalent and affected all treatments and 91% of all plants scouted. Powdery mildew (caused by the fungus *Erysiphe graminis f. sp. Tritici*) was present in 33% of plants scouted. Leaf rust and stripe rust were both present in the barley weed control trial, with rust affecting 23% of plants sampled.

The pathogen of most concern among grain growers is *Fusarium* head blight (FHB). It is predominantly caused by the species, *Fusarium graminearum*. This disease can be very destructive and cause yield losses, low test weights, low seed germination, and contamination of grain with mycotoxin, a vomitoxin called deoxynivalenol (DON). The spores are usually transported by air currents and can infect plants at flowering through grain fill. Spores can also overwinter on grain stubble. Signs of FHB infection include premature bleaching of grain heads and pink or orange colored mold at the base of the spikelet. Eating contaminated grain greater than 1 ppm of DON poses a health risk to both humans and livestock. Approxinately 4% of plants scouted displayed signs of infection with *Fusarium graminearum*.

**Table 4: Pre-harvest measurements in barley weed control trial, Alburgh, VT, 2017.**

| Treatment | Barley height | Mustard height | Lodging | Pest and disease |
|---|---|---|---|---|
| | cm | cm | % | % foliar surface affected |
| Band | 66.5* | 59.7 | 20.0 | **1.25** |
| Band with Cultivation | 65.9* | **51.5** | 17.5 | 1.50 |
| Narrow | 57.1 | 57.4 | **11.3** | **1.25** |
| Standard | 65.0* | 62.5 | 20.0 | **1.25** |
| Wide | **67.7*** | 58.0 | 27.5 | 2.00 |
| LSD (0.10) | 10.2 | NS | NS | NS |
| Trial mean | 64.4 | 57.8 | 19.3 | 1.45 |

*Treatments with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference between treatments.

Within each treatment, biomass was sampled and separated into barley, mustard, grasses and broadleaf weeds (Table 5). The average barley biomass was 5311 lbs $ac^{-1}$. This includes all aboveground biomass. The wide seeded treatment produced the most barley biomass with 7264 lbs $ac^{-1}$. This was significantly higher than all other treatments. The standard treatment had the most weed biomass in all categories, and had significantly higher mustard and grass biomass than all other treatments. Overall, the wide treatment had the largest amount of barley biomass and the least amount of weed biomass.

**Table 5: Biomass of barley, mustard, and other weeds, Alburgh, VT, 2017.**

| Treatment | Barley biomass | Mustard biomass | Grasses | Broadleaf weeds |
|---|---|---|---|---|
| | lbs $ac^{-1}$ | lbs $ac^{-1}$ | lbs $ac^{-1}$ | lbs $ac^{-1}$ |
| Band | 5654 | 125* | 931* | **68.0** |
| Band with Cultivation | 4541 | 112* | 718* | 176 |
| Narrow | 4696 | **51.0*** | 977* | 130 |
| Standard | 4398 | 379 | 1691 | 349 |
| Wide | **7264*** | 60.0* | **523*** | 96.0 |
| LSD (0.10) | 1579 | 85.9 | 770 | NS |
| Trial mean | 5311 | 145 | 968 | 164 |

*Treatments with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference between treatments.

After harvest, barley was assessed for harvest moisture, test weight, and yield (Table 6). The average harvest moisture was 14.8%. There was no significant difference between treatments, and all treatments were above 14% and required drying for long-term storage. None of the treatments reached the ideal test weight of 48 lbs per bushel; the narrow seeded treatment was significantly lower than all other treatments. The average barley seed yield was 2238 lbs $ac^{-1}$; there were no significant differences between treatments.

**Table 6: Harvest measures of barley seeding treatments, Alburgh, VT, 2017.**

| Treatment | Harvest moisture | Test weight | Yield |
|---|---|---|---|
| | % | lbs bu$^{-1}$ | lbs ac$^{-1}$ |
| Band | **14.4** | **44.3*** | 2264 |
| Band with Cultivated | 14.9 | 43.4* | **2457** |
| Narrow | 15.0 | 42.5 | 2280 |
| Standard | 15.1 | 45.0* | 1805 |
| Wide | 14.8 | 44.2* | 2386 |
| LSD (0.10) | NS | 1.94 | NS |
| Trial mean | 14.8 | 43.9 | 2238 |

*Treatments with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference between treatments.

Barley from the five different treatments was tested for quality (Table 7). There were no significant differences between treatments regarding germination, crude protein, or DON. The trial averaged 98% germination, 9.07% crude protein, and DON levels of 0.96 ppm. The band sowing treatment that was not cultivated had the plumpest kernels, but was not statistically different from the cultivated band sowing treatment or the wide seeded treatment.

**Table 7: Barley quality assessments, Alburgh, VT, 2017.**

| Treatment | Germination | Crude protein @ 12% moisture | DON | Plumpness (>2.38 mm) |
|---|---|---|---|---|
| | % | % | ppm | % |
| Band | **98.5** | 8.84 | 1.00 | **90.7*** |
| Band with Cultivation | 98.3 | **9.39** | 1.08 | 86.7* |
| Narrow | 97.8 | 8.94 | 0.98 | 84.1 |
| Standard | 97.5 | 9.30 | 1.00 | 84.4 |
| Wide | 97.8 | 8.90 | **0.73** | 86.1* |
| LSD (0.10) | NS | NS | NS | 6.16 |
| Trial mean | 98 | 9.07 | 0.96 | 86.4 |

*Treatments with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference between treatments.

# DISCUSSION

It is important to remember that the results only represent one year of data. Overall, it appeared that the band and wide sown treatments were successful in decreasing weed presence without sacrificing barley yield or quality. The wide treatment had the lowest weed pressure, and was statistically similar to the top performers in yield and quality. Although the wide sown treatment had the highest barley biomass during preharvest sampling, it also had the highest incidence of lodging and this may have had an impact on yield (Figure 1). All of the experimental treatments in this trial fared better in terms of yield and weed suppression than the standard row spacing that is most widely used by farmers in the Northeast. Further research should be conducted to evaluate the cost benefit of farmers adopting new planting and weed control schemes in small grains.

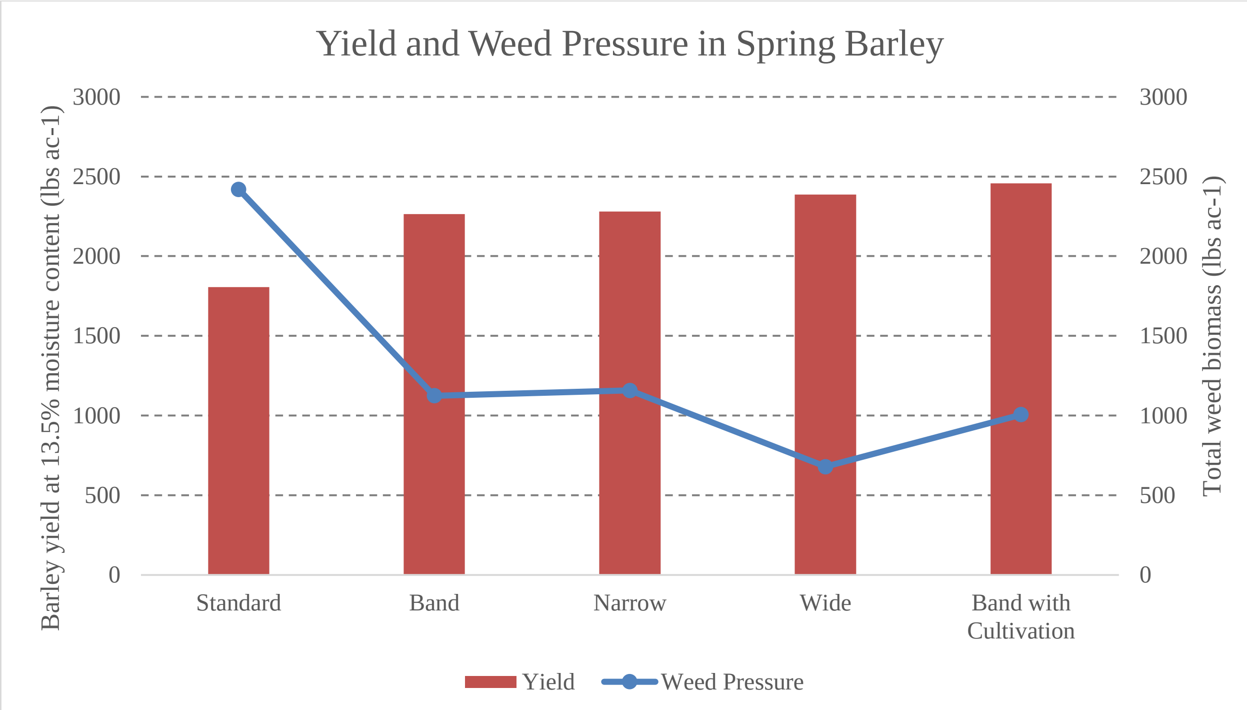


**Figure 1. Barley yield and weed pressure by row spacing, Alburgh, VT, 2017.**

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