

NORTHWEST CROPS & SOILS PROGRAM



2015 Hop Compost Tea Trial



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As the acreage of hops continues to rapidly expand in the northeast, there is a great need for production knowledge specific to our region. Downy mildew has been identified as the primary pathogen plaguing our hop yards. This disease causes reduced yield, poor hop quality, and in extreme cases, plant death. Control measures are desperately needed that can effectively reduce disease incidence and have a minimal impact on the environment. Farmers have increasing interest in the potential impact of bio-based foliar products on yield, quality, and disease incidence of hops. Compost teas have been used to control disease and provide fertility in a wide range of crops. This study evaluates the impact of compost tea on disease incidence and yield of second year hops.

MATERIALS AND METHODS

The replicated research plots were located at Borderview Research Farm in Alburgh, VT on a Benson rocky silt loam soil. The experimental design was a randomized complete block with 5 replicates. The experiment included the following two treatments (8 plants per treatment):

- 1) Hops with standard granular fertilizer regime and downy mildew controlled with Champ WP (copper hydroxide).
- 2) Hops with standard granular fertilizer regime plus compost tea added as a foliar fertilizer and disease control.

The small hop yard was located east of the main hop yard and had a smaller design. Two parallel trellises, 517 feet in length, were constructed with 13 feet of space between them. Due to the short duration of this trial, this trellis was only 12 feet tall to accommodate the smaller first and second year plants. The construction of the small hop yard was similar to that of the main hop yard. Poles were set every 95 feet. Unlike the main hop yard, the posts were set at a 90° angle to the ground surface. A step-by-step guide for building a trellis can be found at www.uvm.edu/extension/cropsoil/wp-content/uploads/Rainville-Building-a-Hopyard.pdf.

The small hop yard was irrigated sporadically throughout July and August due to the ample moisture provided by precipitation during the growing season. When irrigation was applied, the rate was 3900 gal ac⁻¹. Detailed information for the drip irrigation systems as well as a parts and cost list can be found at www.uvm.edu/extension/cropsoil/hops#irrigation.

Fertility Management

Granular fertilizer was applied at the beginning of the season prior to the application of the compost tea. 50 lbs ac⁻¹ N was applied to the small hop yard in the form of sodium nitrate (16-0-0). The plants were also sidedressed with boron and zinc at rates 1 lb ac⁻¹ and 8 lbs ac⁻¹, respectively. The compost tea provided a very small amount of additional nutrients to the plots associated with the treatment (Table 1).

Table 1. Total nutrients applied via compost tea treatment over the growing season, Alburgh, VT, 2015.

	Total nitrogen (N)	Nitrate nitrogen (NO ₃ -N)	Ammonium nitrogen (NH ₄ -N)	Phosphorous (P)	Potassium (K)
Compost tea lb ac ⁻¹	0.183	0.181	0.002	0.020	0.677

Downy Mildew Management

Downy mildew was scouted each week using a variety of techniques. Plants in each treatment were scouted for downy mildew. The total number of basal spikes were recorded as well as the average severity of the spikes present on each hill using a 1-5 rating scale, with 1 representing a low severity infection and 5 representing a highly infected spike. The total number of aerial spikes per hill was also recorded, but severity was not evaluated. Leaf infection was evaluated by scouting 10 leaves on each plant and recording the total number that exhibited downy mildew characteristics.

Trial treatments were sprayed weekly due to the 2015 growing season's favorable downy mildew conditions (Table 2). The compost tea treatment, WP Liquid Extract, was produced by Worm Power, LLC., and is an OMRI-approved compost tea produced from worm castings. The compost tea was applied using a backpack sprayer with a hand pump and nozzle attachment. The control formulation included Champ WG (Nufarm Americas, Inc, EPA Reg. No. 55146-1) and Regalia (Marrone Bio Innovations, EPA Reg. No. 84059-3). Champ WG is 77% copper hydroxide and works as a control measure against downy mildew in hops. When copper hydroxide is mixed with water, it releases copper ions, which disrupt the cellular proteins of the fungus. Regalia is a broad spectrum bio-fungicide that works by stimulating the plant's natural defenses. The Champ WG and Regalia mixture was sprayed using a Rear's Manufacturing Nifty Series 50-gallon stainless steel tank utility sprayer with PTO-driven mechanical agitation, a 3-point hitch, and a Green Garde® JD9-CT spray gun. All pesticides applied were OMRI-approved for use in organic systems and were applied at rates specified by their labels.

Table 2. 2015 Spray schedule in the small organic hop yard, Alburgh, VT.

Week of:	Champ WG (lbs ac ⁻¹)	Compost tea (gal/plant)
1-Jun	0.50	-
8-Jun	0.50	0.38
15-Jun	0.89	0.31
22-Jun	0.89	0.38
29-Jun	1.00	0.44
6-Jul	0.89	0.38
13-Jul	0.89	0.38
20-Jul	0.89	0.38
27-Jul	0.89	0.38

Harvest

Hop harvest was targeted for when cones were at 20-25% dry matter. At harvest, hop bines were cut in the field and brought to a secondary location to be run through our mobile harvester. Picked hop cones were weighed on a per plot basis, 100-cone weights were recorded, and moisture was determined using a dehydrator. 100 cones from each plot were assessed for incidence of downy mildew. They were also assessed for severity of browning due to disease on a scale of 1-5, 5 being worst. All hop cones were dried to 8% moisture, baled, vacuum sealed, and then placed in a freezer.

Yields are presented at harvest moisture and at 8% moisture on a per acre basis. Per acre calculations were performed using the spacing in the UVM Extension small hop yard of 374 hills per acre. Yields were analyzed using the GLM procedure in SAS and brew values were analyzed using the PROC MIXED procedure in SAS with the Tukey-Kramer adjustment, which means that each cultivar was analyzed with a pairwise comparison (i.e. 'Cluster' statistically outperformed 'Cascade', Cascade statistically outperformed 'Mt. Hood', etc.). Relationships between variables were analyzed using the GLM procedure.

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the months spanning from the beginning of the 2015 growing season to the 2015 harvest. The 2015 growing season (March-September) accumulated 5693 GGD's, which was 344 days more than the 30 year average (1981-2010 data). Overall precipitation was below average the 2015 growing season, we did experience a significantly wet June (Table 3).

Table 3. Temperature, precipitation, and Growing Degree Day summary, Alburgh, VT, 2015.

Alburgh, VT	March	April	May	June	July	August	September
Average temperature (°F)	26.0	43.4	61.9	63.1	70.0	69.7	65.2
Departure from normal	-5.1	-1.4	5.5	-2.7	-0.6	0.9	4.6
Precipitation (inches)	0.02	0.09	1.94	6.42	1.45	0.00	0.34
Departure from normal	-2.19	-2.73	-1.51	2.73	-2.70	-3.91	-3.30
Growing Degree Days (base 32°F)	70	373	930	938	1188	1184	1010
Departure from normal	70	-11	174	-76	-10	45	152

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.

Weather conditions in 2015 were highly conducive for downy mildew infection with 36 of 108 days between 1-May and 16-Sep exhibiting conditions that increased downy mildew susceptibility (Figure 1). Spikes on Figure 1 extending over 500 in the forecast for disease severity indicate a likely infection event.

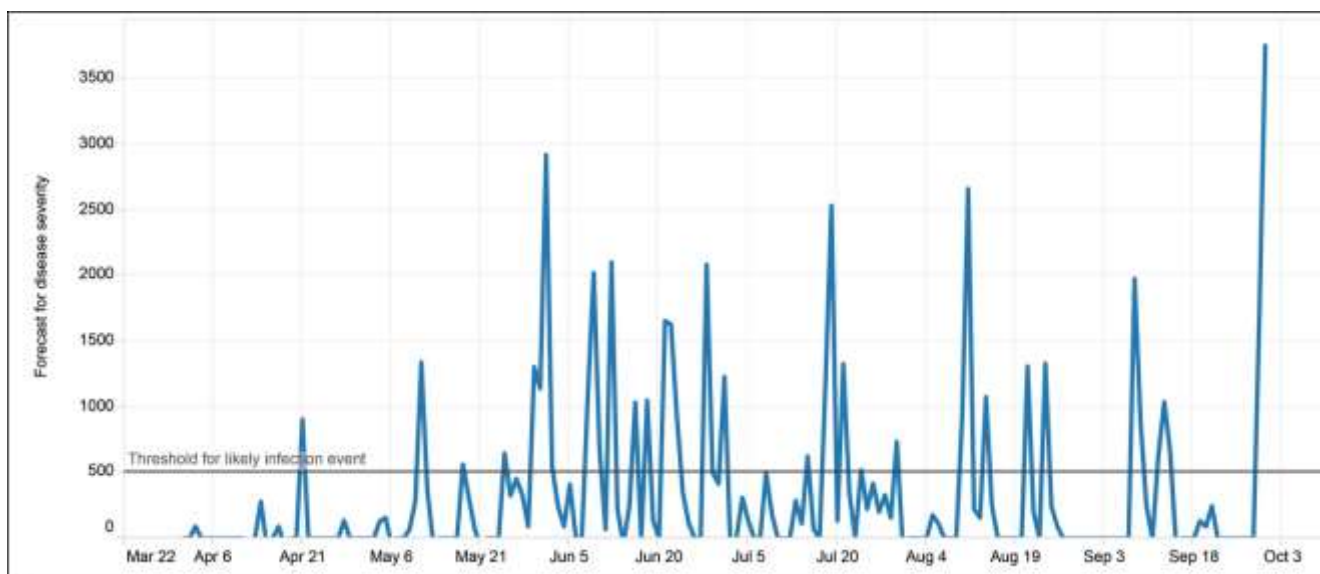


Figure 1. Susceptible days for downy mildew infection, Alburgh, VT, 2015.

Impact of Treatment on In-Season Downy Mildew Indicators:

There was a significant difference between treatments for the number of aerial spikes present on the hops, but no difference between the number of basal spikes or infected leaves present on the plants (Table 4). Aerial and basal spike emergence represents systemic downy mildew infection. Infected leaves indicate downy mildew infection during the growing season.

Table 4. Downy mildew scouting data, Alburgh, VT, 2015.

Treatment	Basal spikes %	Aerial spikes #	Infected leaves %
Champ WG	0.19	2.1	0.63
WP Liquid Extract	0.12	2.3	0.62
<i>p</i> -value	0.15	0.03	0.82
Trial mean	0.16	2.2	0.63

Impact of Treatment on Harvest Quality:

Hop yields were slightly higher in the Champ WG treatments (Table 5). Cone infection by disease was significantly less in both the percentage of cones infected as well as the severity of infected cones in the Champ WG plots. The 100 cone weight at 8% moisture was not impacted by the treatments.

Table 5. Effect of foliar spray on hop yield and quality, Alburgh, VT, 2015.

Treatment	Yield 8% moisture lbs ac ⁻¹	100 Cone weight 8% moisture g	Disease incidence %	Disease severity 1-5
Champ WG	280	15.8	38.7	1.7
Compost tea	213	15.3	64.2	2.9
<i>p</i> -value	0.07	0.66	<0.0001	0.0002
Trial mean	246	15.55	51.5	2.3

DISCUSSION

Overall, the second year hop plants had very low yield and quality. Poor yields may be related to the low trellis system (10ft) utilized for this short term trial. This hop yard also had significant exposure to the elements (wind) and had traces of leaf scorch and wind damage at the very beginning of the season. The staggering level of leafhopper damage and amount of downy mildew present in hop yard throughout the growing season likely also correlated to the overall poor yields.

Overall, the conditions were very favorable for downy mildew infection during the 2015 growing season. There were no statistically significant differences between hops treated with Champ WG and those treated with compost tea in regard to basal spikes and infected leaves. It should be noted that aerial and basal spikes are a poor indicator of in-season downy mildew infection; however, they can be used to quantify systemic downy mildew infection. Leaf lesions provide the best indicator of in-season downy mildew infection. Based on these parameters, the in-season infection rate between the Champ WG and compost tea treatments was not statistically different from each other. This project indicates that compost tea provided in-season downy mildew control similar to Champ WG.

At harvest, cone disease incidence and severity was assessed for each treatment. The primary diseases identified on the cones were *Alternaria* and *Phoma*. These are secondary diseases that can colonize cones that have been previously damaged or injured. Downy mildew was not the primary pathogen identified on the cones. The severity of these diseases appeared to increase when spraying of control materials commenced prior to the beginning of harvest. The Champ WG treatment was more effective at minimizing diseases on cones when compared to the compost tea. It is possible that the Champ WG provided some longer term protection of the cones after we commenced spraying. The protection of these cones through to harvest may have led to slightly higher marketable yields.

It is clear that additional research needs to be conducted to clearly understand the impact of compost tea on disease incidence in hops. More research should be conducted to evaluate the impact on hops with a combination of compost teas and fungicides. It is possible that this product could have synergistic activities with other disease protectants. Additional years of investigation will be required to fully understand benefits from compost tea products.

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