2015

Hop Weed Management Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2015 HOPS WEED MANAGEMENT TRIAL

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INTRODUCTION

As the acreage of hops continues to grow in the northeast, there is increasing need for regionally specific agronomic information. The majority of hop production and research is conducted in the Pacific Northwest, a region that has a much drier climate than our own. The University of Vermont (UVM) has carried out a number of trials to build relevant experience on small scale hop production in our wet and cool climate. The results and observations from our hops research can be found on the UVM Extension Northwest Crops and Soils website: **www.uvm.edu/extension/cropsoil/hops**.

As for any perennial crop, managing weeds can require significant time and resources. Growers are looking for weed management methods that are effective, quick, and affordable. There are few herbicides labeled for use in hop production for VT and the region. Hence, growers are looking for alternative strategies to control weeds in hops. The main methods of control for weeds in the UVM hop yard have been hand weeding and mulch applications. While relatively effective, hand weeding has taken as much as 200 cumulative hours of labor per acre per year. In 2015, four alternative weed management methods were compared in the UVM hop yard including steam weeding, mulching, tilling, and applying a certified organic citrus-based herbicide.

Figure 1: Steam Jenny pressure washer.

Figure 2: Spraying Avenger herbicide.

Figure 3: Hardwood mulch.

Figure 4: Honda FG 110 Mini-tiller.

MATERIALS AND METHODS

The replicated research plots were located at Borderview Research Farm in Alburgh, VT on a Benson rocky silt loam. The experimental design was a randomized complete block with three replicates; treatments were steam, herbicide, till, and mulch.

Steam weeding was performed with a Steam Jenny hot water pressure washer (Figure 1); the primary method of terminating weeds with the Steam Jenny was heat.

Organic OMRI-approved herbicide Avenger (Cutting Edge Formulations, Inc., EPA reg. no. 82052-1) was applied according to the label recommendation of about 5 gallons per acre (before dilution). It was mixed one part Avenger to 6 parts water and applied with a 10-gallon electric sprayer unit pulled by a ride-on lawnmower (Figure 2). Avenger is a citrus-based concentrate that removes the plant cuticle on contact, making the plant unable to adequately regulate moisture. It works by direct surface contact only, so all vegetation must be sprayed to be killed. Avenger is meant for all types of weeds, but it is most effective on annual plants and may take multiple applications to kill established perennials such as quack grass.

Mulch was assorted hardwood and was applied six inches thick and spread 3-4 feet wide. The mulch was applied early enough to smother young weeds that had already germinated and prevent new germination (Figure 3). The total amount of mulch used was equivalent to about 110 cubic yards per acre of hops. Choosing an appropriate type of mulch is very important: the mulch must be at least partially composted, or else it will likely absorb important plant nutrients such as nitrogen, limiting their availability to the hop plants.

"Tilling" was performed with a Honda FG 110 mini-tiller (Figure 4), which was used to scratch the surface of the soil enough to remove weeds but not deep enough to disturb the main root system of the hop plant.

Each weed control treatment was applied once to a treatment area. All treatments were applied following bine training. The mulch and herbicide treatments were applied on 10-Jun when hop bines were 4+ feet tall. Steam weeding and mini-tilling treatments were applied on 11-Jun. Following harvest, an 18" x 18" section of weed vegetation was harvested from each plot, dried, and weighed. Percent cover of broadleaf weeds, grass, and bare ground within the 18" x 18" area was also visually assessed.

Fungicides were sprayed regularly throughout the season. The fungicides used in the research yard in 2015 were Champ WG (Nufarm Americas Inc., EPA Reg. No. 55146-1), and Regalia (Marrone Bio Innovations, EPA Reg. No. 84059-3).

The hop yard was irrigated weekly in July and August at a rate of 3900 gallons of water per acre. Detailed information as well as a parts and cost list for the drip irrigation system can be found at **www.uvm.edu/extension/cropsoil/hops#irrigation** under the Irrigation section. Starting in late May, the hops received 3lbs/acre of nitrogen through the irrigation system on a weekly basis until side shoots were observed (5 weeks). On 14-May, 100lbs of N per acre was applied by hand. An additional 50lbs/acre of N was applied by hand in late June. Total N application (including fertigation) for the season was 165lbs per acre. All fertilizers were OMRI-approved for use in organic systems.

Yield was not taken into account this year because results were biased by different fungicide treatments in the same plots. Results were analyzed using the PROC Mixed procedure in SAS.

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the 2015 growing season (Table 1). The 2015 growing season (March-September) experienced 5692 GDD's, which were 220 more than the 30 year average (1981-2010 data). Precipitation was below average during each month in the growing season except June, which was 2.7" above average. (Table 1).

Table 1: Temperature, precipitation, and Growing Degree Day summary, Alburgh, VT, 2015.

Alburgh, VT	March	April	May	June	July	August	Sept
Average temperature (°F)	26.0	43.4	61.9	63.1	70.0	69.7	65.2
Departure from normal	-5.0	-1.4	5.6	-2.7	-0.6	1.0	4.7
Precipitation (inches)	0.8	2.6	1.9	6.4	1.5	0.0	0.3
Departure from normal	-1.5	-0.2	-1.5	2.7	-2.7	-3.9	-3.3
Growing Degree Days (32-90°F)	70	373	930	938	1188	1184	1010
Departure from normal	-54	-16	177	-76	-9	45	154

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 steam treatment had significantly higher weed biomass than the other three treatments (Figure 5).

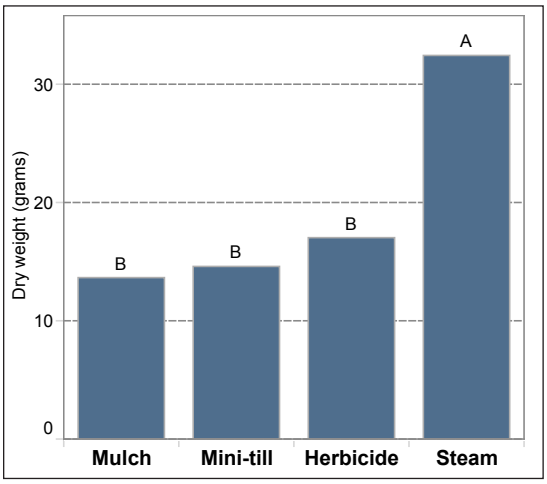

Figure 5: Amount of weed biomass by treatment, Alburgh, VT 2015.
Treatments followed by the same letter are not significantly different.

Weed composition varied significantly by treatment (Table 2). The mulch treatment had a significantly higher percentage of bare ground than the other treatments (Figure 6, Table 2). Perennial grasses, which are the hardest weeds to manage, were lowest in the mulch treatment as well, followed by mini-till and herbicide (Table 2)

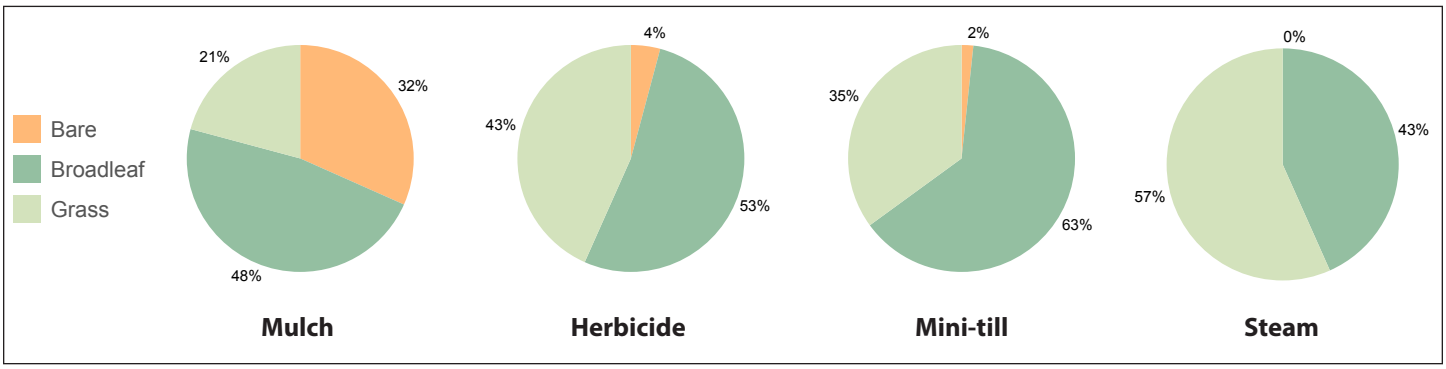

Figure 6: Percent ground cover by treatment, Alburgh, VT 2015.

Table 2: Ground coverage by plant type and weight of total biomass, Alburgh, VT, 2015.

Treatment	Broadleaf		Grass		Bare		Dry Weight	
	%		%		%		g	
Herbicide	53	a	43	ab	4	b	17.0	b
Mulch	48	a	21	b	32	a	**13.6**	b
Steam	43	a	57	a	0	b	32.4	a
Till	63	a	35	ab	2	b	14.6	b
p-value	.71		.29		.03		.04	

Within a column, values followed by the same letter are not significantly different. Values in ***bold*** *indicate top performing treatments.*

DISCUSSION

Results were clear that steam weeding performed with a Steam-Jenny is not effective for weed control. A unit that achieves higher heat might be effective, as opposed to the Steam Jenny, which is not specifically built for killing weeds. 2015 mulch treatments had low weed biomass, highest percentage of bare ground and lowest percentage of grass, but the downside of mulch is its higher cost. Note that treatments were not repeated throughout the season. Treatments that can be repeated inexpensively two or three times over the summer months, such as herbicide or mini-tilling, present good opportunity.

In the 2014 weeding trial, treatments with the lowest weed biomass had the highest hop yields, suggesting that lower weed biomass is correlated with higher yield. All of the weed control methods in this study work best on annual weeds in early stages of development. Waiting until weeds reach reproductive stages will cause longer-term weed issues in the hop yard and will require more intensive treatment.

Cost is a major concern for the viability of different treatments. A comparison of cost and labor for weeding treatments is shown in Table 3. Of the higher performing treatments, herbicide application is much cheaper at $330 per application per acre than mulching at $2,200, even if applied multiple times. Currently, registered conventional herbicides cost similar to the Organic herbicide used in the UVM hop yard. Mini-tilling is cheaper as well, but great care must be taken not to harm hop plants. Herbicide can damage hop leaves and growing tips, but mature bines were not damaged even with direct contact in our experience.

Table 3: Cost and effectiveness considerations for weed treatments, Alburgh, VT, 2015.

Weed Control Method	Estimated Duration of Effectiveness	Labor ($15/hr)	Equipment Cost	Pros	Cons
Hand Weeding	3-4 Weeks	80hrs ($1,200)	$50 gloves, hand tools	Consistent, relatively long-lasting	Very time consuming
Steam Weeding	2-3 Weeks	8hrs ($120)	$5,000 steam weeder	Fast	Equipment is very expensive
Mini-Tiller	2-3 Weeks	10hrs ($150)	$300 mini-tiller	Relatively fast	Can harm hop plants if not careful
Mulch	3-4 Weeks	8hrs ($600)	$1,600 100 yds mulch	Very effective	Expensive
Herbicide	2-3 Weeks	2hrs ($30)	$300 5gal/acre Avenger (OG), $400 for 5gal/acre Scythe (conventional)	Works well on broadleaves. Fast.	Not effective on perennial grasses

Other herbicides certified for use in Vermont are listed in Table 4. The application timing information, with the exception of Avenger, comes from the Pacific Northwest Weed Management Handbook (**http://pnwhandbooks.org/weed/agronomic/irrigated-field-crops/hops**). Some of these herbicides can harm hop plants - make sure to read the label and follow application instructions.

Table 4: Herbicides labeled for use on hops in Vermont, 2015.

Active Ingredient	Brand Name	Restricted use	Certified Organic	Time of Application
D-Limonene	Avenger Ag Burndown	No	Yes	Smaller weeds are easier to control.
2,4-D	Amine 4 2,4-D Weed Killer	Yes	No	Apply when annual broadleaf weeds are small.
2,4-D	Clean Amine	Yes	No	Apply when annual broadleaf weeds are small.
Clethodim	Clethodin 2EC	No	No	Apply to actively growing grasses at the size recommended on the label.
Clethodim	Intensity One Post-Emergence Grass Herbicide	No	No	Apply to actively growing grasses at the size recommended on the label.
Clethodim	Section 2EC	No	No	Apply to actively growing grasses at the size recommended on the label.
Glyphosate, glycine	Credit Extra	No	No	Apply to actively growing weeds.

Another method of weed control not studied in this experiment is plastic mulch or landscaping fabric. Using one of these materials for ground cover in the first couple years of a hop yard is common and worth considering.

ACKNOWLEDGEMENTS

The UVM Extension Crops and Soils Team would like to thank Borderview Research Farm and staff for their generous help with the trials. We would like to thank Hillary Emick and Dan Ushkow for their assistance with data collection and entry. This work is made possible through funding provided by the USDA Hatch Initiative and The Environmental Protection Agency. Any reference to commercial products, trade names, or brand names is for information only, and no endorsement or approval is intended.

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