NORTHWEST CROPS & SOILS PROGRAM

2014 Hops Weed Management Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2014 HOPS WEED MANAGEMENT TRIAL

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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) Extension 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 2014, four alternative weed management methods including steam weeding, mulching, tilling, and applying a certified organic citrus based herbicide were compared in the UVM hop yard.

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. The plot size was 4' x 20' and replicated three times (3 hills of hops per treatment). Steam weeding was performed with a Steam Jenny hot water pressure washer; 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 5 gallons per acre (before dilution). It was mixed one part Avenger to 5 parts water. Avenger is a citrus-based concentrate that removes the plant cuticle, 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 better established perennials. "Tilling" was performed with a Honda mini-tiller, 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. Mulch was assorted hardwood chips applied six inches thick and spread 3-4 feet wide. The mulch was applied early enough to smother early weeds as well as prevent new germination. Mulch was applied evenly to a depth of 6 inches. All weed control treatments were applied once to the treatment area. On 5-Jun 2014, steam weeding was applied and all other treatments were applied on 9-Jun 2014. On 10-Sep, an 18" x 18" section of weed vegetation was harvested from each plot, dried, and weighed. Each weed species present within the 18" x 18" area was recorded.

Fungicides were sprayed when the forecast predicted downy-mildew-favorable weather (warm and moist) (Table 1). The fungicides used in the research yard in 2014 were 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. All pesticides applied were OMRI-approved for use in organic systems and were applied at rates specified by their labels 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.

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.

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, and moisture was determined using a dehydrator. Hop cones were dried to 8% moisture, baled, vacuum sealed, and then placed in a freezer.

Yields are presented at 8% moisture on a per acre basis. Per acre calculations were performed using the spacing in the UVM Extension hop yard of 622 hills per acre. Yields were analyzed using the PROC MIXED procedure in SAS using the Tukey-Kramer adjustment, which means that each variety was analyzed with a pairwise comparison (i.e. 'Cluster' statistically outperformed 'Cascade', Cascade statistically outperformed 'Mt. Hood', etc.).

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the 2014 growing season (Table 1). The 2014 growing season (March-September) experienced 5,325 Growing Degree Days (GGD's), which were 25 less than the 30 year average (1981-2010 data). Precipitation was slightly above average during the growing season.

Table 1. Temperature, precipitation, and Growing Degree Day summary, Alburgh, VT 2014.

Alburgh, VT	March	April	May	June	July	August	September
Average temperature (°F)	22.2	43.0	57.4	66.9	69.7	67.6	60.6
Departure from normal	-8.9	-1.8	1.0	1.1	-0.9	-1.2	0.0
Precipitation (inches)	1.70	4.34	4.90	6.09	5.15	3.98	1.33
Departure from normal	-0.51	1.52	1.45	2.40	1.00	0.07	-2.31
Growing Degree Days (base 32°F)	25	330	789	1041	1171	1108	860
Departure from normal	25	-54	33	27	-27	-31	2
Growing Degree Days (base 32°F)	25	330	789	1041	1171	1108	860
Departure from normal	25	-54	33	27	-27	-31	2

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 weeds observed in the experiment included Creeping Charlie (*Glechoma hederacea)*, dandelion (*Taraxacum officinale)*, foxtail (*Setaria glauca*), and quack grass (*Elytrigia repens)*. Creeping Charlie was observed in at least one plot of each treatment, while dandelion was not observed in any herbicide or steam treated plot (Table 2). Overall, weed biomass was relatively low across treatments and most of the weeds were perennial grasses.

Table 2. Weed species observed in weed control treatment plots. Alburgh, VT 2014.

	Creeping Charlie	Dandelion	Foxtail	Quack grass
Herbicide	X		X	X
Mulch	X	X		X
Steam	X		X	
Till	X	X	X	X

The herbicide and mulch treatments had higher yields than the till and steam treatments, although the mulch treatment did not perform significantly different than the lower two (Figure 1).

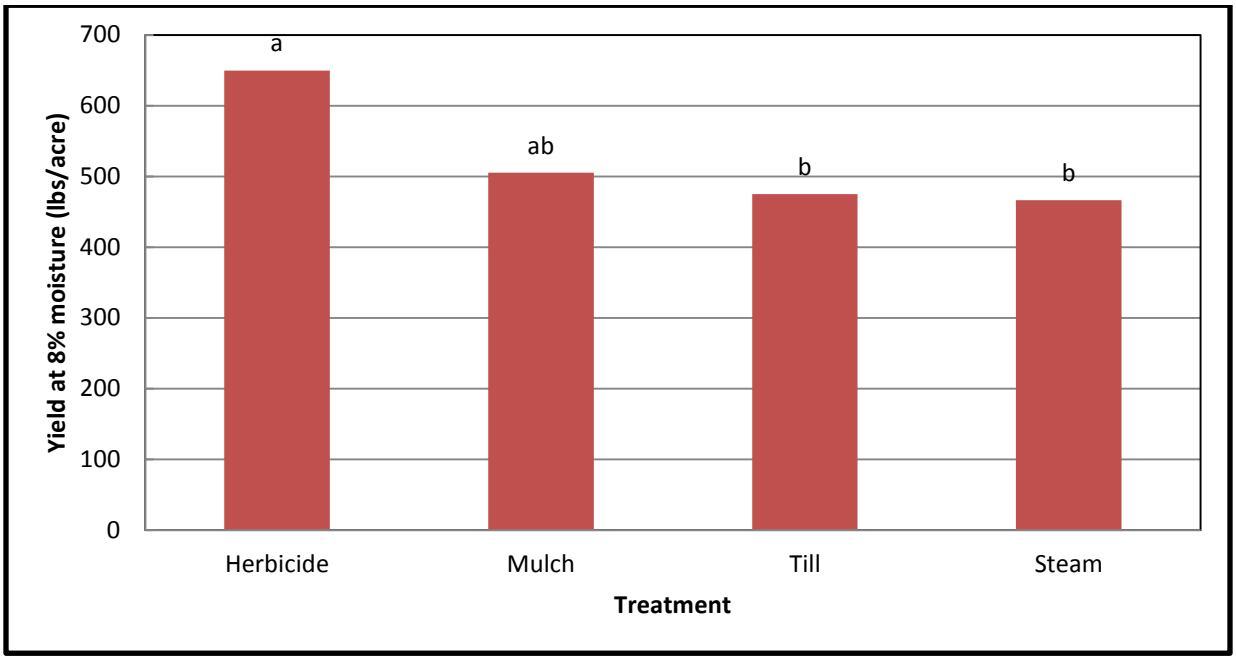

Figure 1: Impact of four weed control strategies on hop yield. Treatments with the same letter are not significantly different from each other, Alburgh, VT 2014.

Mulch and herbicide treatments, which yielded highest, had the lowest weed biomass as well. However, the mulch treatment did not perform significantly better than the till treatment (Figure 2).

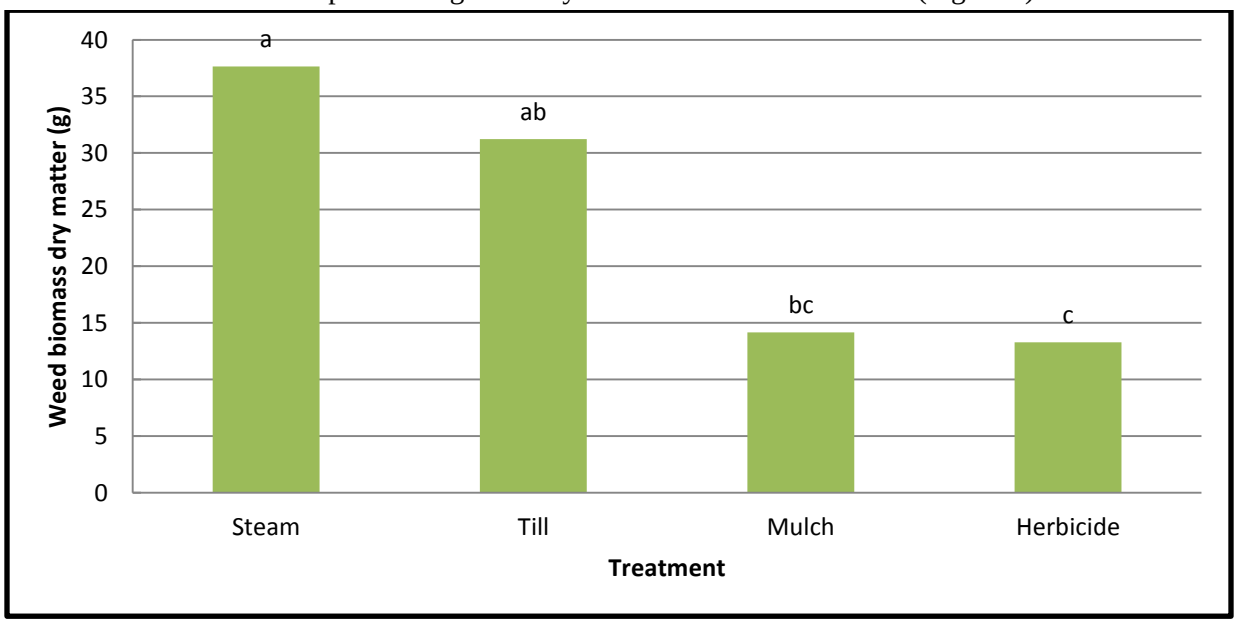

Figure 2: Impact of four weed control strategies on weed biomass in hops, measured in grams of biomass dry matter per plot, Alburgh, VT 2014. Treatments with the same letter are not significantly different from each other.

DISCUSSION

Mulch and herbicide treatments had the lowest weed biomass and the highest yields, suggesting that they were more effective at controlling weeds and that lower weed biomass is correlated with higher yield. Many other factors contribute to yield and quality. While the plots were not all the same variety, steam and herbicide plots, which represented lowest and highest yields respectively, shared the same two hop varieties. This suggests that variety did not likely influence weed biomass.

Overall the weed biomass was relatively low in the experiment. This is likely a result from adequate weed control in the first few years of establishment. More effective weed control may likely be obtained with multiple applications of steam, till, or herbicide, including fall treatments when the weeds are most vulnerable. It should be noted that continuous tilling may harm the hop root system. Increased efficacy of steam weeding may be obtained by purchasing a larger scale applicator that is geared towards weed removal, as opposed to the Steam Jenny, which is not specifically built for killing weeds. The application of steam and organic herbicide also provided a "pruning" of the lower hop foliage, which is often done intentionally to help hops stay disease-free. All weed control methods would work best on annual weeds and weeds in early stage of development. Waiting until weeds reach reproductive stages will cause longer-term weed issues in the hopyard 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 two higher performing treatments, herbicide application is much cheaper at $330 per application than mulching at $2,200, even if applied multiple times. However, mulch has no potential for damaging the hop plant and has other ecological benefits such as helping the soil regulate moisture and temperature.

Table 3. Cost and labor for five weed control methods, Alburgh, VT 2014.

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
Organic Herbicide	2-3 Weeks	2hrs ($30)	$300 5gal/acre Avenger	Works well on broadleaves. Fast.	Not effective on perennial grasses

Other herbicides certified for use in Vermont are listed in Table 4. These herbicides have not been evaluated in our research program and the following information comes from the Pacific Northwest Weed Management Handbook (http://pnwhandbooks.org/weed/agronomic/irrigated-field-crops/hops).

Table 4. Herbicides labeled for use on hops in Vermont, 2014.

Herbicide	Restricted use	Certified Organic	Time of Application
Paraquat	Yes	No	Before hops emerge in spring or after hops are 6ft tall.
Pelargonic Acid (Scythe)	No	No	Before hops emerge or while they are growing if spray does not touch hops.
Carfentrazone	Yes	No	Can be used throughout the season, but do not let it touch green parts of plant.
Clopyralid (Stinger)	Yes	No	When growing points of the hop plant are above the spray zone.
Clethodim	Yes	No	Throughout season. Controls grasses only.

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

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