NORTHWEST CROPS & SOILS PROGRAM

2017 Beneficial Exclusion Experiment

Dr. Heather Darby, UVM Extension Agronomist
John Bruce, Abha Gupta, Freddy Morin, and Scott Lewins
UVM Extension Crops and Soils Technicians
(802) 524-6501

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2017 BENEFICIAL EXCLUSION EXPERIMENT

Dr. Heather Darby, University of Vermont Extension
heather.darby@uvm.edu

There are over 400 acres of hops currently in production within the Northeast with many new growers coming onto the scene. While hop production in the Northeast continues to rebound, many farmers are looking for additional information and clarity on how pests can impact their crop production. Compared to the Pacific Northwest and other hop growing regions around the world, we do not currently have a clear understanding of the role and impact that beneficial insects have within our hop yards. It is particularly important to quantify the benefit that natural enemies provide in order to help determine economic and action thresholds for hop pests.

Within the Northeast, hop aphids (HA), two-spotted spider mites (TSSM), and potato leaf hopper (PLH) prove to be among the most detrimental pests for hop growers and can have significant impacts on hop yields and quality.

Image 1: PLH nymphs on hop leaf underside.

Potato leafhopper (Image 1) is a native pest that feeds on a wide array of broad leaf plants causing leaf necrosis on the outer edges resulting in damage known as "hopperburn". Damage is caused by feeding on hop stem and leaf via piercing sucking mouthparts resulting in reduced yields and in severe cases can result in first year plant death. The PLH generally overwinter in southern locations and will migrate north during the early summer months, weather dependent.

HA are soft bodied insects that can be often found residing on the undersides of leaves (Image 2). Cool wet conditions foster favorable conditions for HA. During feeding they secrete a sugary substance called "honeydew". When secreted, the honeydew provides the perfect habitat for sooty mold fungi to grow. Plant productivity is reduced by aphid feeding on foliage yet the greater yield and quality problems come as a result of sooty mold resulting in diminished cone quality and marketability.

Image 2: Wingless HA on hop leaf.

Image 3: Adult female two spotted spider mite with prominent black spots on each side (photo courtesy of D.G. James).

The TSSM is a very small eight-legged pest that causes stippling damage on leaves and cones of hop plants (Image 3). This can lead to browning, defoliation and severe cone damage within the hop yard. Hot, dry and dusty conditions often occurring mid-summer are ideal for outbreaks of TSSM during the critical periods of cone development and maturation. It is here within cone development that we tend to see the most damage from TSSM, often times resulting in cone browning and shattering.

These pests can have detrimental impacts on the hop quality, yields, and plant vigor, and are capable of causing economic impacts depending on population levels within the hop yard. Due to the impacts and potential for damage among these common pests, we are driven to determine the impact that beneficial insects can have on these pest populations.

MATERIALS AND METHODS

Within the study, we quantified naturally occurring predation and parasitism of TSSM, HA, and PLH by conducting a natural enemy exclusion experiment. The exclusion experiment was conducted at three sites (Alburgh, VT, Starksboro, VT, and Northfield, MA) three times throughout the season (June, July, and August). We used a split plot design where the treatments were "open" vs "excluded" and we replicated it across ten Nugget and ten Cascade plants at each site. We paired one "open" string and one "excluded" string per hill, and block by variety. The "excluded" treatments consisted of a single hop leaf enclosed in a 6" x 10" organza mesh bag (Uline.com) with a small piece of cotton wound around a petiole to before cinching the bag closed. The "open" treatments consisted of a single hop leaf with a small piece of cotton wound around the petiole and a twist-tie to hold it in place.

Image 4: Hop plant with bine treatments.

Prior to applying the treatments, we scouted 20 mature hop leaves per variety, recording the number of PLH, TSSM, and HA on each leaf. After the leaves were scouted, if any natural enemies were found they were removed. Ten leaves per variety were then assigned the "exclusion" treatment enclosed in a mesh bag and the other ten leaves per variety were assigned the "open" treatment where pests were subjected to natural enemy attack.

One week after the treatments were applied at each site, we returned, again recording the number of PLH, TSSM, and HA on each leaf (Table 1). At the end of each trial period, we compared the increase in PLH, TSSM, and HA between the "open" and "excluded" leaves for both varieties at the three sites (Image 5 & 6).

Table 1: Treatment observation dates from June-August in Northfield MA, Starksboro, and Alburgh, VT.

	Northfield	Starksboro	Alburgh
Start	20-Jun	22-Jun	26-Jun
End	27-Jun	30-Jun	3-Jul
Start	21-Jul	26-Jul	25-Jul
End	28-Jul	2-Aug	1-Aug
Start	10-Aug	17-Aug	14-Aug
End	23-Aug	24-Aug	21-Aug

Image 5: Excluded treatment with organza mesh bag and cotton around petiole.

Image 6: Open treatment with cotton around petiole.

The three different sites, aside from being geographically distinct, are all managed slightly differently and face distinct challenges in terms of pests within their hop yards.

The Alburgh, VT location has a diverse surrounding landscape, is organic, sprayed three times for disease throughout the season, and has not been sprayed any insecticide for three years. The Starksboro, VT location sprays insecticide occasionally and is managed conventionally. The Northfield, MA location has a comparatively less diverse surrounding habitat and is managed conventionally. The Northfield, MA location follows a more regimen schedule of pesticide applications for weeds and disease, and sprayed on a weekly basis from late-May until early-Sep. Throughout this period, three insecticide applications were made between mid-Jun and mid-Jul consisting of Imidacloprid and Bifenthrin.

Each site within the trial had greater than average number of Growing Degree Days (GDDs) and well above average precipitation for this season, resulting in an uncharacteristically wet spring and early summer. We did generally see rain begin to normalize by the latter half of July for our southernmost locations. With different management practice we saw distinct difference in pest populations throughout the three sites.

RESULTS

The open treatment would have allowed for natural enemies to prey on the hop pest populations whereas the excluded treatment would have kept natural predators away from the pests. Hence, it is expected that a decrease in pests in the open treatment would be a sign of predation due to populations of natural predators. An increase in pests in the open treatment may indicate an absence or low abundance of natural predators.

The Northfield, MA site showed very few significant differences in pest counts between open and excluded treatments for any of the sampling periods. There was a significant difference observed between open and excluded treatments for TSSM in June. There was an increase of 23.3 TSSM in the open treatment, whereas the exclusion treatment showed an increase of 6.40 (Figure 1).

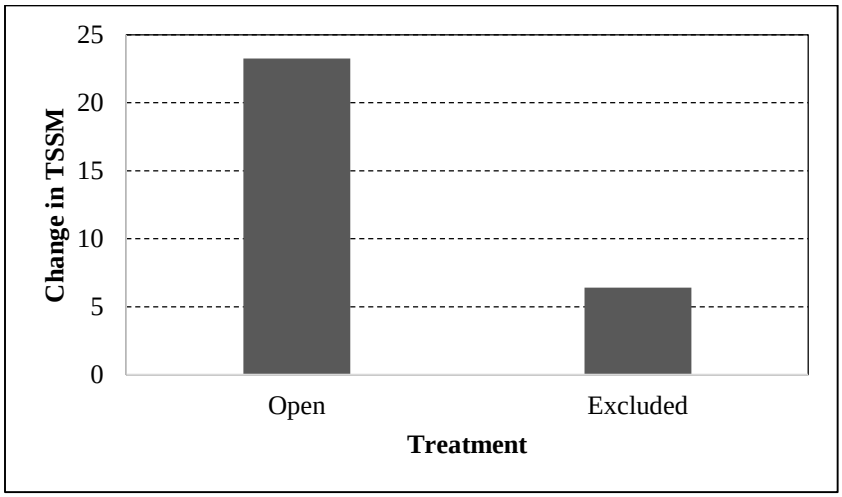

Figure 1: The effect of natural enemy exclusion on TSSM in Northfield, MA in July.

In Starksboro there was no difference in TSSM counts for open and excluded treatments throughout the entire season, but there were some differences in June PLH and August HA counts. For June, there was an increase of 1.80 PLH in the open treatment and an increase of 5.20 for excluded treatment (Figure 2). The HA also showed significant differences in August with an increase of 1.20 for the open treatment, and an increase of 7.95 for excluded treatment (Figure 3).

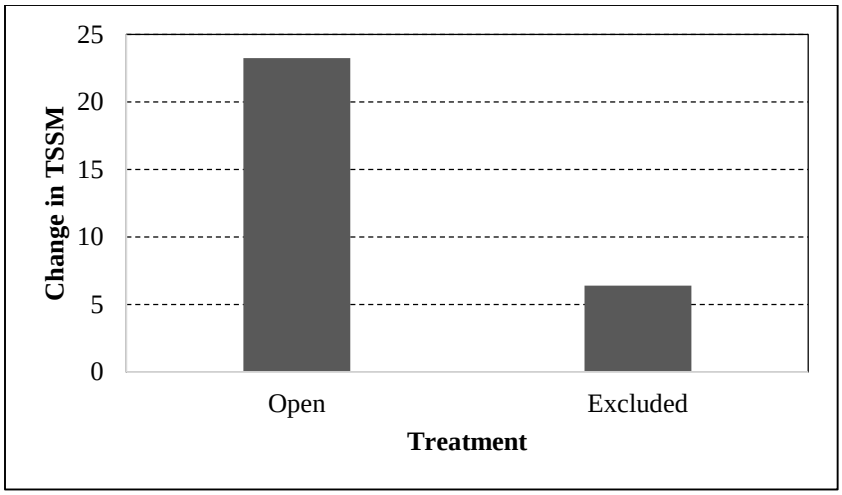

Figure 2: The effect of natural enemy exclusion on potato leafhoppers in Starksboro, VT in June.

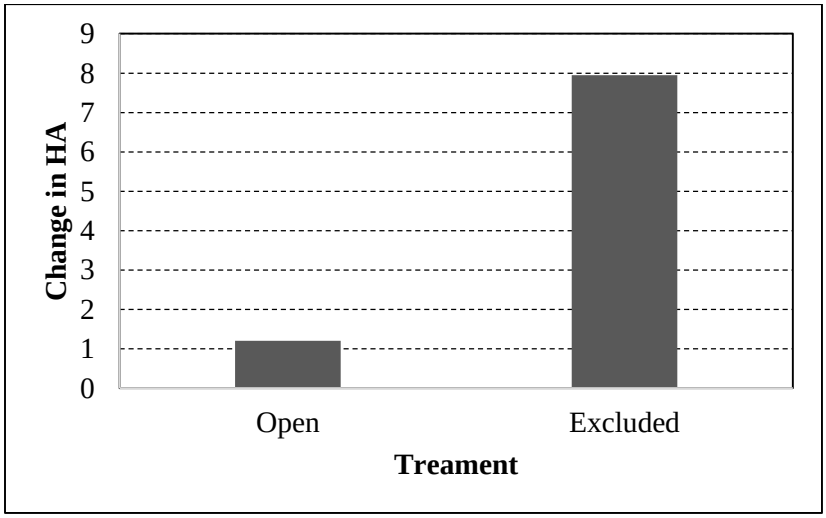

Figure 3: The effect of natural enemy exclusion on hops aphid in Starksboro, VT in August.

The Alburgh site showed the most significant differences in pest counts when leaves were left open or excluded. In June there was a difference in TSSM, though very small, showing and increase of 0.25 for open treatments and a decrease of 0.20 for excluded treatments. In July, the HA showed a 4.10 increase for open and an 18.2 increase for the excluded treatment (Figure 4). In August we saw differences in both HA and TSSM. The HA had an increase of 2.35 for the open treatment whereas the excluded treatment had an increase of 49.1 (Figure 5). For TSSM there was an increase of 0.05 for the open treatment and an increase of 2.83 for the excluded treatment (Figure 6).

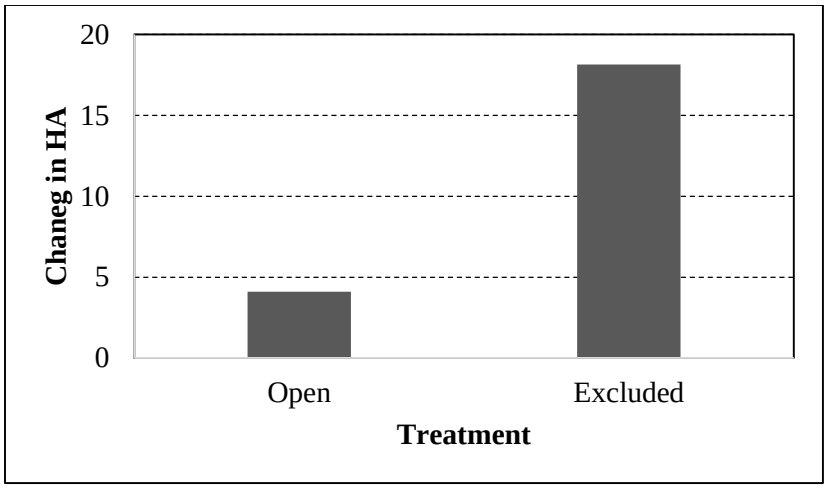

Figure 4: The effect of natural enemy exclusion on hop aphids in Alburgh, VT in July.

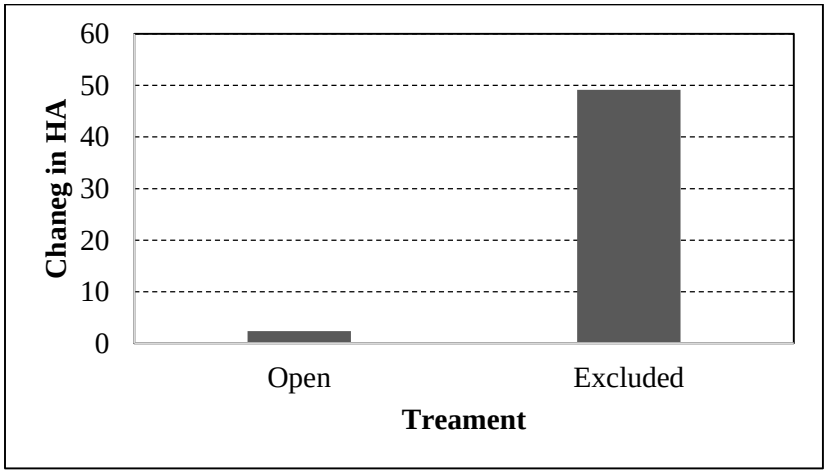

Figure 5: The effect of natural enemy exclusion on HA in Alburgh, VT in August.

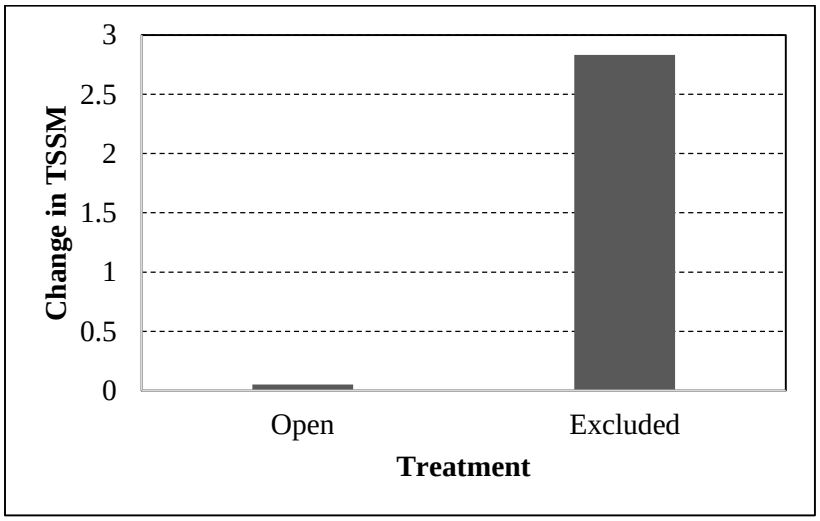

Figure 6: The effect of natural enemy exclusion on TSSM in Alburgh, VT in August.

DISCUSSION

When we saw differences in the change in populations for each pest, they were almost exclusively lower when the hops were open to the environment and potential natural enemies compared to excluded treatments. The opposite effect for June TSSM counts in Northfield, MA could be explained by changes in weather patterns or pesticide applications.

Hop production in the Northeast continues to rebound; many farmers are looking for additional information and clarity on how pests can impact their crop production. While we do not currently have an understanding on how beneficial insects can impact our pest populations, we hope to be able to quantify their impact through continued monitoring. Through our first year study, there were some distinct differences between our open and closed treatments, especially in a no-spray environment. Especially in environments with decreased insecticide applications we noticed smaller pest populations after one week of exposure versus those closed off from the environment. Conversely, conventional practices more often showed no effect in insect populations between treatments. In a more diverse low-spray environment, there is the potential to see more of an impact from predation of natural enemies.

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