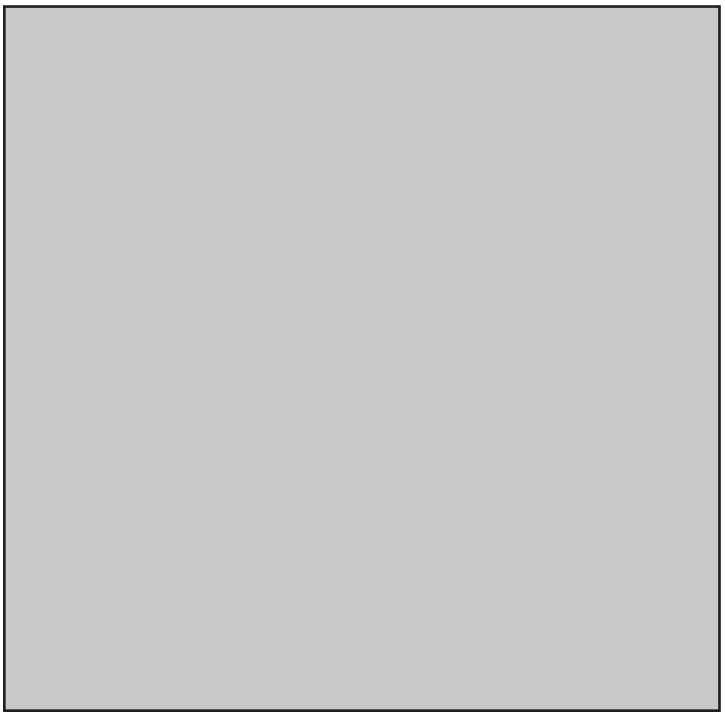

the ne t ng with bags of rocks. The Proteknet 80 and Proteknet 60 are both high-density polyethylene nets with small holes (1x.85mm and 1.9x.95mm respec- tvely), and high levels of light transmission. Ne t ng that was not wide enough to cover an en t re bush was sewed with white polyester thread. S t ches were sized to prevent f y entry at the seams of the fabric. We applied equal numbers of four treatments: (a) control (no ne t ng) with only support posts, (b) support posts with a par t al covering of Proteknet 80, (c) support posts with complete cover of Proteknet 80, and (d) support posts with complete cover of Proteknet 60. The ne t ng was sourced from Dubois Agrinova t on (Quebec). Sampling in the Patriot blueberries started in early July and concluded in late August 2014.

We also conducted tests in fall raspberries at the f rst site only. This farm had recently constructed six hoop houses, which were located in general proximity to each other. Three tunnels were enclosed in Proteknet 80 and three were not. We treated each hoop house as a sample. Sampling in the raspberries started in late August and concluded in early October 2014.

Because this project was conducted on working farms, both blueberry and raspberry plots were managed by the farmers and their crews during the course of the experiment. This means that nets were opened and closed to allow for weeding, pruning and harves t ng. At several points, nets were found open either because of wind, customers at the pick-your-own opera t on, or crews entering and exi t ng the ne t ed areas. Data from these points was discarded prior to analysis.

!Řdzfű ŭŃI·LJLJĭyƎ

Because SWD are not a t racted to fruit before ripening begins (Lee et al. 2011), we set out traps for adult SWD just prior to blueberries being ripe. Our traps followed Extension guidelines (Liburd and Iglesias 2013), and were constructed from red plas t c cups with clear caps, encircled with a ring of black electrical tape with small holes punched around the top (see photograph on page 3). The color scheme has been shown to be highly a t rac- t ve to SWD (Cowles, pers. comm.). Inside the cups were secondary vials, covered col ò

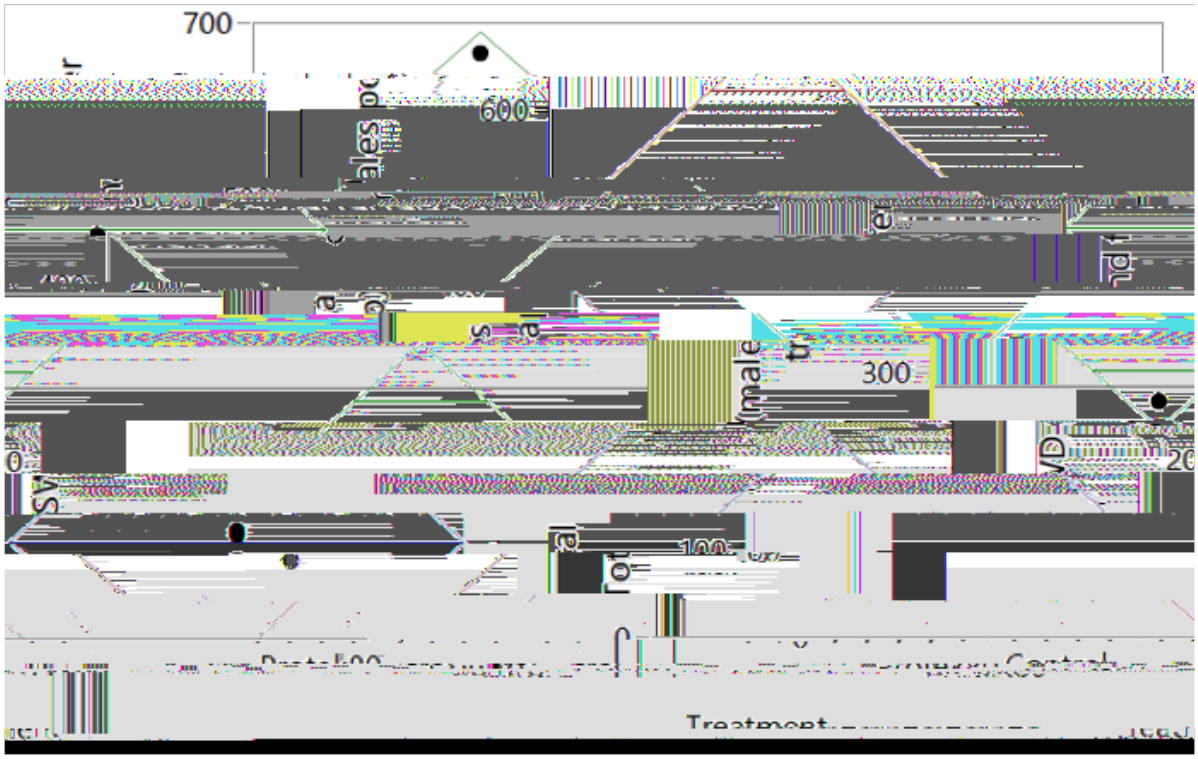

Figure 2: Combined male and female SWD popula t on by treatment in raspberry plan t ngs

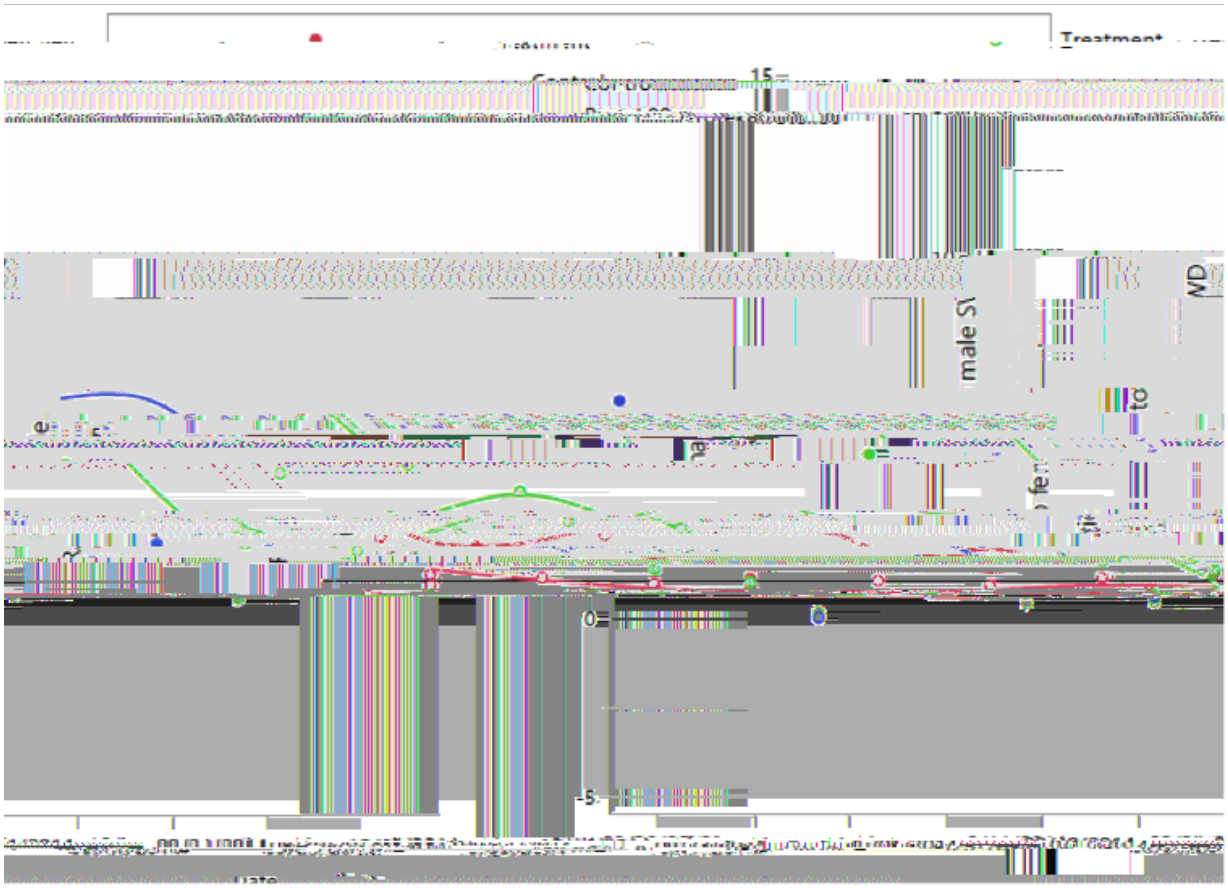

Figure 3: Ra t o of female to male SWD over t me in raspberry plan t ngs

ne t ed traps (t(4)=.0157). (See f gures 3 and 4.) Fig-
ure 3 demonstrates how the ra t o of male to female
f ies changed over the eight week trapping period.

In addi t on, we found that there was more varia-
t on in the number of SWD caught in traps outside of
the ne t ng structure (see f gure 5). In other words,
all three traps inside the ne t ed raspberry plant-
ings had similar numbers of adults, while traps in
the control tunnels (un-ne t ed) had a much larger
spread of individuals. The traps in the ne t ed plant-
ings also had a fairly consistent number of individu-
als caught week to week, while the control (un-net-
ted) traps f uctuated more. These f ndings should be
further explored in a study with a larger number of
samples.

[l·WØl·f Ö2dzyúă

Because of the low levels of adult SWD in traps,
we did not begin sampling for larvae in va ot Ũ Be Ş Mlup er e L: The t ǔ ‘

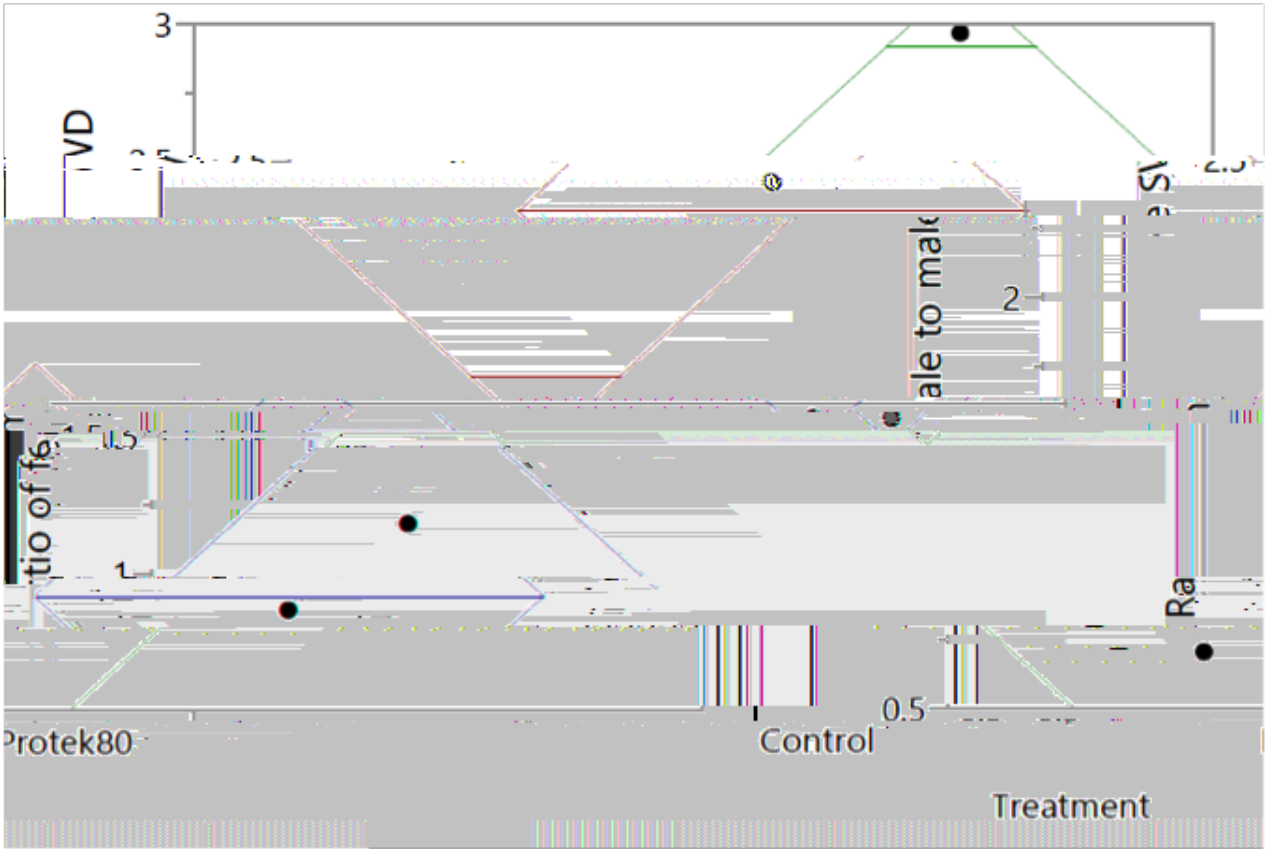

Figure 4: Ratio of female to male SWD per trap by treatment in raspberry plantings

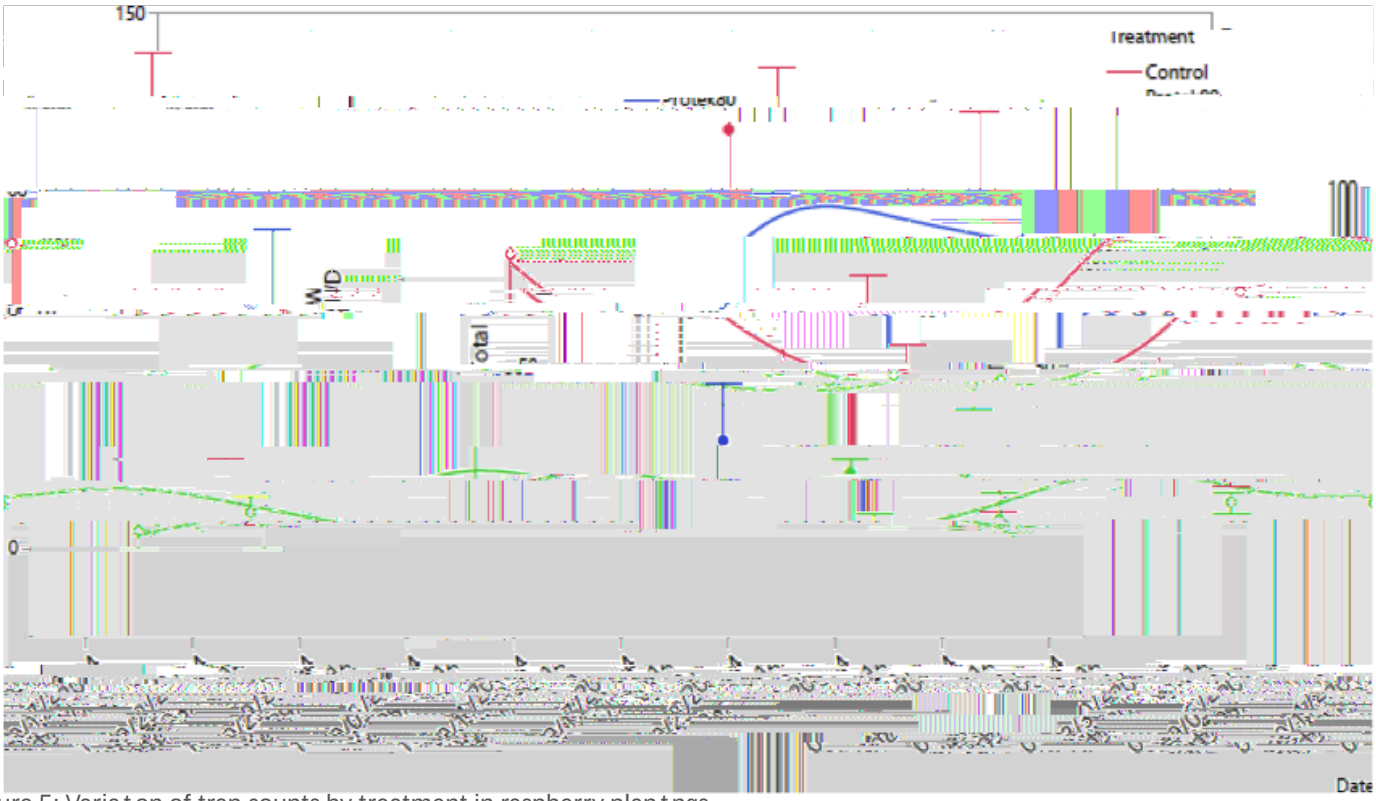

Figure 5: Variation of trap counts by treatment in raspberry plantings

they use in and around their plantings, and other areas of their farm that may provide overwintering habitat for SWD. SWD adults are able to overwinter in mild, temperate climates (Dreves, Walton, and Fisher 2009). Ideal temperatures for active SWD are between 20-25˚C (66-77˚F), with fitness decreasing above 30˚C (86˚F) (Kimura 2004; Calabria et al. 2012). Temperatures below 10˚ Celsius are expected to decrease the survivorship of overwintering populations (Dalton et al. 2011), though surviving SWD are also thought to overwinter in heated buildings and other protected areas.

Our study suggests that the date when SWD populations peak will vary year to year, likely based on the severity of the winter season and the availability of overwintering habitat on or near the farm. Based on only three years of trapping, we see that these important dates can vary by up to one month. The first signs of SWD damage and peak population will likely be seen first in the southern part of Vermont, and later in the northern region of the state. Because blueberries are not attractive to SWD prior to

under ne t ng does or does not impact blueberry yield or quality.

While we did not collect temperature data in the raspberry high tunnels, it is worth no t ng that covering raspberries in this manner is o f en used to both extend the season, with elevated temperatures reported as in f uencing both ripening t me and yield (Strik 2012; Carew et al. 2003) and to protect against rainfall on fruit (which limits shelf-life and harvesting days). Historical research f nds no di ference between plants covered with polyethylene covers and those without, speci f cally on raspberries and cane growth or node deve Θ Me r

treatments were within the temperature range for op t mal growth for raspberries (Strik 2012). More recently, however, Carew et al. (2003) have reported that temperatures up to 24˚C (75˚F) increase yields in raspberries, while temperatures above this level can diminish yield. Strik (2012) also reported that light transmission has an e f ect on harvest t me, which is something that should be taken under considera t on in light-diminishing ne t ng systems. Light transmission of Proteknet80 is 83% (Link 2014).

Humidity was not measured in our study, but is of cri t cal importance in raspberry high tunnel produc- t on. By ne t ng the tunnels, air f ow is reduced and control of excess humidity becomes a challenge, which can increase the condi t ons favorable for fungal disease. An increase in fungal disease pressure

would cost $10,675 per acre (see tables 2 and 3).

r conventional growers, the external costs of this management approach should be considered (including worker and ecological health). Organic growers do not have adequate chemical control options available to them, with only one spray available with acceptable efficacy.

Berry varieties that ripen early in the season do not require extensive protection from SWD at this point. This is due to the low numbers of SWD that are likely to overwinter in a northeastern U.S. climate. Milder winters will likely increase survivorship rates, however. Growers should be prepared for fluctuations in SWD pressure on crops depend-

Resources for Growers

- Vermont Vegetable and Berry Growers Association, Spotted Wing Drosophila resource webpage: http://www.uvm.edu/vtvegandberry/?Page=SWDInfo.html
- Factsheet on netting trellis designs: http://www.uvm.edu/vtvegandberry/SWD/SWDNetting-FrameFactsheet.pdf
- Michigan State University Integrated Pest Management, Spotted Wing Drosophila resource webpage: http://www.ipm.msu.edu/invasive_species/spotted_wing_drosophila
- Cornell University, Small Fruit http://www.fruit.cornell.edu/spotedwing/

Sources of netting, sewing, and vestibules (not an exhaustive list):

- Berry Protection Solutions: berryprotection@fairpoint.net 413-329-5031
- Dubois Agrinovation: http://www.duboisag.com 800-463-9999
- American Netting and Fabric: http://www.americannetting.com 800-811-7444
- Brookdale Fruit Farm: http://www.brookdalefruitfarm.com 603-465-2240

Acknowledgements

This research was funded by the Vermont Agency of Agriculture, Food and Markets Specialty Crop Block Program, the Vermont Vegetable and Berry Growers Association, the University of Vermont Extension (UVM) Center for Sustainable Agriculture, and the UVM Department of Plant and Soil Science. Thanks to the growers who hosted our study, Ben Waterman (Waterman Berry Farm, Johnson VT) and Adam Hausmann (Adam's Berry Farm, Charlotte, VT). Thanks also to Rich Cowles, Vern Grubinger, Alan Howard and Martha Caswell for their assistance with study design, analysis, and presentation. Hannah Lee Link was the undergraduate research assistant during the 2014 field season. Our work was hosted by UVM's Agroecology and Rural Livelihoods Group and the Insect Agroecology Lab, both in the Department of Plant and Soil Science.

References

Baptista, M.C., P.B. Oliveira, C.M. Oliveira, Instituto Superior De Agronomia, and Tapada Ajuda. 2006. "Early Ripening of Southern Highbush Blueberries under Mild Winter Conditions." In VIII International Symposium on Vaccinium Culture, 191–96.

Beers, E.H., R. a Van Steenwyk, P.W. Shearer, W.W. Coates, and J.A. Grant. 2011. "Developing Drosophila Suzukii Management Programs for Sweet Cherry in the Western United States." (11): 1386–95.