Fruit Notes

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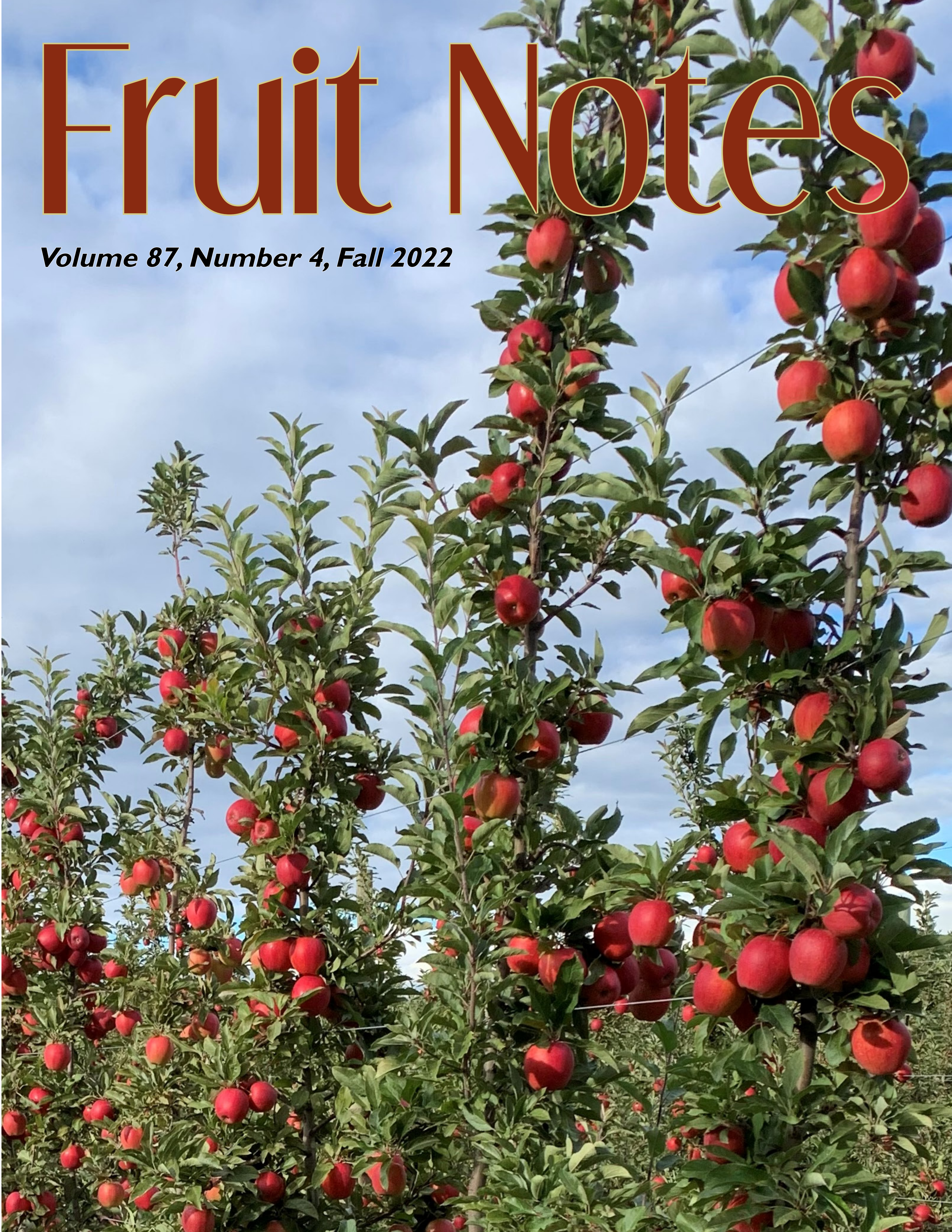

Fruit Notes

Editors: Jaime C. Piñero & Winfred P. Cowgill, Jr.

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Cover: Gala cv. Buckeye/ B9 rootstock- 5th leaf trees at Brookdale Fruit Farm, taken September 2022, yield 400 Bushels/Acre Brookdale Fruit Farm and Brookdale Farm Supply are located in Hollis, New Hampshire. https://www.brookdalefruitfarm.com
Photo Credit: Win Cowgill

Massachusetts Fruit IPM Report for 2022

Jaime C. Piñero[1], Jon Clements[2], Duane Greene[1], and Daniel Cooley[1]
[1]Stockbridge School of Agriculture, University of Massachusetts Amherst
[2]University of Massachusetts Extension

Weather

Minimum winter temperature was -4 degrees F. on 16 January 2022. No winter injury to fruit buds observed or reported, largely because temperatures were steady and cold beginning in December and continuing through February (meteorological winter). For the second year in a row, snowfall was modest at best.

Spring came about right on time as far as the fruit trees were concerned, McIntosh green tip occurring April 8. Average spring temperatures brought about bloom right on schedule, McIntosh full bloom on May 10. At the UMass Cold Spring Orchard in Belchertown, MA, there were no frost/freeze problems during the spring, although some orchards flirted with damaging temperatures. Apple bloom was generally modest across the board after a heavy crop in 2021. Some Honeycrisp blocks in particular were weak in bloom quantity, and ended up producing few to a modest amount of apples (for the second year in a row in some blocks). Peach bloom was interesting, we noted very light bloom in some varieties, others were much better, no explanation for that except maybe, like the apples, some varieties needed a "rest." Plus, it was wet and not too sunny in 2021 which may have impacted flower bud development. Despite some early panic as to the lack of bloom, the peach and apple crop turned out to be decent, nothing to write home about, but certainly adequate (with the exception of a few orchards/blocks/varieties). Shall I say production of apples was probably a bit down off of the average?

Summer, unlike in 2021, was dry, dry, dry. Much of Massachusetts was under moderate to severe drought beginning in late June. Much of eastern Massachusetts was in a severe drought. At the UMass Orchard, we saw some thunderstorm activity that ameliorated our drought. Irrigation (and a good water supply) has become a must if you care to farm in this day and age of climate change. Orchards that did not have irrigation suffered in terms of final apple and peach size. It was kind of hot overall, but not excessively so. Low 90's were common, and in early July some apples exhibited sunburn symptoms, and we flirted with more sunburn risk in August which largely did not materialize, thanks to higher humidity and lower than forecast high temperatures. Taking steps to protect apples from sunburn may become a necessity going forward. A summer high temperature of 93 degrees F. was recorded on 23 July, 2022. A stretch of particularly onerous dew points and temperatures in the low 90's during the first week in August made outdoor life (for people and pets) miserable. It did seem like there were a lot of sunny days, and dry weather made brown rot in peaches largely a non-issue. The copious sun also resulted in peaches and apples having very good flavor and overall quality that was noted by most.

Post Labor Day the **Fall** weather turned very seasonal (if not coolish) interspersed with some much needed rainfall. This was a welcome change from many past Septembers that were a bit hot. ReTain applications seemed to work very well in preventing pre-harvest drop, except in drought-stressed orchards where considerable drop (of McIntosh) was noted. Somewhat remarkably, there were very few complaints from growers about the crop quality, weekend weather for PYO, customer count, and crop sales. Growers for the most part raised their PYO prices in 2022. However because all orchard inputs (fertilizer, pesticides, diesel, etc.) were significantly higher in 2022 and still increasing, it remains to be seen if individual orchards will be profitable this season.

NEWA update: During 2022 there are 35 active NEWA (https://newa.cornell.edu/) on-farm weather stations in Massachusetts. NEWA 3.0 has been operational for the full year. If you have not set up a NEWA account, you are missing out on ease of use to quickly get to the weather information you need to make crop management decisions. Visit the NEWA Help Desk (https://newa.cornell.edu/help) for more information and Help (D'oh!). If you don't have a weather station and would like to be on NEWA – where you can take advantage of many Crop, IPM, and Weather tools – feel free to contact Jon Clements, UMASS @ jmcextman@gmail.com or in NJ Dr. Peter Oudemans @ oudemans@rutgers.edu.

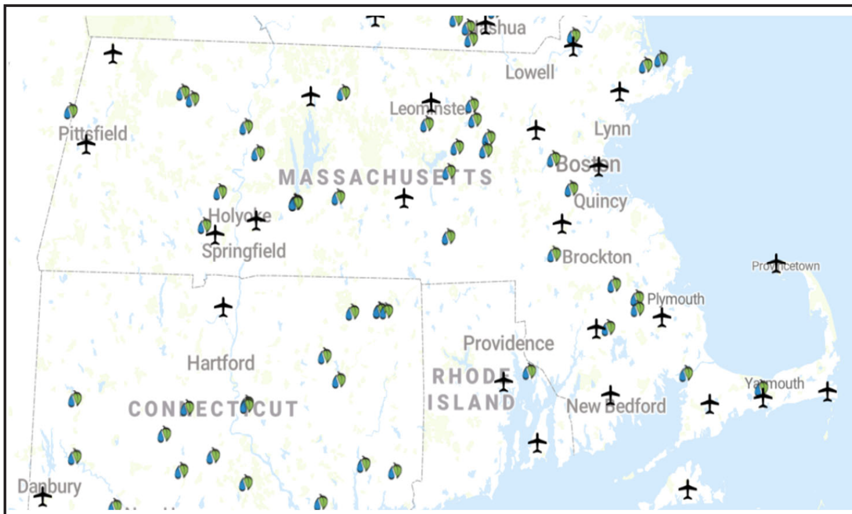


Figure 1. NEWA weather stations in Massachusetts, October 2022. The blue droplet and green leaf symbols represent the locations of the weather stations.

Diseases

One good thing about the "drought" in MA this summer is it was bad for diseases. They were generally easy to control in 2022 with a few notable exceptions.

Apple scab pressure during the primary season was modest, and most if not all growers achieved 100% acceptable scab control. The number of primary apple scab infections at the UMass Orchard varied, depending on which decision support you used, but are close: NEWA - 7 primary infection events; RIMpro - 6-8 primary infection events depending on your risk tolerance level. As we've seen in previous comparisons, NEWA ended primary season much earlier than RIMpro, with 99% ascospore maturity on 24 May for NEWA, and on 6 Jun for RIMpro. This year, that did not translate into a significant difference in infection periods.

With **fire blight**, some nail biting went on in MA, and 2-3 streptomycin applications were typical. At the UMass Orchard, according to RIMpro, the fire blight infection threshold was actually reached 6 times! There was a rather extended bloom period across many apple and pear varieties. There were no fire blight strikes observed afterwards, thanks to those strep applications. However, some orchards reported fire blight strikes later in the summer, typically where no streptomycin was applied. Fire blight is here to stay, or as the epidemiologists say, endemic.

Powdery mildew, given the rather dry spring and summer, was bad at the UMass Orchard in some varieties, particularly Honeycrisp. Bad means the Orchard staff spent time cutting it out, which is a dubious management practice at best. More attention needs to be applied in early spring to select fungicides which are effective against powdery mildew rather than focusing on scab alone. Interestingly, not much fruit showed signs of mildew infections, just vegetative shoots.

Rots, black and bitter were minimal, particularly when compared to the wet 2021 year, however, at least one MA orchard reported a continuing problem. Another orchard that had a big problem last year went on a more specific and rigorous fungicide program and reported no rot this year. The dry summer probably helped there too. Growers need to be more aware of effective fungicide programs, particularly the timing around bloom and fruit set, to prevent rot in wet years.

Marssonina leaf blotch appeared again at the UMass Orchard in September in the usual spots (Figure 2). Evercrisp is particularly problematic, and in wet years, growers need to continue fungicide sprays into September otherwise your Evercrisp will defoliate prematurely. Otherwise, no fruit symptoms were observed. Fuji and Honeycrisp are also susceptible. Some of the MAIA test selections seem susceptible (Sweet MAIA among a couple others), they likely have Fuji, Evercrisp, and/or Honeycrisp as parents. A strong season-long fungicide program, particularly during wet seasons, should keep Marssonina at bay. Note that Cevya fungicide now has a 2EE-17 supplemental label specifically for use on fruit to control Marssonina leaf blotch. PHI = 0 days.

Figure 2. Marssonina leaf blotch at the UMass Cold Spring Orchard, 19 September 2022.

One last thing, we confirmed (via the UMass diagnostic lab) the presence of **southern blight** in a younger orchard which was causing trees to collapse and die (Figure 3). It had escaped us that we previously also had a confirmed diagnosis for southern blight in this block in 2017 when it was just planted (2nd leaf). Symptoms are similar to what you might see with Phytophthora crown rot. Southern blight should be on our radar screen. It probably is coming in on nursery trees. Once arrived, there are no very effective chemical controls. Good soil drainage and attention to irrigation practices (no overwatering) help. We will see if this problem worsens given the trend to warmer and wetter growing seasons. As with the apple rots, with climate change we are seeing more "southern" diseases.

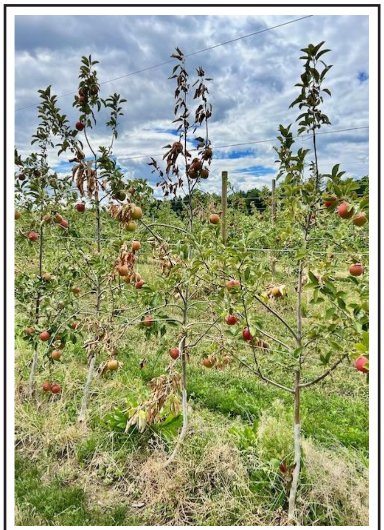


Figure 3. Crimson Crisp trees collapsing upon being infected by **southern blight**.

Insects

*In collaboration with **Jeremy Delisle and Heather Bryant** (University of New Hampshire Extension). Research supported by **Ajay Giri**, **Mateo Rull-Garza**, and **Heriberto Godoy-Hernandez**.*

PEST ALERT: The Spotted Lanternfly has become established in Massachusetts. The first established (breeding) population of spotted lanternfly (SLF) in Massachusetts was detected in the city of Fitchburg (Worcester County) in 2021. Additional SLF populations have been detected in Worcester County (Shrewsbury, MA in January, 2022; Worcester, MA in September 2022). As of August of 2022, a breeding population of SLF has also been detected in Hampden County, MA in the city of Springfield (Figure 4).

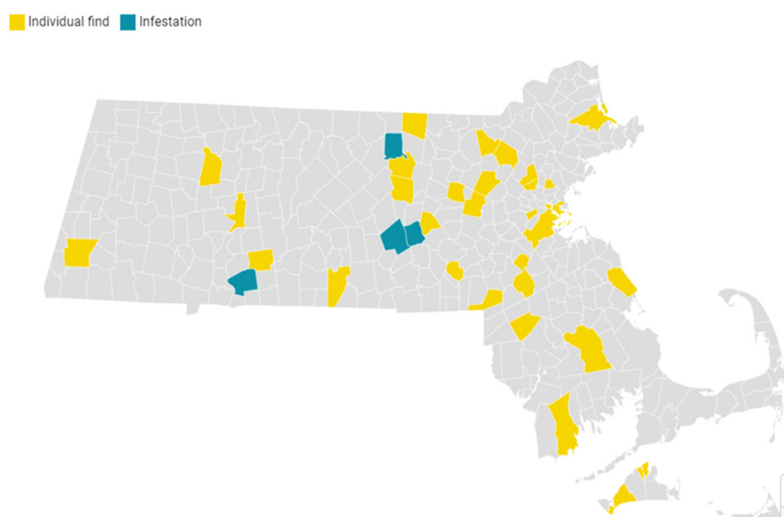


Figure 4. Distribution of spotted lanternfly in Massachusetts. Source: Matt Fortin [Massachusetts Department of Agricultural Resources]

According to Jennifer Forman Orth (MDAR): "*In Massachusetts, 33 communities have had spotted lanternfly sightings since 2018, and of the state's four local infestations -- in Fitchburg, Springfield, Shrewsbury and Worcester -- three came this year*".

Fruit injury assessments at harvest in MA and NH. In 2022, the UMass fruit team conducted pre-harvest surveys in 11 orchards (9 in MA, 2 in NH) to assess the level of fruit damage by arthropod pests. Two blocks were sampled per orchard; therefore, 22 blocks were surveyed. In all, 5,533 fruits were visually inspected (= non-destructive sampling) to assess injury.

Figure 5 shows the average level of injury by nine insect pests separately for each of the two blocks that were sampled. We are presenting results for each of the two blocks that were assessed to show that insect pest injury can vary from block to block.

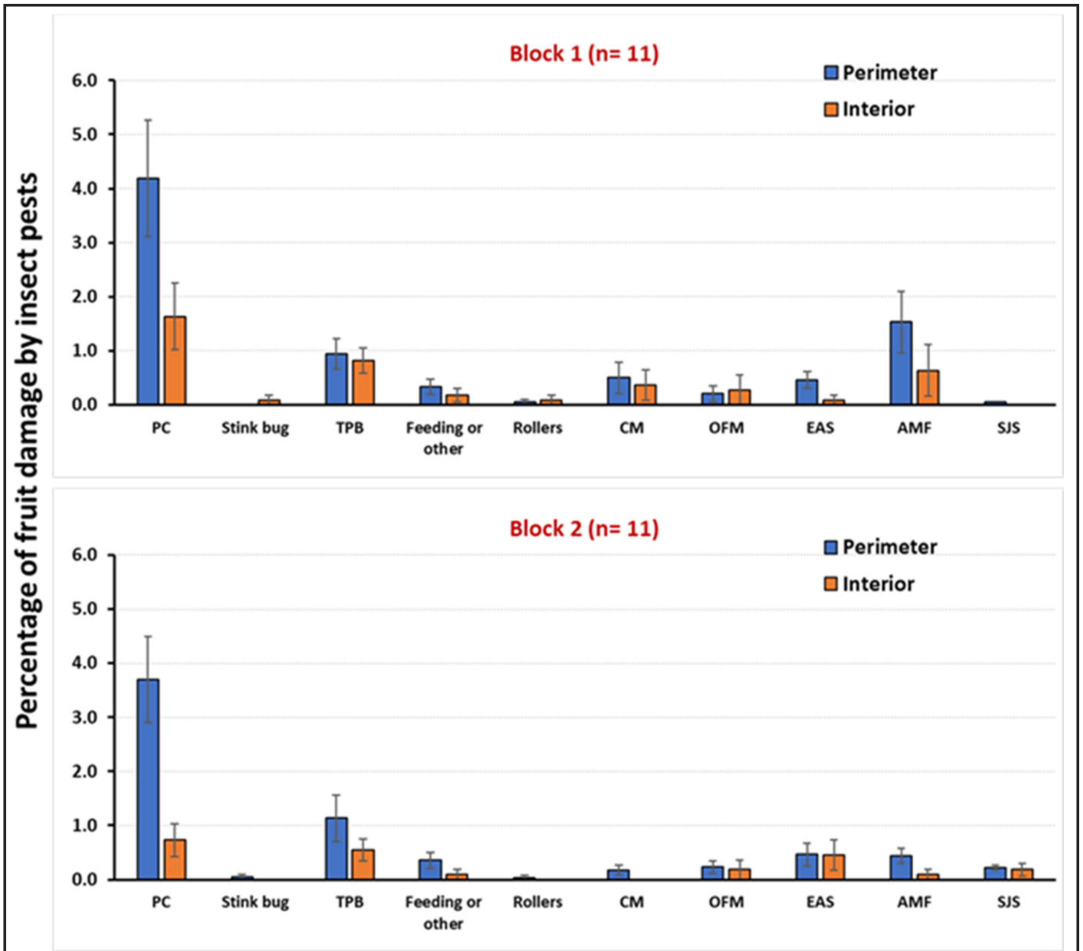


Figure 5. For each of two apple blocks per orchard, level of fruit injury by nine insect species recorded at pre-harvest surveys in nine MA orchards and two NH orchards.

Plum curculio (PC) continued to exert the greatest pressure in most blocks. In terms of injury to fruit sampled from perimeter-row trees, only 3 out of 22 blocks had zero PC injury (range: 0 – 12.5%). As expected, fruit sampled from interior trees had comparatively less PC damage; 12 out of 22 interior-fruit blocks received some level of PC damage (range: 0 – 6%). Apple maggot fly (AMF) mostly infested perimeter-row fruit in 12 out 22 blocks (range: 0 – 5.6%) while small levels of AMF oviposition injury were recorded in interior trees. In turn, tarnished plant bug (TPB) caused some injury mostly in perimeter-row trees in 9 out of 22 blocks (range: 0 - 2.7%). The level of fruit damaged by the other pests was kept at <1%.

Spotted-wing drosophila (SWD). Monitoring of SWD using diluted Concord grape juice continued in 2022. Figure 6 presents the seasonal activity of SWD in 6 MA orchards (traps were removed from the field in early August).

Parasitoids of SWD. JP collected raspberry fruit from a fruit farm located in western MA and with the help of Mateo Rull-Garza determined that multiple species of larval parasitoids were found attacking SWD. The level of parasitism was estimated to be around 24%. In British Columbia, researchers reported the presence of *Leptopilina japonica*, and *Ganaspis brasiliensis*. The range of parasitism in those samples was 0-66%.

Brown Marmorated Stink bug (BMSB). In 2021 and 2022, we sought to evaluate the extent to which sunflower and buckwheat could increase BMSB

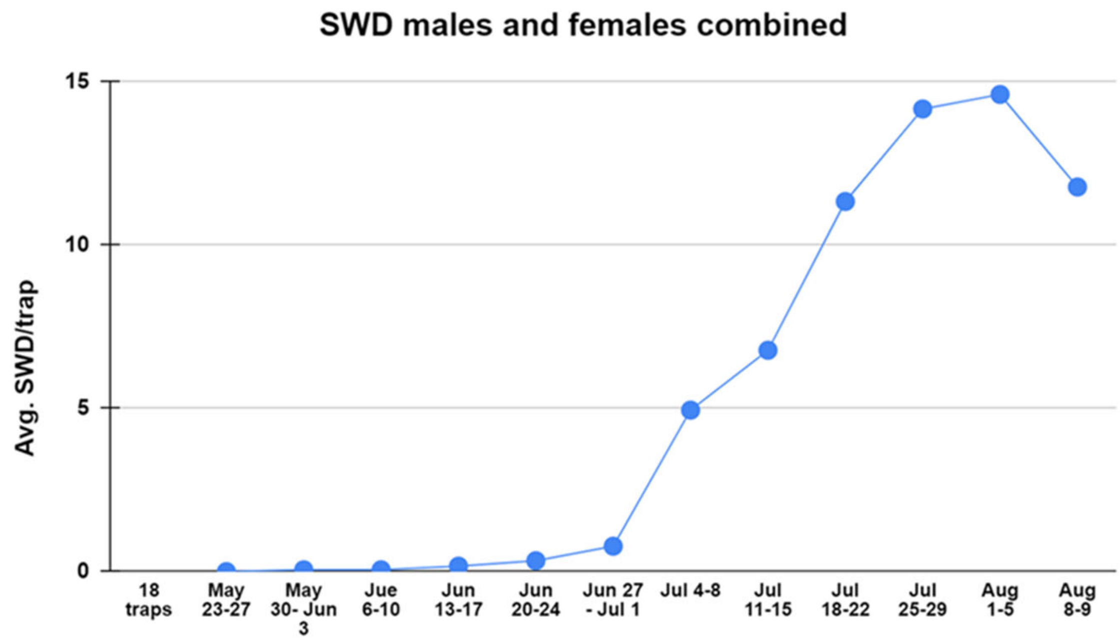
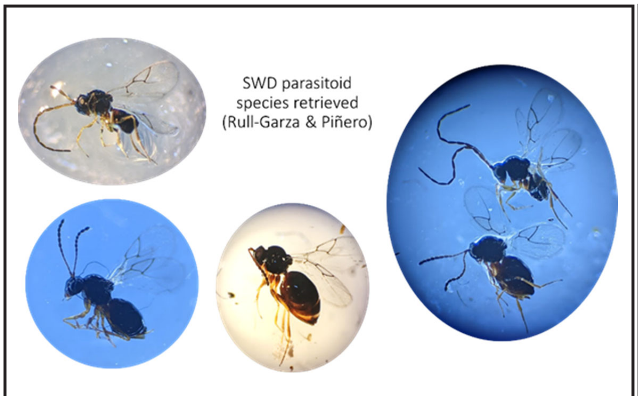


Figure 6. Captures of SWD in traps baited with diluted Concord grape juice deployed at six MA orchards in 2022. Trapping was discontinued in early August.



mortality in ghost traps (Figure 7), relative to that recorded in ghost traps alone. In 2022, research was conducted at 9 MA orchards and 1 NH orchard. This research is being conducted in collaboration with Jeremy Delisle (UNH Extension). Across the 10 participant orchards and across the entire period of experimentation (early July to late September), 655 BMSB (adults and nymphs combined) were killed by ghost traps in 2022. Three additional species of stink bugs were recorded this year: green (16 killed by ghost traps), brown (6), and green burgundy stink bug (4). For detailed results on the performance of trap cropping see accompanying Fruit Notes article.

In relative terms, BMSB populations in 2022

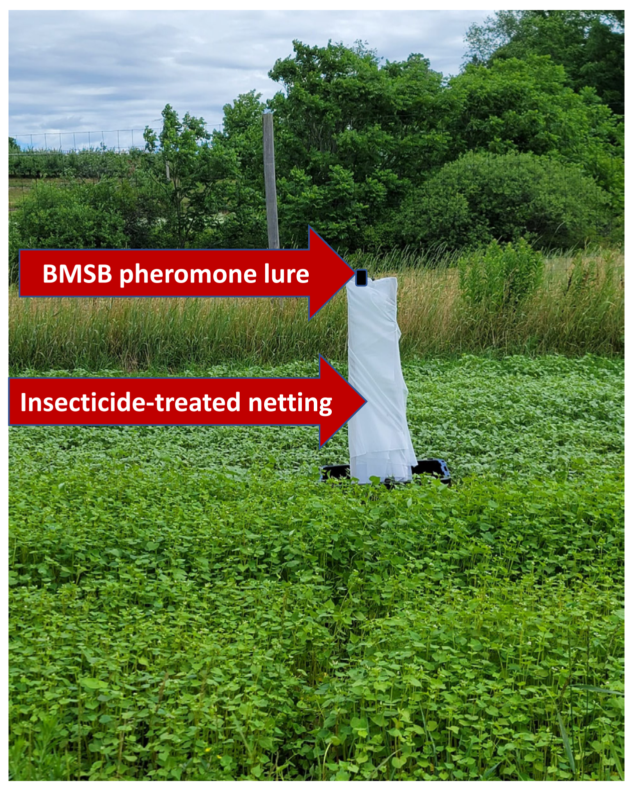


Figure 7. Current design of ghost trap evaluated by UMass researchers in association with trap cropping (dwarf sunflower and buckwheat).

were greater than those recorded in 2021, but lower than BMSB numbers recorded in 2020 (year of highest BMSB population levels recorded in MA).

Horticulture

A Review of the 2022 Chemical Thinning Season. The chemical thinning season once again proved to present new challenges. Return bloom in general was not robust. Some of this may be attributed to a heavy crop in 2021. Some varieties appeared to be more affected, especially Honeycrisp. The weather between harvest in 2021 and the bloom period in 2022 could be characterized as being somewhat normal so weather that occurred during the dormant period is unlikely to have influenced thinner responses in 2022. The early bloom period was cool, thus leading to slow flower development. The flowers on some varieties opened early leading to an extended bloom period. Early bloom and petal fall thinner applications during the cool weather were marginally effective. More favorable thinning weather appeared starting at the end of the third week in May. Favorable thinning weather appeared on about May 19 (late bloom) and extended for a period of about two weeks when fruit size reached 16 to 18 mm. The challenge for growers was to try to match specific thinners and their concentration with fruit size and the changing weather conditions. An important tool to accomplish this was the NEWA Apple Carbohydrate Thinning model.

Thinning experiments were conducted using the newly registered late-season thinner Accede™ and the much-anticipated thinner metamitron. **Accede** received full registration for use to thin apples in 2021, although full-scale, commercial use was delayed for a year. Paperwork for Metamitron registration was submitted by Adama to the EPA in December 2021 and approval is anticipated soon. Metamitron can be applied from the time the fruits reach 5mm to about 14 mm. It has proven to be a somewhat reliable thinner to apply when there is a significant carbon deficit. This year, Metamitron was successful at thinning Gala when applied at the 6 mm (petal fall) fruit size stage. Accede was evaluated as a thinner on Macoun apples when applied when fruit size was 16.9 mm. Accede did not thin in this experiment although the weather was not ideal for thinning when this application was made.

Accede (Valent Biosciences) had full registration for use on both apples and peaches, however, there was very limited formulated product available. Several growers applied Accede to peaches, with anecdotal results being positive. At the UMass Orchard, two applications of Accede were made to a mixed variety block of PF 'Flaming Fury' peaches, and the outcome – with very little hand thinning – was a nice crop of large peaches.

Bitter pit continues to be problematic in Honeycrisp blocks (Figure 8) despite copious calcium applications and leaf analysis results that looked good. Geneva rootstocks, particularly 41 and 11, have more bitter pit than, for example, Bud. 9. Be forewarned. Lightish crops of Honeycrisp with large apples spell a bitter pit problem. Horticulturally, this negative trait of Honeycrisp is most vexing.

Figure 8. Bitter pit on Honeycrisp followed by lenticel breakdown/rots. Picture credit: Jon Clements.

Precision Apple Crop-load MANagement (PACMAN) is a hot topic among industry, researchers, growers, and Extension these days. Industry in particular – for example Farm Vision Technologies (FVT) and FruitScout – is attempting to bring PACMAN to smaller growers. Both do precision apple thinning using the fruitlet growth rate model, fruit sizing, and harvest yield estimation using hand-held "apparatus" centered around a smartphone, GPS, and digital camera. In 2022 at a grower orchard and the UMass Orchard, the Farm Vision Technologies "platform" was used in Honeycrisp, Evercrisp, Gala, and Fuji blocks and compared to manual measurements entered into the fruitlet growth rate model to predict thinning response based on fruitlets persisting vs. abscising. Although not without glitches, FVT looks promising and with further refinement could be very useful to apple growers trying to better manage apple crop load in smaller orchards of high value varieties such as Honeycrisp, Gala, Evercrisp, and Fuji. FruitScout claims to do the same thing using just a smartphone, however, we were not as successful in using their app and protocol, which we expect will be refined and revisited in 2023. For more information on Precision Apple Crop-load MANagement see https://pacman.extension.org/.

"A modern, pedestrian apple orchard system(s) comparison using a disease-resistant rootstock/variety combination to be planted in 2022" was funded by the **New England Tree Fruit Research Committee** (Thank you!). Rootstock: G.11 (fire blight resistant). Variety: Crimson Crisp (scab-resistant). Planting location: UMass Cold Spring Orchard, Belchertown, MA. In-row tree spacing (3 treatments, leader spacing similar across three systems at 1.5 feet: super-spindle, single leader,1.5 feet between trees; bi-leader, two leaders 3 feet, between trees; and UFO, 4-leader, 5 feet between trees (Figure 8); Between-row tree spacing: 10 feet. Replications: 5, with 6 trees per replicate, times 3 treatments (as above) = 90 trees total. The planting was successfully established and grew well in 2022 with the exception of some unplanned herbicide injury when Chateau was applied, that set some of the trees back (phytotoxicity), particularly the bi-leader and UFO multi-leader where foliage is closer to the ground and subject to drift.

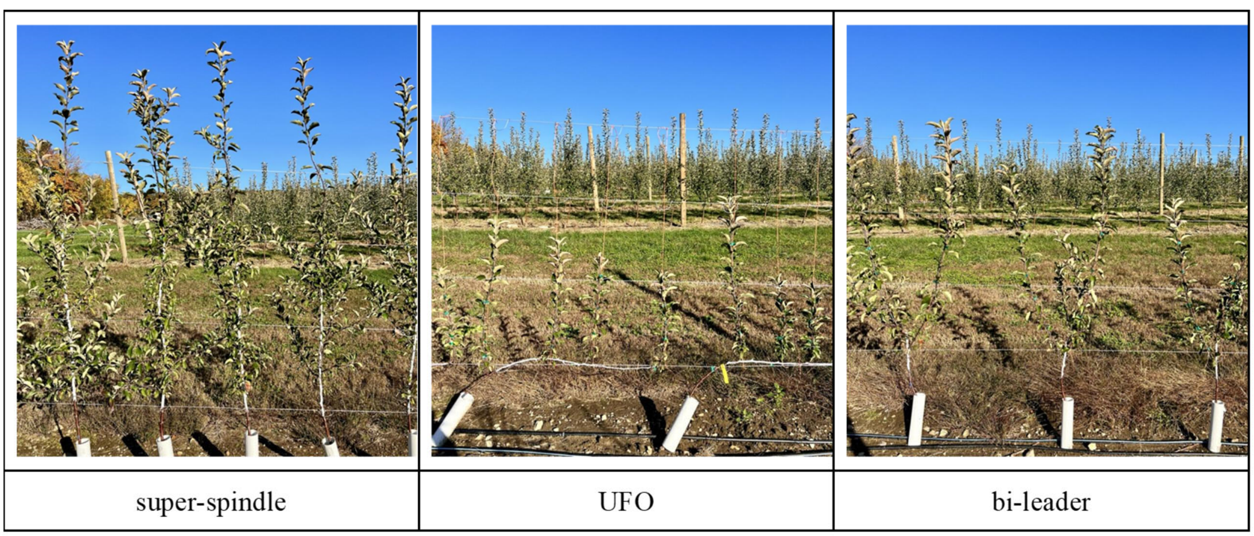


Figure 9. A modern, pedestrian apple orchard system(s) comparison using a disease-resistant rootstock/variety combination planted in 2022. Three training systems, Crimson Crisp apple on Geneva 11 rootstock.

Jeff Alicandro, aged 66, passed away September 28th, 2022

SODUS POINT, NY/ELLENTON, FL: Jeff Alicandro, aged 66, passed away September 28th surrounded by his loving family. Jeff was a renowned crop consultant with a highly regarded local business that served the northeast fruit growing industry for over 35 years. He was active in the community, establishing a youth Saturday Basketball League and serving on the school board at North Rose Wolcott. Jeff was an avid gardener, landscaper & lover of plants. He was the undisputed funniest guy around, his sarcasm and wit was second to none. But more than anything, Jeff was a dedicated family man. He leaves behind a legacy of love and jokes and enough memories to fill a lifetime twice over. Jeff is survived by his wife, Dottie, his son, Ryen (Becca), daughter Lindsay (Earl) LaMora, grandkids Ava, Chase, Elle, Chester & Oscar, older brothers Chuck & Vin Alicandro, younger sisters Kathy Alicandro & Rose (Scott) Nyman, many nieces and nephews, bushels of devastated fruit growers, countless business partners and friends, and an apple industry that will never be the same. A Celebration of Life will be held on Saturday, October 8th at 10am at the Living Word Assembly of God at 2344 Ridge Rd in Ontario.

https://waynetimes.com/obituaries/alicandro-jeff/

From Lindsey LaMora, Jeffs daughter

'None of us know what to do right now, please join us if you can to celebrate a father, grandfather, husband, friend, trailblazing consultant, and against-the-grain, under-dog, ever-prevailing, advocate-for-all-things-that-mattered-in life, fierce leader'.

There's a huge hole in our family, our farms and our entire industry. He loved us all that much. "The Bigger the Love the Bigger the Loss." Jeff loved everything he gave his heart to and he gave it to only 2 things: his family and his work. He went above and beyond in both.

Thank you for being part of his life's work.'

Lindsay & Family, and Jeff who brought all of us together.

Early Defoliation and Injury by Buffalo Tree Hopper Observed in Fuji

Peter Jentsch[1] and Win Cowgill[2]
[1]*Poma Tech Inc.*
[2]*Professor Emeritus Rutgers, Win Enterprises Int., LLC*

During harvest of Fuji in its fourth leaf, discoloration and early defoliation became apparent in a Orange County, NY orchard this season. A closer look found injury to tree shoots arising from egg-laying slits made by the Buffalo treehopper (BTH), a species of treehopper (Hemipteran) native to North America.

As the insect was likely foraging in the nearby open range of broadleaf plants, dandelion and dock, found along the orchard headlands, buffalo treehopper populations migrated over to the woody tissue of apple to begin reproduction. During the spring the adult insect, relatively indiscrete when in the tree, is only ¼" in size, was not observed this season during scouting sessions. The triangular shape and humped back from which it gets it name, resembles plant thorns, likely blended in quite well within the tree canopy.

Buffalo treehopper, *Stictocephala bisonia*

This insect is only an occasional pest of fruit trees, yet can cause significant injury to 1-2 year wood, known to also infest quince, pear, cherry and prune trees. This season the insect may have been prompted to move into irrigated orchards for moisture, as a season long drought across the mid-Hudson Valley placed extreme pressure on food resources from June through early September.

Biology

Upon mating, the female will lay eggs from July to October creating a slit in the underside of apple twigs inserting up to 12 eggs in each oviposition site. The nymphs emerge from eggs the following year, from mid-May into June, depending on degree-days. Nymphs are wingless, crawling out of the orchard canopy to infest grasses and broad-leaf non-woody plants. The slits in the branches caused by egg-laying provide harborage and establishment of **Wooly Apple Aphid** (WAA), feeding on the sap of the tree from mid to late season through harvest of late season fruit. WAA infestations can lead to honeydew deposits on the

4th leaf Fuji shoots with egg-laying slits created by the Buffalo Tree Hopper, Orange County, NY. Image: Win Cowgill.

foliage and fruit, causing the growth of sooty mold and subsequent downgrading of fruit quality and loss of foliage from scorch. WAA colonies can also serve as a nuisance to pickers during harvest.


Aerial Colony of WAA.

Scouting

Adults migrate to tree fruit to begin egg-laying in mid-late May and should be included in observational scouting assessments. Upon first find of adults and or early spring egg-laying sites, management should be strongly considered using contact insecticides. Presence of the insect may be seen throughout the season if left unmanaged.

Management

Pruning in the winter and likely again in the spring when dying buds and lack of foliage become obvious should be conducted to remove damaged wood. This would best be done prior to nymph emergence in late May. If left unmanaged, limb breakage from damaged fruiting branches will likely occur during the season as fruit load develops. Limbs having been attacked by the plant hopper should be pruned to the nearest healthy bud to restart growing shoots. Since the egg-laying period is a summer event, the presence of the adult may linger into the end of the season, with insecticide spray timing becoming somewhat elusive.

Removing injured branches will also reduce harbor sites for early establishment of WAA. When bark split caused by BTH or cicada go unnoticed, considerations for WAA management should then be considered at the onset of aphid presence. Basically Red Delicious and varieties with Red Delicious in the parentage are susceptible to WAA (Empire, Fuji).


Advanced Wooly Apple Aphid Infestation on Suncrisp Apple, Rutgers Synder Farm, 2014. Image: Win Cowgill

To manage WAA, the use of the systemic insecticide **Movento SC** (Spirotetramat) at 6 oz./A in combination with a penetrant / adjuvant such as LI-700 or horticultural oil such as Damoil / at 32.0 oz./100 gal. is required and will be very effective. Two applications would be recommended for full season control, the first in May (1st cover) and then approximately one month later. Remember it takes 2 weeks for the Movento to get into the tree. Movento applied later in the season (August) **is not** as effective as the leaf cuticle is thicker and the Movento cannot penetrate efficiently.

Note, **do not apply** a penetrating surfactant/oil with Movento SC with any PGR or Captan. It can enhance the uptake of the pgr and overthin. Combined with Captan the surfactant/oil can cause russeting. You can follow at Mancozeb program until 2nd cover or 77 day phi and also Switch the Captan to Ziram as well.

Senstar (Pyriproxyfen/Spirotetramat) is a combination of the a.i.s in Movento and Esteem, and is registered for use against a range of foliar pests in pome and stone fruit in NYS. Its label includes aphids (including WAA), mealybugs, San Jose scale, with suppression effects on several additional species such as mite. Non-toxic to honeybee adults, but potentially toxic to honeybee larvae through residues can be found in pollen and nectar. The use of a penetrant / adjuvant or oil will also be necessary to obtain the benefit of the systemic component of the Spirotetramat. **Note**, **do not apply** a penetrating surfactant/oil with Movento SC with any PGR or Captan. It can enhance the uptake of the pgr and overthin. Combined with Captan the surfactant/oil can cause russeting. You can follow at Mancozeb program until 2nd cover or 77 day phi and also Switch the Captan to Ziram as well.

Controlling weeds within the orchard should help to reduce the alternate feeding sites of BTH populations. Managing Sod Middles and Grass Headlands. Treat every year, one time.

Late fall after harvest is one of the best times to control broad leaf weeds and white clover. There are multiple reasons why it is essential to control broad leaf weeds and clover.

1) Broad leaf weeds host multiple viruses that can be transmitted to fruit trees via nematodes
2) Dandelion bloom competes with apple bloom, bees prefer dandelion.
3) White clover blooms all season and therefore makes most insecticides applied to apple & peach off label if white clover blooms are present!
4) Broad leaf weeds are host to many insect pests; Tarnished Plant Bug, Buffalo Tree Hoppers, Native and invasive Stink Bugs, Two Spotted Spider Mites..

Treatment options: 2,4-D amine formulation (Weedar 64) @ 1.0 quart /Acre or the new 2,4-D choline formulation (Embed 3.8SL) or OLF Plus Copyralid @ 3.0=4.0 0unces/ 64 acre (Spur or Stinger).

References

Poma Tech Blog- Peter Jentsch https://pomalab.org/

Tree Fruit Insect Pest - Buffalo Treehopper-Grzegorz (Greg) Krawczyk, Ph.D.
https://extension.psu.edu/tree-fruit-insect-pest-buffalo-treehopper

Sunflower and Buckwheat Enhance the Performance of an Attract-and-kill System for the Brown Marmorated Stink Bug

Jaime C. Piñero[1], Clement Akotsen-Mensah[2], Ajay Giri[1], Heriberto Godoy-Hernández[1], Mateo Rull-Garza[1], Jeremy Delisle[3]

[1]Stockbridge School of Agriculture, UMass Amherst
[2]Lincoln University Cooperative Research and Extension
[3]University of New Hampshire Cooperative Extension

Small-scale growers face tough choices about protecting crops from the brown marmorated stink bug (BMSB) near harvest, when pest populations are high. Broad-spectrum insecticides are effective but also kill beneficial insects and some materials cannot be applied near harvest. Using insecticides only when they are necessary saves growers money and reduces the risk of resistance developing. It would be desirable to develop an attract-and-kill system that would pull BMSBs to particular areas of the farm where they could be killed, thereby applying less or no insecticides to the cash crop.

Attract-and-kill (AK) strategies for managing BMSB are under investigation as promising components of sustainable IPM programs. In 2014, one Pennsylvania grower (Tom Haas of Cherry Hill Orchards in Lancaster, PA) conceived the idea of coupling insecticide-treated nets with BMSB pheromone lures, and the resulting AK system was termed 'ghost trap'. The netting treated with insecticide has been shown to be effective at killing BMSB (Kuhar et al. 2017). The field efficacy of 'ghost traps' has been evaluated in some locations of the United States. Another AK strategy targeting BMSB that has been investigated is the use of trap crop plants to attract BMSB. For example, using sunflowers in combination with sorghum was evaluated recently in vegetable crops by Dr. Anne Nielsen at Rutgers University (Nielsen et al. 2016).

While ghost traps appear highly effective at attracting and killing BMSB when deployed around orchards, most evaluations have used ghost traps deployed on tarps (to record BMSB mortality) in the absence of natural or synthetic sources of host plant odor. Build-ing from positive results with trap cropping reported by Dr. Nielsen and collaborators (2016), in 2021 and 2022 we sought to evaluate, in Massachusetts and New Hampshire, the extent to which sunflower and dwarf buckwheat acting together could increase BMSB mor-tality in ghost traps, relative to that recorded in ghost traps alone. An additional field study conducted in Missouri aimed at assessing the relative contribution of buckwheat and dwarf sunflower tested alone to the attractiveness of the pheromone to BMSB and other stink bugs.

Materials and Methods

Massachusetts and New Hampshire research. Field-scale studies were conducted in commercial apple or-chards located in Massachusetts (4 in 2021, 9 in 2022) and New Hampshire (1 in 2021 and 2022). For each or-chard, two non-crop areas of 100 ft long and 30 ft wide, in most cases adjacent to wooded areas, were used. The distance between trap crop plants and fruit trees (largely apple) was at least 50 yards. One area was used for the evaluation of trap crop + ghost trap (described below) whereas the second area had a ghost trap alone. The trap crops consisted of dwarf sunflower, planted in a swath 100 ft long and 20 ft wide, and buckwheat, planted in the remainder of the trap crop area. Planted dates were between mid-June and early-July. Buckwheat started blooming approx. mid-July to early-August.

Each ghost trap consisted of (1) a 5 ft by 3 ft piece of insecticide-treated netting (provided by BASF, Inc.) which laid over two tomato stakes, (2) one BMSB Pherocon™ stink bug dual pheromone lure (Trécé, Inc., Adair, OK) which attracts BMSB and other stink bug species, and (3) a 17-gallon heavy-duty storage container with 20-25 small holes on the floor to drain rainfall water and two larger (1-inch in diameter holes) in the center to accommodate the two tomato stakes that supported the netting (Figure 1). The plastic containers were used as insect collection devices.

Figure 1. (A) 'Ghost trap' originally developed by Tom Haas of Cherry Hill Orchards in Lancaster, Pennsylvania, in 2014. (B) Current design of ghost trap evaluated by UMass researchers in association with trap cropping (sunflower and buckwheat). Photo credits: Greg Krawczyk and Jaime Piñero.

The cooperating growers were provided with the dwarf sunflower and common buckwheat (variety not stated) seeds, which were planted from mid- to late-June, 2022, except for one grower who planted the trap crop plants in early July. The ghost traps were installed at the center of each plot once the buckwheat plants had germinated and started to grow. Starting in early July, each ghost trap was inspected on a weekly basis, except for a few instances where ghost traps were checked bi-weekly due to logistic reasons. At each inspection session, all stink bugs were removed from the ghost traps and identified according to species and instar (adult versus nymph). The insecticide-treated netting and the pheromone lures were replaced every four weeks. One farm was organic; therefore, on that farm we used clear sticky panels (Trécé Pherocon™) stapled to the upper part of the tomato stakes, instead of the insecticide-treated netting.

Missouri research. The Massachusetts research evaluated buckwheat and dwarf sunflower in combination (i.e., planted in the same areas). The Missouri research sough to assess the relative attractiveness of buckwheat and dwarf sunflower tested separately. Each trap crop was tested either, alone or in combination with the BMSB pheromone. Five treatments were evaluated using the row middles, and each treatment was replicated three times: (1) buckwheat alone, (2) buckwheat in combination with the BMSB pheromone, (3) sunflower alone, (4) sunflower + BMSB pheromone, and (5) control (row middles with native vegetation allowed to grow).

Ten rows of plastic mulch measuring 2 ft by 80 ft were installed in the field. The spacing between the row was 8 ft. Buckwheat (variety *"Koto"*) and sunflower (variety *"Peredovic")* were seeded directly on May 17th in the row middles. Field-recommended seeding rates were used for both plants. Eight week-old, tomatoes, peppers, and eggplants were planted on the plastic mulch. Each row middle was assigned a particular treatment and received one Pherocon sticky dual panel adhesive trap either, baited or unbaited depending on the treatment. The BMSB Pherocon™ stink bug dual pheromone lures and traps were purchased from Trece Inc. (Adair, OK). Each trap was installed on a 4-foot wooden stake about 20 ft apart. This was repeated in grassland with just weeds. Traps were inspected weekly for BMSB adults and nymphs. In addition, 3-minute visual observations were made on a weekly basis. Sampling started on 10 June and ended 17 August. No insecticides or fungicides were applied.

Results

2021 research in MA and NH. In 2021, 164 BMSB, 7 green, and 4 brown stink bugs were recorded in ghost traps across the 5 participant orchards. Overall, the BSBM populations were about 9 times lower in 2021 than those recorded in 2020, in the same 5 monitored orchards.

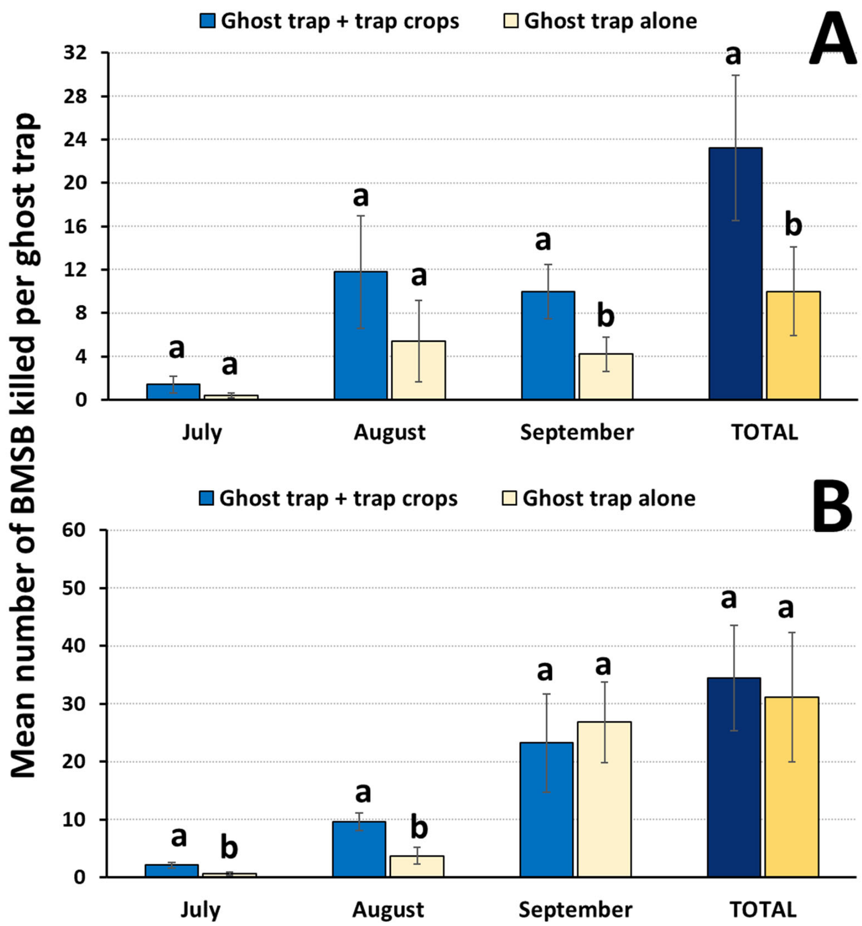


Figure 2. Mean number of BMSB captured by ghost traps on a monthly basis when evaluated either, alone or in combination with dwarf sunflower and buckwheat as trap crops in (A) 2021, and (B) 2022. For each month on each year, bars superscribed by the same letter are not significantly different at odds of 19:1.

As shown in Figure 2A, BMSB numbers were very low during the month of July, and no effects of trap cropping on BMSB mortality were noted. During July, BMSB populations are typically low and sunflowers were in vegetative state whereas buckwheat plants in general terms had just started flowering. During August, ghost traps in association with trap crop plants killed at least twice as many BMSB then ghost traps in the absence of trap crops. Such a difference, however, was not statistically significant due to high variability among samples. During September, the number of BMSB killed was significantly greater in ghost traps in association with trap crops than in ghost traps placed in isolation. Overall, when BMSB numbers were pulled across the three months that the study encompassed, the effect of trap cropping on BMSB mortality by ghost traps was clear and significant.

2022 research in MA and NH. Across the 10 participant orchards and across the entire period of experimentation (early July to late September 2022), 655 BMSB (adults and nymphs combined) were killed by ghost traps. Three additional species of stink bugs were recorded this year: green (16 killed by ghost traps), brown (6), and green burgundy (*Banasa dimidata*) (4). In 2022, BMSB captures during July and August were significantly greater in ghost traps in association with trap crop plants than in ghost traps alone (Figure 2B). However, in September such a difference was lost. It is important to point out that drought conditions prevailed in Massachusetts during July and August; therefore, our results may differ from those recorded on a 'normal' year. Across the three months of field evaluation, statistically similar numbers of BMSB were killed by ghost traps, irrespective of whether they had trap crop plants or not (Figure 2B).

2022 research in MO. It is important to highlight that the 2022 field research in Missouri was conducted under extreme heat and drought conditions. Our observations indicated that under those environmental conditions the growth of buckwheat was more impacted than that of sunflower. Sunflower in association with the BMSB pheromone lure outperformed all other treatments in terms of BMSB attraction (data combined visual counts and trapped insects) (Figure 3). Sunflower in association with the BMSB pheromone lure attracted about 8 times more BMSB than sunflower in the absence of pheromone did.

Figure 3 shows that captures of green stink bugs were statistically similar in buckwheat, sunflower and weedy area when the BMSB pheromone was present. Green stink bug attraction to the BMSB Pherocon™ stink bug dual pheromone lure is noticeable given the 10-fold increase in captures in sunflower when the pheromone lure was present than when it was absent.

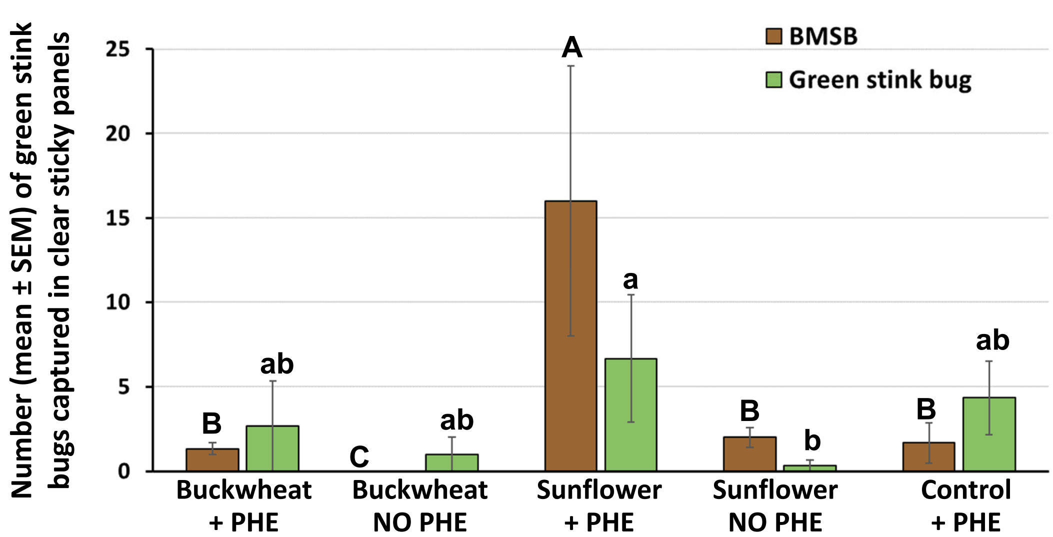


Figure 3. Captures of BMSB and green stink bugs in clear sticky cards throughout the entire period of assessment (mid-June to early-August, 2022) in Jefferson City, MO. Data collected by Dr. Clement Akotsen-Mensah (Lincoln University in Missouri). PHE= BMSB pheromone lure. For each stink bug species, bars superscribed by the same letter are not significantly different at odds of 19:1.

Conclusion

Across two years in multiple fruit farms in Massachusetts and New Hampshire, trap cropping represented by dwarf sunflower and buckwheat planted in June enhanced, depending on the month, the performance of ghost traps. The contrasting late (in 2021) versus earlier (2022) performance of trap crop plants may be due to the drought conditions that occurred in Massachusetts in 2022. Results form Missouri showed that sunflower in association with the BMSB pheromone outperformed all other treatment combinations pointing to an excellent performance of sunflower, as also documented in previous studies. More field research is needed to optimize the performance of this attract-and-kill IPM strategy, which will help growers control BMSB with little pesticide use.

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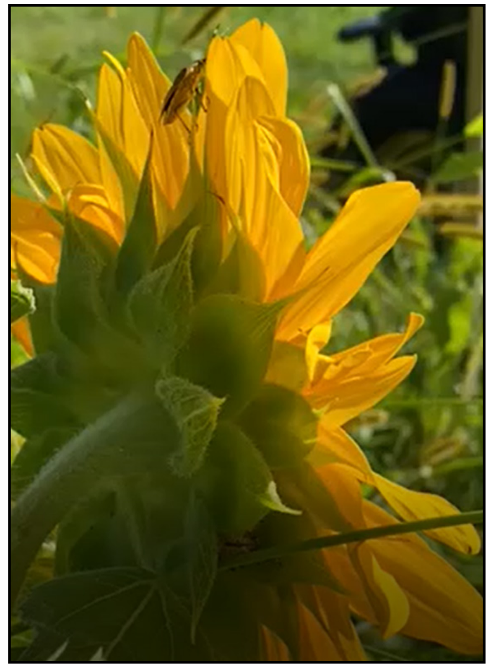
Ajay Giri and Heriberto Godoy-Hernandez are graduate students and Mateo Rull-Garza is a research associate at the UMass Stockbridge School of Agriculture.

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Monitoring Egg Parasitoids of the Brown Marmorated Stink Bug in Massachusetts

Mateo Rull-Garza, Zoe Robinson, Jaime C. Piñero
Stockbridge School of Agriculture, University of Massachusetts Amherst

The growth and spread of invasive pests like the brown marmorated stink bug (BMSB) is not usually encumbered by natural enemies (e.g., predators, parasites), which are not well-suited to interact with the invasive species (Venette & Hutchison, 2021). Instead, the responsibility to control the pest falls on growers, who often rely on chemical pesticides. However, the use of broad-spectrum insecticides can kill and deter beneficial insects that naturally control BMSB population levels (Leskey et al., 2012).

In a variety of cropping systems throughout the US, there are native species of parasitoids that attack stink bug eggs (Tillman, 2010). Over the decades, several uninvited biocontrol candidates have popped up on new continents. One example is the exotic samurai wasp (SW), a parasitoid that, though smaller than a tenth of an inch, is capable of killing up to 80% of BMSB populations in Northern China (Ogburn et al., 2021). This tiny wasp achieves such powerful control by laying its eggs inside BMSB eggs, effectively killing the developing stink bug nymphs as their offspring develop. The SW was first detected in Maryland in 2014 and, as of 2022, has been found in at least 13 states, including our neighboring New York State (Ogburn et al., 2021). We do not yet know if the SW is present in Massachusetts. If present, the SW could become a *biological control agent* critical to the suppression and control of BMSB.

Here, we report the results of field surveys aimed at assessing the presence of the SW in Massachusetts and identifying the complex of BMSB egg parasitoids that already exist in the state.

Materials and Methods

Sentinel Egg Preparation. We purchased BMSB eggs from the Phillip Alampi Beneficial Insect Laboratory (New Jersey Department of Agriculture, NJ). Upon arrival, egg shipments were frozen in -80 degrees Celsius (Tillman et al., 2020) for either 48 hours (May through mid-August) or 120 hours (three shipments in late August and September). After freezing, egg masses were individually attached to a piece of white paper using a small amount of superglue and left to dry for at least 30 minutes before deployment. In the field, prepared sentinel egg masses were stapled on the underside of leaves from trees in the orchard perimeter (Ogburn et al., 2021). Specifically, eggs were deployed on/near plant species known to be attractive to either the BMSB or wasp parasitoids.

Figure 1. Deployment of brown marmorated stink bug masses in the field.

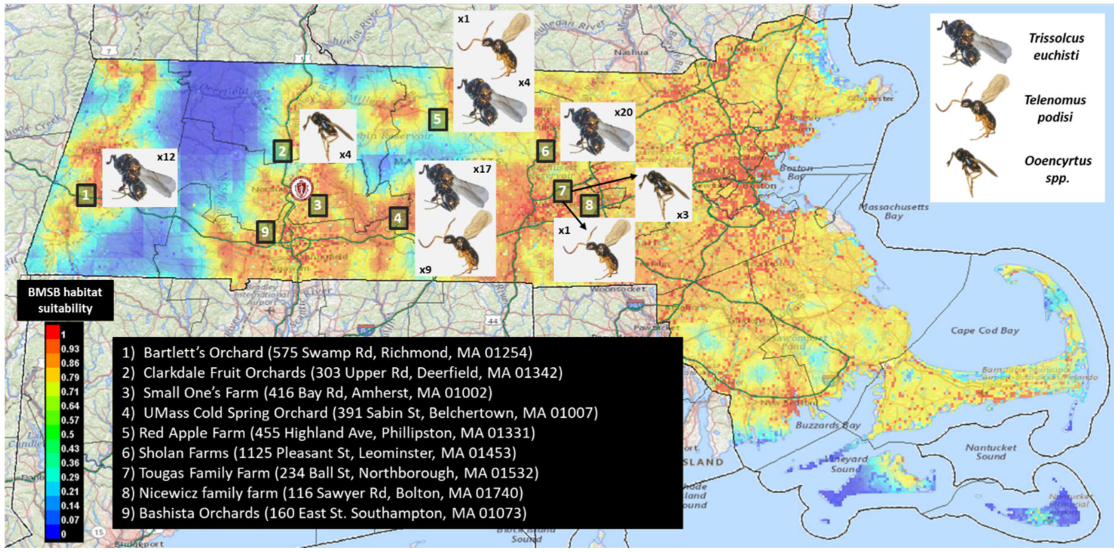

Figure 2. Brown marmorated stink bug (BMSB) sentinel egg deployment sites in Massachusetts. Incidence of wasp parasitoids is shown inside the pictures. Sites were chosen based on BMSB habitat suitability. In this heat map, redder colors mean higher habitat suitability for BMSB. The approximate location of the nine farms selected for this study is noted with numbers (1-9). Map credit: Dr. Javier Gutierrez Illan, Oregon State University.

Study Sites. For sentinel egg deployment, we selected ten fruit tree orchards located in the outskirts of either rural or suburban centers across the state of Massachusetts based on BMSB habitat suitability data (Figure 1). The ten orchards were visited at least once per month except for May, when only four of the orchards were visited.

Incubation and assessment of parasitism and predation. After 72 hours in the field, the sentinel egg masses were retrieved and counted, noting chewing predation damage (Tillman et al., 2020). Predated eggs were discarded, and the remaining were placed inside petri dishes unique for each orchard. The tops of the petri dishes were covered in four layers of insect netting (1 × 0.5 mm) before being incubated. Eggs were left inside the incubator until parasitoids emerged and died, at which point the petri dishes were removed, and the parasitoid wasps were transferred into 70% ethanol and refrigerated for preservation. After five weeks and no new parasitoid emergence, the remaining eggs were dissected to recover underdeveloped parasitoids that were not able to emerge.

Results

All results are summarized in Table 1. In May, we recovered 1,224 eggs from 4 orchards, out of which 6 (0.5%) had signs of chewing predation, and none hatched wasp parasitoids. In June, we doubled the number of eggs deployed to 2,556 and recorded 28 eggs (1.1%) with chewing damages, while no parasitism was recorded. July was the first and only month when we recovered parasitized eggs (84), constituting a 2.5% parasitism rate out of the 3,405 eggs deployed in that same month. The adult parasitoids that actually emerged were *Trissolcus euchisti* (n= 53), *Telenomus podisi* (n= 10), and *Ooencyrtus* sp. (n= 7), as well as two underdeveloped parasitoids from the subfamily *Telenominae* (Figure 2).

We also recorded the highest levels of predation in July, when 328 eggs (9.6%) showed signs of chewing. Out of 1,888 eggs recovered in August, 71 of these (3.8%) showed signs of predation. No parasitoid wasps emerged in August. Only two orchards were visited in September and 738 eggs were deployed. Out of these, 16 (2.2%) showed signs of chewing and we recorded no parasitoid emergence (Table 1).

Table 1. Summary of predation and parasitism on Brown Marmorated Stink Bug sentinel eggs. Recovered egg masses were assessed to identify chewing predation damage. Parasitism was noted as parasitoids that either, emerged or were dissected out from the eggs if underdeveloped. Highest rates of predation and parasitism were observed in July.

Month	Eggs recovered	Eggs chewed	% Eggs chewed	Eggs parasitized
May	1224	6	0.5	0
June	2556	28	1.1	0
July	3405	328	9.6	84 = **(2.5%)**
Aug	1888	71	3.8	0
Sep	738	16	2.2	0

Conclusion

While we did not find evidence of SW presence in the Massachusetts orchards that were surveyed, across five out of the nine participating orchards we observed 2.5% parasitism of sentinel eggs and recovered 72 parasitoid wasp specimens. While parasitism rates were not substantial, few orchards in MA currently report BMSB infestation problems, which could indicate low BMSB population levels. With few BMSB eggs around, native wasps may preferentially parasitize well-established host populations. According to our data, BMSB egg predators currently seem to exert more powerful control than parasitoid wasps, as we report chewing predation rates as high as 9.6% mid-summer. Our surveillance efforts will continue in 2023.

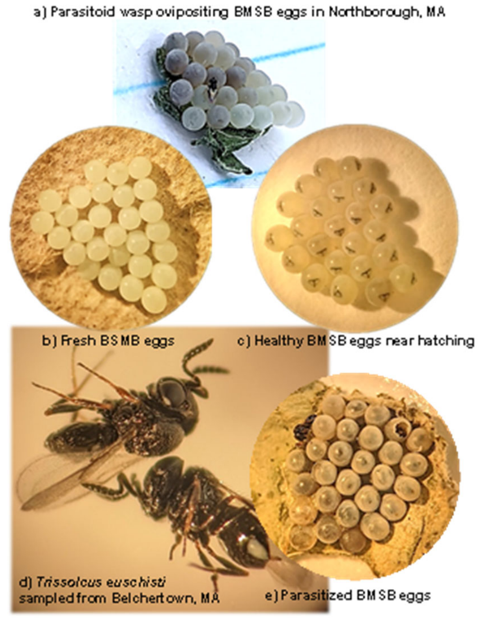

Figure 3. Brown Marmorated Stink Bug (BMSB) egg development and parasitism**.** Chemical cues from BMSB eggs lure parasitoid wasps to the egg mass, where females lay their own eggs (a) into freshly laid BMSB eggs (b). Unparasitized eggs will hatch healthy nymphs within a few days, developing characteristic burster marks (c). However, when parasitized, the eggs will adopt a darker, brown color, and hatch wasp adults (d). Adult wasps usually emerge 2-4 weeks after oviposition, leaving behind emergence holes on top of the eggs (e) from which they emerged from.

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