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

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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. Building 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 mortality 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 orchards located in Massachusetts (4 in 2021, 9 in 2022) and New Hampshire (1 in 2021 and 2022). For each orchard, 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.

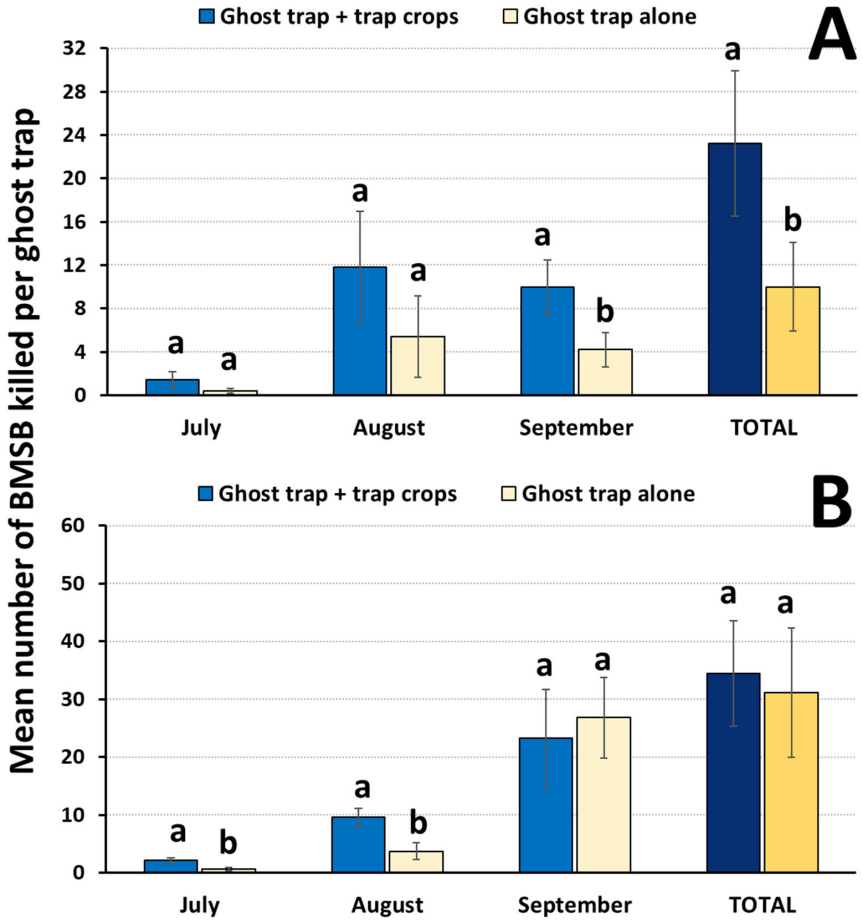

Figure 2. Mean number of BMSB captured by ghost traps on a monthly basis when evaluated either, alone or in combination with dwarf sunflower and buckwheat as trap crops in (A) 2021, and (B) 2022. For each month on each year, bars superscribed by the same letter are not significantly different at odds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

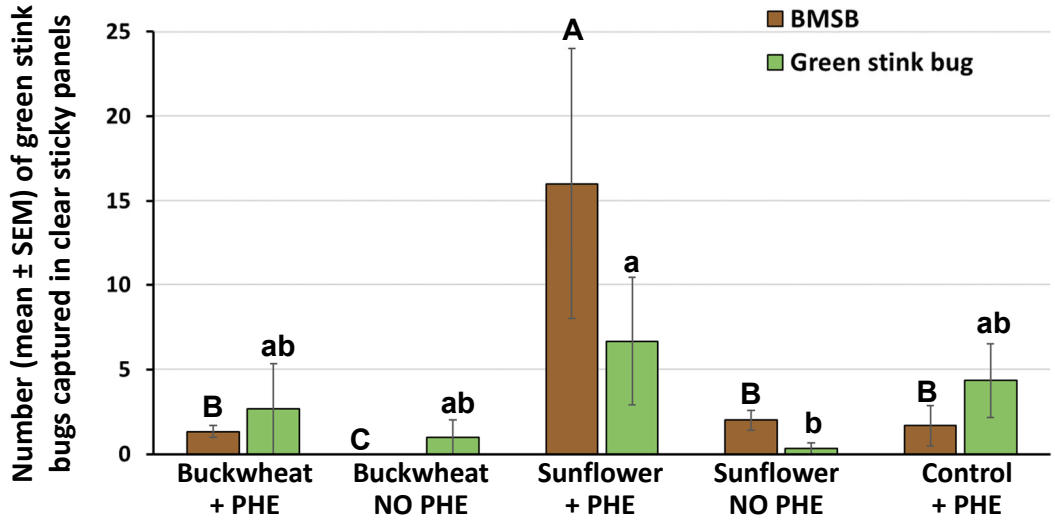

Figure 3. Captures of BMSB and green stink bugs in clear sticky cards throughout the entire period of assessment (mid-June to early-August, 2022) in Jefferson City, MO. Data collected by Dr. Clement Akotsen-Mensah (Lincoln University in Missouri). PHE= BMSB pheromone lure. For each stink bug species, 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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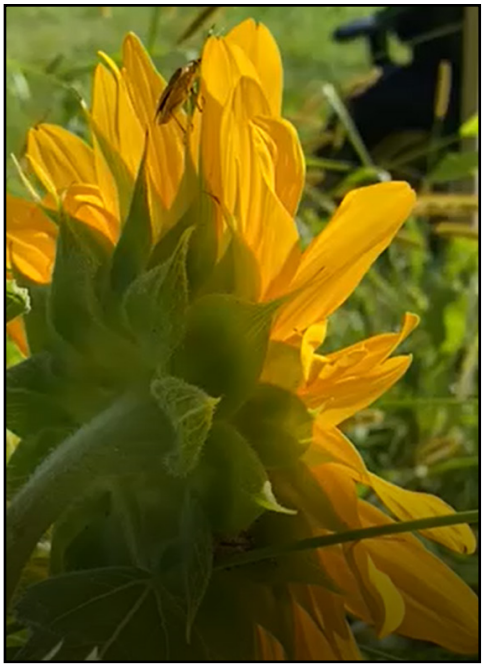

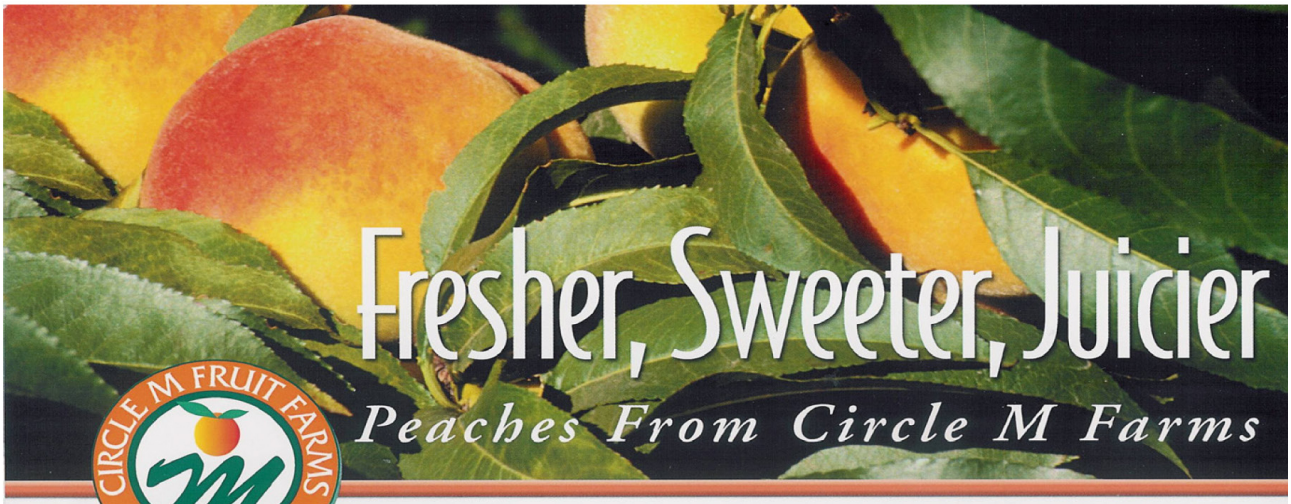

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