PHENOLOGY AND DISTRIBUTION OF BROWN MARMORATED STINK BUGS IN CALIFORNIA PEAR ORCHARDS

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ABSTRACT

In March 2014, a total of ten pyramid brown marmorated stink bug (BMSB) traps were placed in the area of the 2013 midtown Sacramento infestation and checked weekly. Nymphal stage and adult sex were determined, one-minute searches for adults and nymphs were conducted outside each trap and on host trees in the infestation area. The first eggs were found on May 5 and the first nymphs were found in traps on June 3. Only four traps caught substantial numbers of BMSB through the season. A small population peak of adults was seen in the traps in early July, and a large peak of adults and nymphs was seen in mid-September. According to the development model, there were likely two generations. Foliage searches through the season found consistent adults and nymphs on only tree of heaven. Very large populations were found in late August and September on trident maple and waxleaf privet. A total of 15 traps were placed from South Sacramento to Walnut Grove and checked weekly or bi-weekly; no BMSB were found. Eighteen traps were placed in Lake and Mendocino counties at the interface of orchards and areas with heavy vehicular traffic, and foliage was checked bi-monthly, no BMSB were found.

OBJECTIVES

Sacramento County:

1. Determine seasonal phenology of BMSB
2. Determine the spread from the initial infestation area

Lake & Mendocino Counties:

1. Conduct a BMSB survey in vegetation surrounding pear orchards and in urban areas
2. Continue to deploy monitoring traps in pear orchards adjacent to high vehicle traffic corridors.

PROCEDURES

Sacramento County

1. Determine seasonal phenology of BMSB

BMSB populations were monitored weekly from mid-March through late September 2014. A total of ten traps on 4-ft.-tall, black pyramid stands (AgBio, Inc.) were placed in yards and landscape strips of residences and businesses in and near the central core area of the 2013 midtown Sacramento BMSB infestation (Fig. 1). Traps were placed where BMSB were reported in 2013. Five of the traps were baited with AgBio lures and five were baited with Rescue lures (see Fig. 8). In both cases one lure contained aggregation pheromone and the other contained methyl decatrienoate (MDT). Because it was assumed that different traps would catch different numbers of BMSB, the two lure types were switched in each trap according to manufacturer recommendations. In addition, a Hercon Vaportape II insecticide strip was placed in each trap and changed bi-monthly.

BMSB nymphal stage and adult sex were determined, one-minute searches for BMSB adults and nymphs were conducted outside each trap. In addition, one-minute searches and beat tray sampling were conducted on host trees in the infestation area. Foliage of trees and a community garden were checked twice per week for eggs in April and early May to start the development model for predicting the number of generations per year.

2. Determine the spread from the initial infestation area

In March, a total of 15 traps with two lures each were placed from the Pocket area of Sacramento south to Walnut Grove (Fig. 2). Traps were placed at the following types of locations, chosen because of their higher risk from people travelling from midtown/downtown Sacramento:

- Farms that host visitors (5)
- Pear orchards near which a resident commutes to Sacramento (6)
- Pocket area/Freeport Blvd (4)

Traps were checked weekly through June, then every other week for the rest of the season. Foliage of nearby susceptible hosts was checked for BMSB with timed visual searches and beat sheet samples. This monitoring was in addition to following the spread within Sacramento and nearby communities based on reports of BMSB sightings and verification that the stink bugs were actually BMSB (Fig.3).

Lake and Mendocino Counties

1. Conduct a BMSB survey in vegetation surrounding pear orchards and in urban areas

At three locations each in Mendocino and Lake Counties during, host plants adjacent to

pear orchards were monitored bi-monthly during spring and summer for BMSB using beating tray samples. In late summer and early fall host plants were surveyed visually in the cities of Ukiah and Lakeport.

2. Continue to deploy monitoring traps in pear orchards adjacent to high vehicle traffic corridors.

Three 4-ft. tall, black pyramid traps (Dead-Inn™ Stink bug Trap, AgBIo Inc.) were deployed in early March at each of three locations in both Lake and Mendocino Counties and removed at the end of September. The orchard chosen were adjacent to heavy vehicle traffic. The orchards in Lake County were in: Upper Lake, Finley and Kelseyville; those in Mendocino County were close to Ukiah in: Perkins, Hastings and River Rds. At each location two of the traps were baited with AgBio lures (aggregation pheromone + MDT) and one trap was baited with Rescue 9 wk stink bug attractant. Lures were changed following manufactures' recommendations. A Hercon Vaportape II insecticide strip was placed in each trap and changed monthly.

RESULTS

Sacramento County

1. Determine seasonal phenology of BMSB

Only four traps caught substantial numbers of BMSB through the season (Fig. 4), so only these four traps were used for data analysis. Traps were placed on March 12 and overwintering adults were found on the first check on March 17 (Fig. 5). The small peak of overwintering adults in April and another was seen on July 7. A large peak was seen in mid-Sept. Female and male trapping followed a fairly similar pattern, although females predominated in late April/early May (data not shown). Sixty-two percent of the adults caught were males. The first eggs were found on spinach leaves on May 5.

The first nymphs were found in traps on June 3 (Fig. 6). There were no clear trends in nymph population peaks except for a large peak in mid-September. Between June 3 and Oct. 1, over 10 times more nymphs were trapped than adults (1,428 vs. 138). A large majority of nymphs caught in the first half of Sept., especially on Sept. 11, were 3rd and 4th instar nymphs.

In addition to BMSB, over 100 *Astata occidentalis* were found in the Midtown and south-of-Sacramento traps through the season. *A. occidentalis* is a large, solitary, predatory wasp that is known to prey on adults and nymphs of stink bugs. Also, a species of jumping spider (Salticidae family) was found in the traps periodically, and one was seen feeding on a BMSB nymph in a cherry tree.

In weekly foliage searches on marked branches of many susceptible species, very few or none were found on cherry, peach, plum, Chinese pistache, and rose. Only on tree of heaven were BMSB consistently found, and numbers found on this species are shown

in Fig. 7. Nymphs were often found on butterfly bushes, young elm trees, and sunflowers from mid-May through mid-June. Few egg masses were found through the season on the marked branches. Beating sheet sampling generally yielded very few BMSB except in Sept., when large numbers of BMSB were found on trident maple and waxleaf privet trees, both of which had maturing fruiting structures. Adults tended to fly away upon beating when temperatures were over about 70°F.

Severe fruit damage was noted on peach, nectarine, apple, and Asian pear; no European pear trees were found. No damage was observed on plums, persimmons, citrus, and grapes growing near the above trees.

2. Determine the spread from the initial infestation area

Although two individual finds were reported in Elk Grove (Dec. 2013 and April 2014), no BMSB were found in traps placed between South Sacramento and Walnut Grove.

Lake and Mendocino Counties

The species of stink bugs caught in the pyramid traps are presented in Table 1. No BMSBs were detected in either the pyramid traps or during the host plant surveys in Lake or Mendocino Counties.

DISCUSSION

The trapping plan was to exchange the AgBio and Rescue lures monthly to compare lures, since traps with one lure type may catch more or less BMSB based simply on location. However, this strategy risked inaccurate comparisons due to population and/or attraction variability through the season. Fortunately, the four traps that caught the most BMSB were on the same lure rotation cycle (Fig. 8). No obvious differences were seen between the two lure manufacturers, even though the Rescue MDT lures contained twice the amount of scent (123 mg) compared to those of AgBio (66 mg). The newly developed AgBio MDT lure (2x, 60 day duration) placed in the four traps on July 30 were essentially identical to the Rescue MDT lures in amount of compounds released. Research in the mid-Atlantic states has shown that trapping efficacy is dependent on lure loading rates (Leskey et al., 2012).

The small population peak in mid-April was due to a trap that was set up late (April 8) in which 16 adults were found on both April 15 and 21 compared to only one other adult found between the other three traps on those dates, so this peak does not necessarily indicate a population peak. For the small peak of first generation adults trapped on July 7, substantial numbers were found in only two of the four traps. Temperatures climbed into the 90s starting June 28, and two of those days before July 7 had highs of 100°+. It cannot be ruled out that the observed small peak may have resulted from warming temperatures. It remained mostly in the 90s from mid-Aug. through mid-Sept., with only two days over 100°, so the large peak in September appears to have resulted from higher populations and/or increased attraction to the lure scents.

Research at Rutgers University has shown that seasonal development of BMSB is based on a low temperature threshold of 57°F and an upper threshold of 97°F (Nielsen, 2008). Development from egg to adult requires 968 degree-days (DD) and from adult to egg laying requires another 139 DD, for a total of 1107 DD for a complete generation. The development model was run on the online UC IPM DD calculator using a starting date of May 5, 2014 and weather data from the Sacramento Executive Airport. Based on these criteria, new adults would begin to develop on July 4 and the first eggs from these adults should have been laid on July 11. Therefore, the early July peak in adults seen in Fig. 4 might be expected, although this would be only the first predicted adults.

Also based on this model, second generation adults should start to be seen on Aug. 30. The reality is that eggs of the overwintering generation are laid over an extended period, so nymph and adult populations generally overlap by early to mid-summer. The large adult population spike in the first half of September reflects the large number of second generation adults, but the large number of nymphs caught at the same time indicates the overlapping of development stages as well as the possible increased attractiveness of the lures.

Not finding BMSB in agricultural areas does not necessarily mean that no BMSB are present in those areas. Lure scents are known to attract BMSB from only short distances – less than 100 ft. away (Leskey et al., 2013). Also, it takes 4-5 years for BMSB populations to build up to major pest levels after the first introduction (T. Leskey, personal communication). It is possible that the pest could be present and populations beginning to increase somewhere in agricultural areas but not yet detected.

LITERATURE CITED

Leskey, T.C. 2013. Presentation at Cumberland-Shenandoah Fruit Workers Conference. Dec. 2013.

Leskey, T.C., S.E. Wright, B.D. Short, et. al. 2012. Development of behaviorally based monitoring tools for the brown marmorated stink bug in commercial tree fruit orchards. J. Entomol. Sci. 47(1):76-85.

Nielsen, A. 2008. Developmental rate estimation and life table analysis for *Halyomorpha halys*. Environ. Entomol. 37(2):348-355.

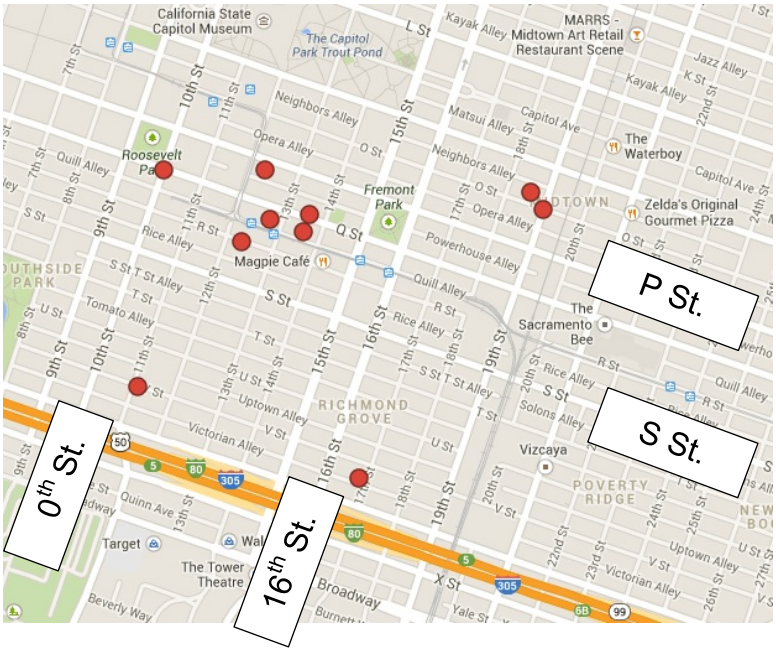

Figure 1. Locations of the 10 BMSB traps placed in Midtown Sacramento in 2014.

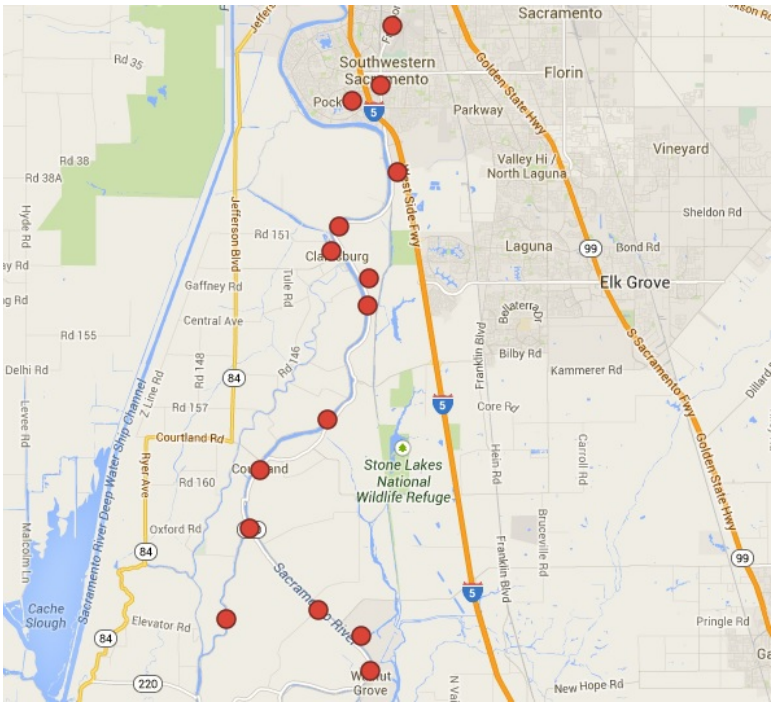

Figure 2. Locations of the 15 BMSB traps placed from S. Sacramento to Walnut Grove.

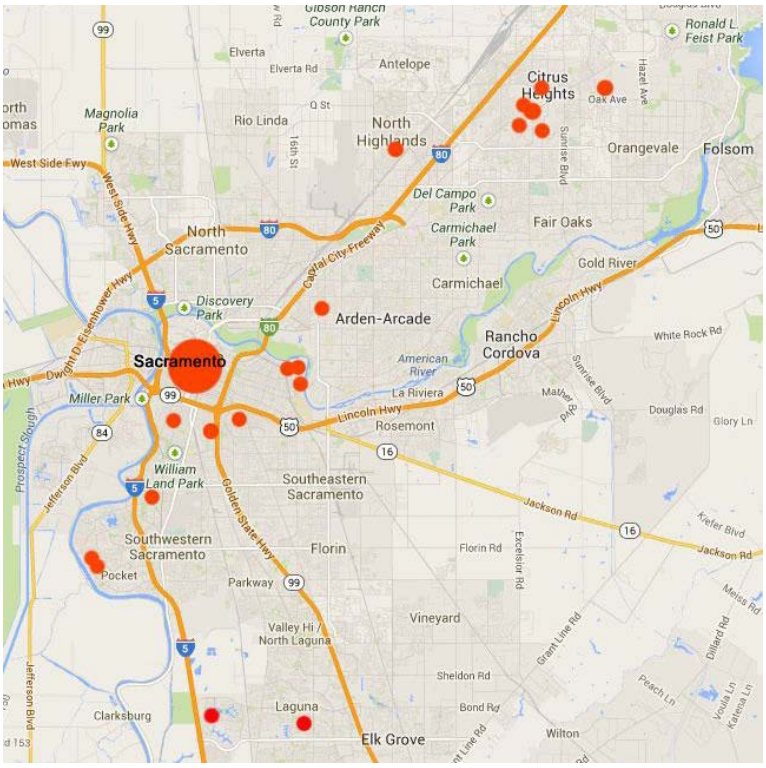

Figure 3. Locations where at least one BMSB was found (confirmed) in Sacramento County as of Nov. 2014.

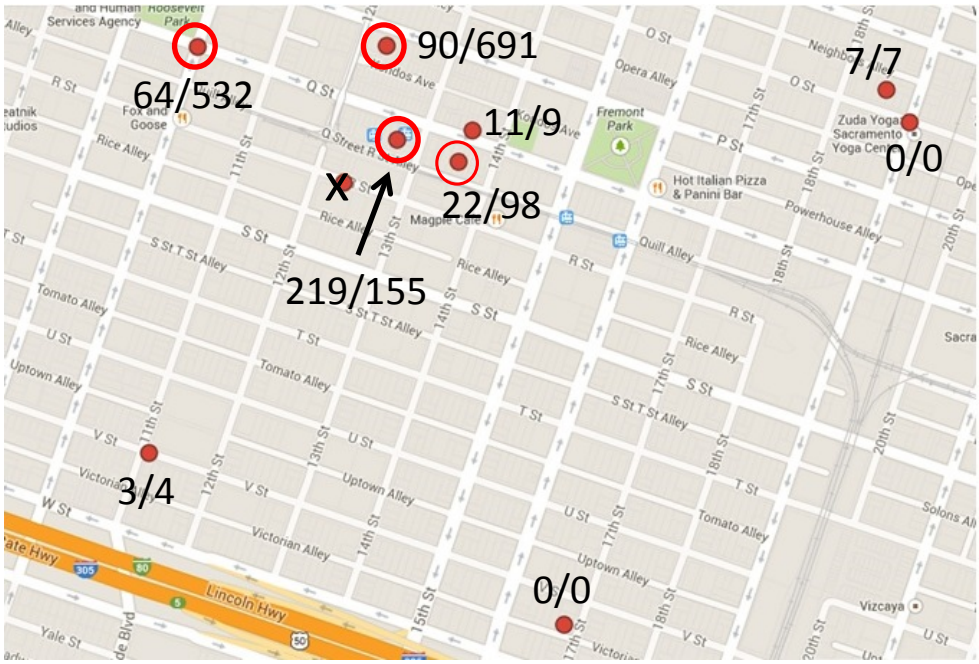

Figure 4. Cumulative trap counts (adults/nymphs) in Midtown Sacramento in 2014. The four circled traps were used for data and analysis.

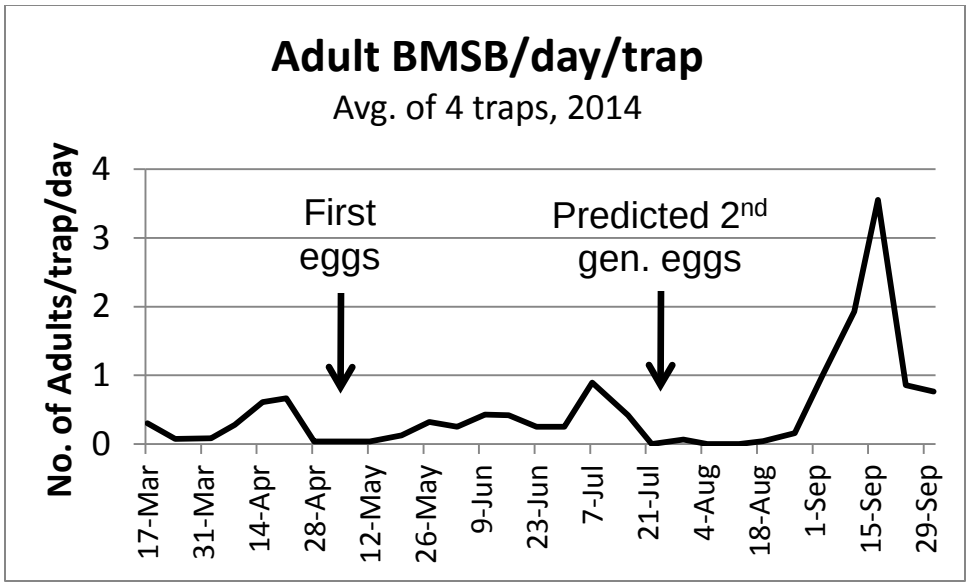

Figure 5. Average number of adults per trap per day found in the four Midtown traps that caught substantial numbers. First eggs were found May 5 and second generation eggs were predicted for July 23, based on the Rutgers model (low 57°F, high 97°F).

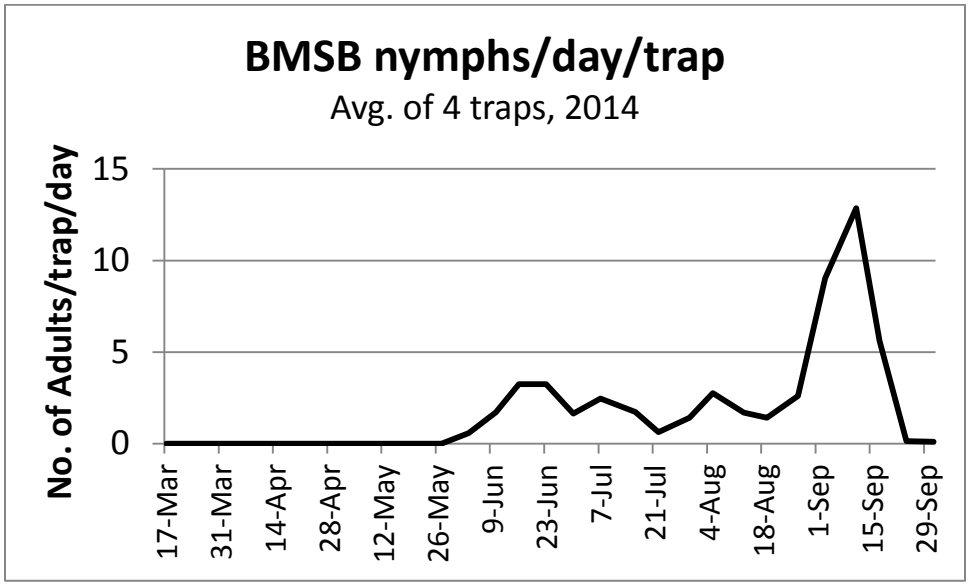

Figure 6. Average number of nymphs per trap per day found in the four Midtown traps that caught substantial numbers.

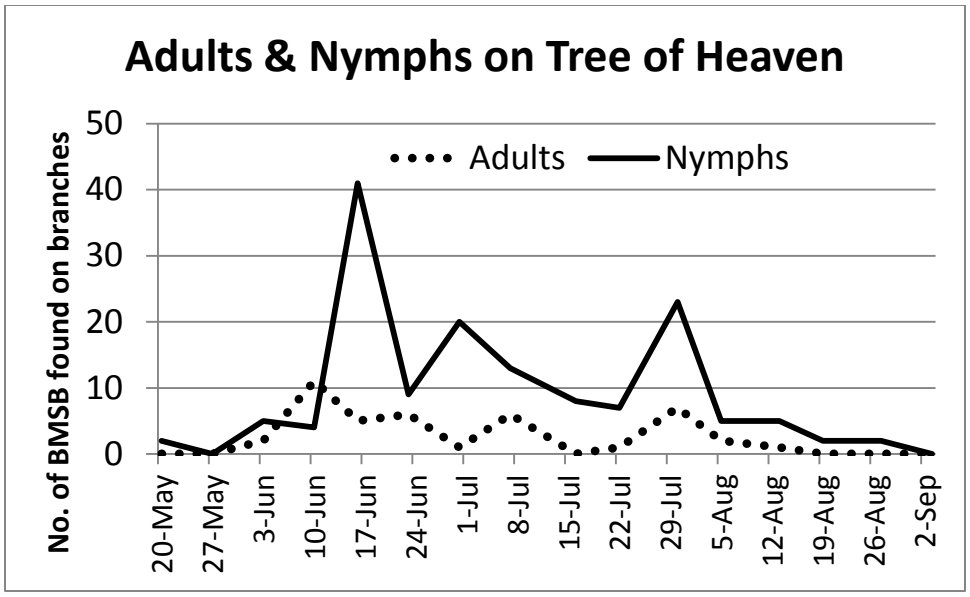

Figure 7. Adults and nymphs found on tree of heaven.

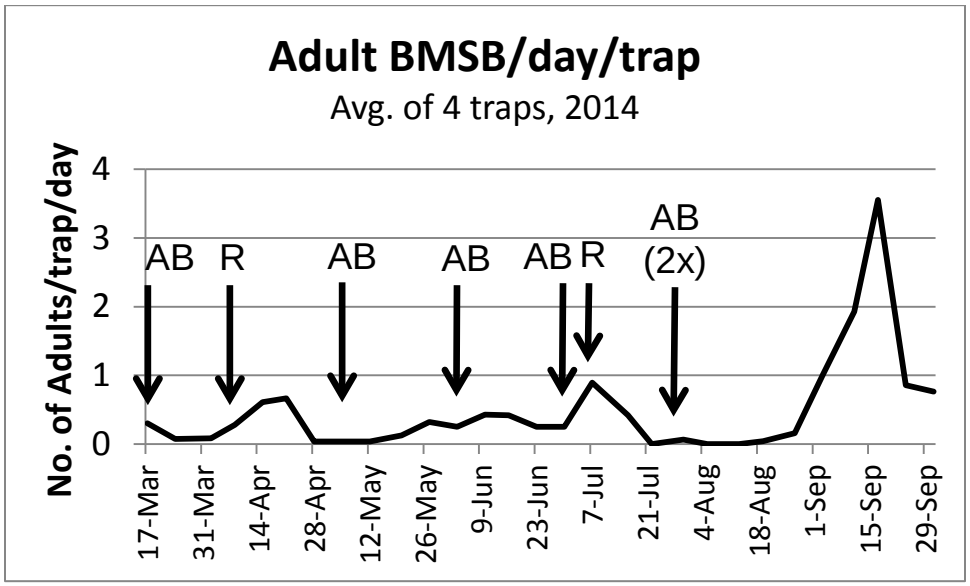

Figure 8. Dates of lure replacement or rotation in the four traps. AB = AgBio lure, R = Rescue lure, AB (2x) = new AgBio lure with twice the MDT content compared with the AB lure (equal to Rescue).

Table 1. Stink bug adult species (unless noted as 'nym' for nymph) caught in black pyramid traps baited with aggregation pheromone and MDT during 2013 – 2014 in Lake and Mendocino Counties.

	Mendocino County			Lake County		
Date	Perkins	Hastings	River Rd	Upper Lake	Kelseyville	Finley
	# per species					
7/18/13	1 Green SB[1] 2 Consp[2]	-	-	1 Consp	1 Consp	-
7/25/13	1 Consp	-	-	-	-	-
8/8/13	2 Consp	-	-	-	-	-
8/15/13	1 Say's SB[3]	-	-	-	-	-
8/22/13	1 Consp	-	-	-	-	-
9/12/13	-	-	-	Conchuela[4]	-	-
10/3/13	1 RSSB[5]	-	-	-	-	-
2014						
3/31/14	-	-	1 RSSB	-	-	-
5/5/14	1 Consp	3 Consp	-	-	-	-
5/12/14	1 Consp	-	-	-	-	-
5/19/14	1 Consp	-	-	-	1 Consp	-
5/27/14	3 Consp	1 Consp	-	-	-	-
6/2/14	1 Consp	-	-	-	-	-
6/9/14	1 Consp	1 Consp	-	-	-	-
6/23/14	3 Consp	-	-	-	-	-
6/30/14	2 Consp	-	-	-	-	-
7/7/14		1 Consp	-	-	-	-
7/14/14	1 Consp	1 Conchuela 1 RSSB 1 RSSB nym	-	-	-	-
7/21/14	5 Consp	-	-	-	-	
7/28/14	-	-	-	-	-	1 RSSB
8/4/14	1 Consp	-	-	-	-	-
8/11/14	2 Consp nym	-	-	-	-	-
8/18/14	1 Consp	-	-	-	-	-
8/25/14	-	1 Conchuela	-	-	-	-
9/2/14	1 Consp	-	-	-	-	-
9/15/14	-	-	1 RSSB	-	-	-

[1] Green SB = Green stink bug, *Acrosternum hilare* (Say)
[2] Consp = Consperse stink bug, *Euschistus conspersus* Uhler
[3] Say's SB = Say's stink bug, *Chlorochroa sayi* (Stål)
[4] Cochuela = Conchuela, *Chlorochroa ligata* (Say)
[5] RSSB= Redshouldered stink bug, *Thyanta accerra* McAtee