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Brown Marmorated Stink Bug
An invasive insect pest

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The brown marmorated stink bug (BMSB, *Halyomorpha halys*) is a nonnative pest of many of Wisconsin's fruit, vegetable, and grain crops, as well as ornamental trees and bushes. Originally from Asia, BMSB was first found in the United States in Pennsylvania in 1998. Populations of BMSB seem to follow a specific pattern following first detection in a new area. First, infestations build up in urban areas where the adults overwinter in homes and can become a serious nuisance as their numbers grow. Populations tend to then spill over into cropland. As numbers continue to increase, BMSB can become a significant agricultural pest.

BMSB was first detected in Wisconsin in 2010. Within the first five years of its introduction to the state, populations in urban areas have steadily increased, following the trend mentioned above. In the summer of 2016, BMSB was detected for the first time in agricultural crops in Wisconsin, initially in apples and pumpkins near urban areas. It is expected to continue to expand its range and prevalence in the coming years. Adults are expected to continue to move into agricultural landscapes to feed. As they are capable of flying up to 70 miles per day, they are able to travel great distances to reach suitable crops. Most damage is seen in late summer or early fall.

Life cycle and identification

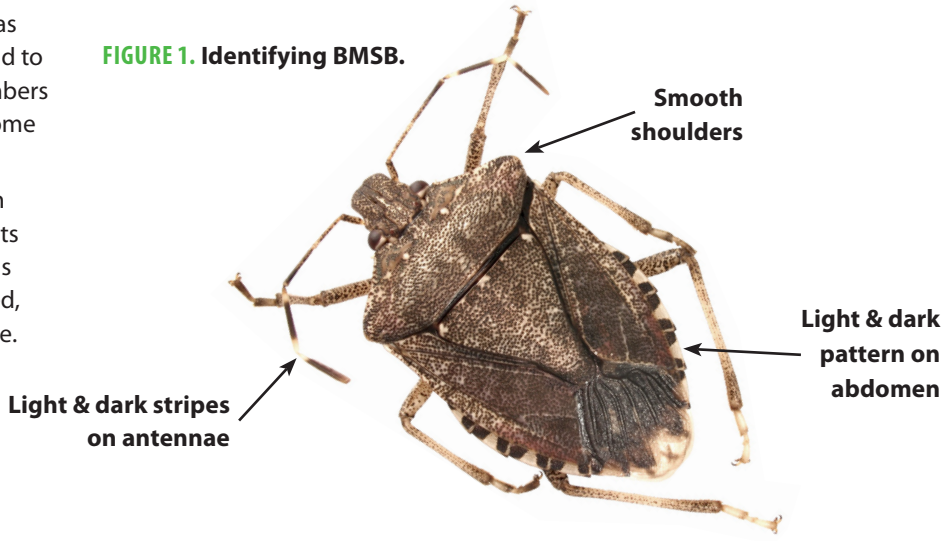
The brown marmorated stink bug looks similar to many native stink bugs, with the characteristic five-pointed body shape, long antennae, and a brown, mottled back. It is important to be able to distinguish BMSB from other similar-looking stink bugs, especially because many native stink bug species are beneficial, and none reach outbreak population levels to the same extent as BMSB. There are several reasons why BMSB can cause such severe damage, including their adaptation to overwinter in the warmth of our homes, their **polyphagous** feeding habits, a high reproductive rate, and a scarcity of predators in their invasive range.

BMSB adults can be identified from other stink bugs by their size (½ to ¾ inch long), alternating white and black pattern on the edge of the abdomen, white bands on the antennae, and smooth shoulders that lack spines. A common look-alike, the dusky stink bug is much smaller and has pointed shoulders, whereas BMSB is larger with smooth, rounded shoulders.

BMSB eggs are light green and laid in a cluster of 20 to 30 eggs on leaves of potential host plants. The nymphs start off red and black, then turn brown as they molt and mature.

To ensure accurate identification, bring any suspected BMSB specimens to your UW-Extension county office or send your sample in alcohol to the University of Wisconsin Insect Diagnostic Lab (1630 Linden Dr., Madison, WI 53706). Alternatively, you may send a high-quality photo with a reference for scale by e-mail to the diagnostic laboratory (labs.russell.wisc.edu/insectlab/contact-us).

FIGURE 1. Identifying BMSB.



BMSB adults overwinter in protected locations, either inside houses, barns, or in dead standing trees. The first eggs are laid in early spring. Each female will lay 10 to 20 egg masses throughout the spring and early summer, and up to 480 eggs in her lifetime. Nymphs go through five instars, or molts, before reaching maturity. In the fall, the new adults find a protected place to overwinter. There is usually one generation per year in Wisconsin, although a second generation is possible during a long, warm summer.

A **degree day** model allows more accurate prediction of BMSB life events based on temperature rather than calendar date. Degree days for BMSB can be calculated using a base 50°F model. Because BMSB adults begin to move out of their overwintering sites when day length reaches 13.5 hours (approximately late April in Wisconsin), this can be used as a **biofix** for when to begin to accumulate degree days. From that time, it will take approximately 148 degree days for adults to reach sexual maturity and begin laying eggs.

Key terms

biofix—A biological event, an indicator of a developmental event, or a calendar date that is used to initiate the calculation of growing/degree days, usually in the life of an insect pest.

degree day—A way of incorporating both temperature and time into one measurement to quantify the rate of plant or insect development. All plants and insects develop in response to temperature. The warmer the weather, the more quickly they develop, and the cooler the temperature, the slower they develop.

polyphagous—Feeding on or utilizing many types of food.

FIGURE 2. Newly hatched first instar BMSB nymphs.

Each egg will take approximately 538 degree days to develop to adulthood. It is important to remember that each female will continue to lay eggs for up to a month, so there is an extended period of time in which BMSB may be found in both egg and nymphal stages.

Host range

BMSB are most damaging to apples, sweet corn, and tomatoes. In particular, apple crops have experienced significant damage in some Eastern states; an average of 25% of apple crops show BMSB risk. Other high-risk Wisconsin fruit crops include grape, peach, pear, and hazelnut. Although cherry is a preferred host of BMSB, there are usually no damage symptoms visible by harvest, so it is not considered an economically significant pest of cherry. High-risk vegetable crops include chard, corn, green beans, pole beans, edamame, eggplant, okra, peppers, snap peas, and tomatoes. BMSB can also be damaging to field crops, including dry beans, field corn, soybeans, and sunflowers. Finally, many ornamental plants show damage symptoms, including cherry, catalpa, crabapples, many species of dogwood, English holly, lilac, redbud, rose, and sunflower. Some commonly grown crops in Wisconsin at medium to low risk of BMSB damage include asparagus, brassicas (such as broccoli, kale, and cauliflower), carrot, flowering dogwood, ginkgo, horseradish, potato, sweet potato, and tomatillo.

Damage symptoms

All life stages of BMSB, from nymph through adult, can cause damage to susceptible plants. Like all true bugs, they feed by piercing into the fruit or vegetation using their proboscis to suck out the plant's juices. Damage can occur from the actual feeding, which looks like a tiny dimple in the fruit surrounded by a slight depression. Additional damage occurs when this opening lets in pathogens or allows feeding by other insect pests, leading to brown or white necrosis of the flesh. Furthermore, chemicals from the saliva of the bug can change the chemistry of a fruit, such as an apple, by decreasing the rate of maturation following feeding, and making the fruit unmarketable. Cherries show a slight external discoloration, but no internal damage. Hazelnut, on the other hand, does not exhibit external damage, but upon shelling, the inner nut will be shriveled, corky, or absent.

Damage from BMSB cannot be distinguished from the damage from other stink bugs. However, it is still useful to be able to distinguish stink bug damage from other similar-looking damage in apples, such as bitter pit, hail damage, and feeding damage from coddling moth. Stink bug feeding damage is distinct in that it exhibits a depression with a small or nearly indistinguishable stylet hole; when cut open, there is corking of the flesh, which reaches all the way to the surface of the fruit.

Monitoring for BMSB

BMSB adults and nymphs all respond to an aggregation pheromone, which draws individuals of both sexes together to an area. This can lead to large aggregations in houses or on suitable hosts, but this can also be used to attract, monitor, and trap BMSB. Commercial lures have been developed using the aggregation pheromone of BMSB combined with that of another stink bug.

The most common way to monitor for BMSB is with a black pyramid trap, generally about four feet tall, with a collection jar containing a lure and kill strip at the top of the trap. The black trap itself mimics the trunk of a tree while the lure contains the aggregation pheromones to attract BMSB. Once the BMSB nymphs or adults climb into the collection jar, they have difficulty escaping and eventually will die from the chemicals. Lures may be attractive to native stink bugs as well, so it is important to identify if stink bugs caught are BMSB or not (check the **Appearance and life cycle** section for identification tips). An alternate trap design uses a clear, sticky panel trap, also baited with a lure. In this trap, the kill strip is unnecessary as bugs will stick to the trap itself. Both trap options and lures are available commercially online.

Regardless of which trap you use, research in apple orchards has shown a provisional economic threshold of a cumulative trap catch of 10 BMSB adults per trap per week from border rows. Border rows are often used for monitoring because the insects fly into the orchard from the surrounding landscape, thus arriving earlier and in greater abundance on the edges of the orchard. No specific economic threshold has been set for other fruit crops, and future research may show if a similar threshold can be used for other crops.

Management

Cultural control

Cultural controls have not been very successful at large scales. Because BMSB is polyphagous and feeds on a variety of crops and native landscape plants (e.g., English holly, various dogwood species, and many native tree species), it would be nearly impossible to remove all alternative host plants. Similarly, because BMSB tends to overwinter in houses or barns, it is not possible to remove overwintering habitats.

Cultural control methods that can be effective are time consuming or expensive to do on a large scale. For example, physical barriers can be an effective method to prevent damage, either through row cover, bagging fruit, or placing a sticky substance on the trunks of trees. This is covered in greater depth in the **Information for backyard gardeners** section.

Another cultural control method, effective only to a limited degree, is the use of a trap crop or overwintering trap. In a trap crop, a highly desirable food source such as soy is provided on the edges of a crop. Then the trap crop is destroyed, hopefully eliminating a large portion of the BMSB population. For an overwintering trap, a box packed with straw or paper attracts BMSB adults looking for a warm place to overwinter. They can then be removed and destroyed before spring. These methods only work at low BMSB population densities and are not sustainable, long-term solutions.

FIGURE 3. BMSB injury to apple fruit before and after peeling.

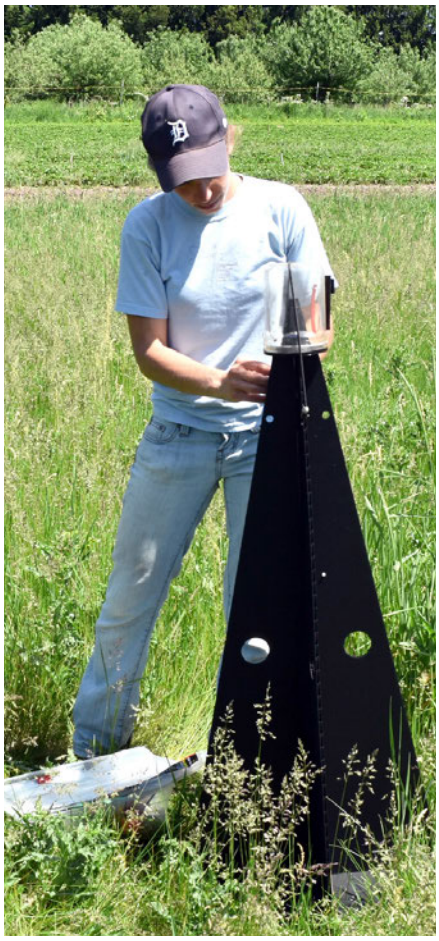


FIGURE 4. Monitoring for BMSB with a black pyramid trap.

Biological control

Biological control can be a cost- and time-efficient control strategy for many pests. BMSB, as a relatively recent invasive pest to the United States, does not have many specialized biocontrol agents present in Wisconsin at this time. However, there are several avenues worth pursuing for future research.

Many insects, including BMSB, are most susceptible to biological control when in the egg stage. BMSB eggs are fed upon by a variety of generalist predators, including lacewing larvae, lady beetles, spiders, big-eyed bugs, and minute pirate bugs. Data from the East Coast suggests these may reduce BMSB eggs by as much as 50%, although no data exists from Wisconsin at this time. In addition to these generalist predators, in its native range, BMSB eggs are parasitized by a specialist parasitoid wasp, *Trissolcus japonicus*. In recent years, *T. japonicus* has been found in Maryland, Virginia, and Washington State, and research is ongoing to determine whether it can be imported, reared in mass, and then released as a biocontrol agent into other parts of the United States.

Chemical control

Chemical control remains the simplest control method to implement. A summary of current chemical control recommendations for BMSB can be found in the *Midwest Fruit Pest Management Guide*[1] or the *Michigan Fruit Management Guide*[2]. Because this pest is relatively new to Wisconsin, insecticides may not yet be specifically registered for BMSB use in this state; however, as long as the insecticide is registered in Wisconsin for a specific crop, it can legally be used against BMSB and should be applied at labeled rates recommended by other states for optimal efficacy against BMSB.

Some insecticide classes known to provide good control of BMSB include pyrethroids (IRAC code 3A), carbamates (IRAC code 1A), and neonicotinoids (IRAC code 4A). In general, the choice of which insecticide to use should take into account the preharvest interval and reentry restrictions, other pests present, and effects on beneficial insects and the environment. Pyrethroids in particular have been shown to have detrimental effects on biocontrol agents, which may lead to the resurgence of other pests such as mites or scales. Make sure to calibrate your sprayers to provide thorough coverage and to rotate chemical classes to delay resistance development. Always remember to avoid spraying insecticides when pollinators are actively foraging in the commodity being treated.

Insecticide use can be minimized through an understanding of BMSB biology. Because BMSB tends to prefer the outer edges of a crop field, spraying just the outer rows can provide up to 85% effectiveness. To further increase insecticide effectiveness while reducing spray volume, aggregation pheromones can be placed regularly along the edges of a field, with insecticide coverage focused just on the areas with the aggregation pheromones. As mentioned in the **Monitoring** section, apple growers can use an economic threshold of 10 cumulative BMSB caught in traps to determine when to begin spraying. If you reach this threshold, it has been shown that spraying an effective insecticide two times at a seven-day interval shows high efficacy.

Information for home gardeners

Many fruits, vegetables, and ornamental plants commonly grown in home gardens are preferred food sources for BMSB, including raspberries, apples, beans, peas, peppers, tomatoes, salad greens, sunflowers, English holly, lilac, redbud, and sunflower. Additionally, BMSB pressure in the home garden may be especially high, particularly early and late in the season, as the adults move out of and back into homes to overwinter. If you have particularly high overwintering adult populations in your neighborhood, monitor for BMSB in your yard. There is some concern that monitoring with pheromone traps will draw BMSB into your yard from surrounding areas, leading to increased damage near the trap. For this reason, it is recommended to place pheromone traps for BMSB at least six feet away from your susceptible plants. Another option is to monitor by carefully observing your plants instead of using traps.

Recommended management measures for BMSB in the backyard include exclusion, physical removal, habitat modifications to support natural enemy populations, and chemical controls. When BMSB populations are particularly high on just a few susceptible plants, exclusion may be the best strategy. For vegetable crops, row covers are recommended. Be sure to remove row

FIGURE 5. BMSB aggregation.

covers when plants are in bloom to allow pollinators access to the flowers. To help protect bushes and trees, apply a sticky substance to the trunk to capture nymphs and some adults as they climb from the ground into the canopy, although some adults may fly directly to the canopy. Bagging fruit can protect apples and other susceptible crops.

Physical removal of BMSB is time consuming, but can be one of the most effective strategies when populations are relatively low on a few susceptible plants. BMSB can be removed by handpicking and placing them into a bucket of soapy water, or using a hand-held vacuum. Physical removal is especially effective when combined with a pheromone trap to draw most of the bugs into a small area. Planting wildflowers provides floral resources and hiding places for predators such as lacewings, minute pirate bugs, and lady beetles, which may keep BMSB populations lower, although this is not an effective management strategy on its own.

If populations escalate and a chemical spray is necessary, backyard gardeners must be sure the chemical they wish to use is registered for home application in Wisconsin for the plant they wish to apply it to.

Nuisance in homes

In the fall, BMSB often invade homes looking for a warm place to overwinter. This can be a nuisance at low densities, or a serious problem if numbers reach the thousands, which has been documented on the East Coast. Although they do not carry disease nor bite humans, BMSB can cause allergies and may emit an unpleasant odor, especially when disturbed.

As BMSB numbers increase in Wisconsin, homeowners in the state can keep their houses stinkbug free using the following guidelines:

- Install weatherstripping under and around doors.
- Put a screen over the top of the chimney and attic vents.
- Caulk or otherwise seal cracks around windows, crawlspaces, or other potential entry spaces.
- Do not crush BMSB because they will produce a strong, offensive smell that can linger for days.
- Knock small numbers of the bugs into a container of soapy water to kill them.
- Vacuum large numbers of bugs.

References

1. The *Midwest Fruit Pest Management Guide* is available through the Purdue Extension Education Store: **https://edustore.purdue.edu/item.asp?Item_Number=ID-465#.WO-QMVPyvUY**
2. The *Michigan Fruit Management Guide* is available through the MSU Extension Bookstore: **https://shop.msu.edu/product_p/bulletin-e0154.htm**

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