Ministry for Primary Industries
Manatū Ahu Matua

Treatments for Brown Marmorated Stink Bug

MPI Technical Advice

Prepared by Biosecurity & Environment

7 September 2015

Note: These treatments are proposed as part of the Vehicle Import Health Standard review, for the current measures see:
https://www.mpi.govt.nz/importing/other/vehicles-and-machinery/

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1 Purpose

The purpose of this document is to detail new information on the efficacy of treatments against brown marmorated stinkbug (BMSB), *Halyomorpha halys*, associated with vehicles imported into New Zealand from the USA.

2 Background

Adult BMSB are an insect pest of concern to New Zealand. In December 2014, MPI imposed emergency measures on vehicles from the USA to manage the pest as it was frequently being intercepted on the pathway and treated at the New Zealand border. The pre-export treatment rates were set using generic schedules and were as follows:

- Methyl bromide fumigation at 48 g/m^3 for 24 hrs at 10-15°C; or
- Methyl bromide fumigation at 40 g/m^3 for 24 hrs at 15-21°C; or
- Sulfuryl fluoride fumigation at 40 g/m^3 for 24 hrs at 16-20°C; or
- Sulfuryl fluoride fumigation at 32 g/m^3 for 24 hrs at 21-25°C; or
- Heat treatment at 60°C for 10 minutes for vehicles weighing <3,000kg and 60°C for 20 minutes for vehicles weighing >3,000kg in the coldest location.

New research information has been presented which shows that a reduction in fumigant gas concentrations, treatment times and reduced heat treatment temperatures are equivalent to the current requirements in their efficacy against BMSB. The new treatment schedules are:

- Methyl bromide fumigation at 48 g/m^3 for 24 hrs[1] at 10-15°C, 30% end point reading; or
- Methyl bromide fumigation at 16g/m^3 for 12 hrs at 15°C or above with a 50% end point reading; or
- Sulfuryl fluoride fumigation at 16 g/m^3 for 12 hrs at 10°C or greater with a 50% end point reading; or
- Heat treatment at 50°C for 20 minutes for vehicles weighing <3,000kg and 50°C for 30 minutes for vehicles weighing >3,000kg in the coldest location.

The new research and treatment schedules are assessed below.

3 Summary of review findings

3.1 SULFURYL FLUORIDE

New research by the USDA Agriculture Research Service (Walse 2015) found that adult BMSB fumigated in laboratory conditions with sulfuryl fluoride for two hours needed cumulative exposures of 248.6 and 535.3 milligrams per litre ($mgL^{-1}h$ [2]) respectively, were projected to cause 99 and 99.9968% mortality in the treated population (respectively LE_{99} and LE_{P9}). For fumigations lasting 12 hours, concentration x time (*Ct*) exposures of 89.8 and 142.8 $mgL^{-1}h$ were projected for LE_{99} and LE_{P9} respectively. Due to the high risk profile of BMSB LE_{P9} has been chosen.

Laboratory reared adult BMSB were used to generate exposure-mortality response data using Labonco chambers at 10°C with 56 separate fumigations carried out including three replicates

[1] Default to existing schedule as no new data.
[2] expressed as (*Ct*): concentration (*C*) × time (*t*)

to confirm mortality. The sulfuryl fluoride was analysed by a gas chromatograph. Fumigant exposures, expressed as concentration (*C*) × time (*t*) products (*Ct*), were calculated following Monro (1969). Mortality of non-exposed (i.e. untreated control) and fumigant-exposed (i.e. treated) specimens was assessed at 2 and 5-d intervals post-treatment and control mortality was included as a response in probit analysis of theoretical exposures (*Ct'*).

The 2 hour rate is not currently intended for use as it requires too much fumigant. Some treatment sites at ports of departure in the USA are required to meet emission targets on venting, these targets are best met using lower fumigation rates. Also, the trial showed that the exposures required for a particular mortality are ~1- to 4- fold lower for fumigations lasting 12-h relative to those lasting 2-h.

Sulfuryl fluoride is the preferred gas by vehicle manufacturers in the USA as methyl bromide is not widely available and some manufacturers have concerns over the effect of this gas on vehicle components. The sulfuryl fluoride *Ct* 142.8 $mgL^{-1}h$ rate over 12 hours equates to $12g/m^3$ constant over the 12 hours under laboratory conditions. When this information is coupled with the normal expectation of commercial fumigation processes, and a minimum final concentration reading of 50% of the starting concentration, the initial dose needs to be adjusted to allow for any gas loss or sorption. Using a straight line decline in concentration gives a starting dose of $16g/m^3$ and an end point reading of $8g/m^3$ to achieve the same *Ct* as the laboratory conditions.

3.2 METHYL BROMIDE

The USDA-ARS supplied MPI with results of research on the control of BMSB with 2 hour methyl bromide fumigations. This is currently being drafted for publication. The same protocol as described for sulfuryl fluoride (*above*) was used for the methyl bromide trials.

At 15.6° C and normal atmospheric pressure, probit analysis of the most methyl bromide-tolerant life stages (2nd & 3rd instar) suggested the following *Ct* exposures for 99% and Probit 9 mortalities, respectively: LE_{99} = 40.494 mg L^{-1} h , LE_{P9} = 90.033 mg L^{-1} h

Using the same logic as used for sulfuryl fluoride, the LE_{P9} *Ct* has been used and some 50 mg L^{-1} h has been added to the methyl bromide schedule to achieve a 140 *Ct* to allow for the often greater sorption/reactivity with methyl bromide on some items. This equates to $16g/m^3$ for 12 hours at 15°C+ with an end point reading of 50%.

3.3 HEAT TREATMENT

Most insects cannot survive exposure to extreme heat (>50°C) for even brief durations (Hammond 2015). High temperatures disrupt the function of proteins, metabolic enzymes and the respiratory and endocrine systems, all of which can lead to insect mortality (Neven 2000). According to Burkes *et al.* (2000) and Fields and White (2002), most stored-product insect pests (coleopterans and lepidopterans) are effectively controlled under the following time-temperature combinations: 24 hours at 40°C, 12 hours at 45°C, 5 minutes at 50°C, 1 minute at 55°C, and 30 seconds at 60°C.

Heat has been used as an option in New Zealand for treatment of live adult BMSB in goods at the rate of 60°C for 10 minutes. Researchers from Virginia Tech (Kuhar and Aigner in publication) recently achieved 100% mortality of adult BMSB exposed to 50°C for ≥15 min or to 45°C for ≥1 hr in the laboratory. Adult BMSB were placed in an incubator at different temperature intervals starting with 35°C through to 50°C and were exposed for time intervals of 15 minutes, 1 hour, and 4 hours. For bugs exposed for 15 min and 1 hour, mortality was assessed immediately after the exposure time, as well as 1 hour after, and 24 hours after exposure. Each time and temperature combination was replicated at least four times.

They also demonstrated that at the Port of Savannah (USA), using the current commercial facility and equipment for heat treating vehicles, the targeted heat treatment exposures for 15 minutes at 50°C resulted in 100% mortality of the BMSB adults placed in the coldest locations within a vehicle (Kuhar and Aigner in publication). Testing had identified three areas in the vehicle that are subject to the coldest temperatures during heat treatment. These areas are located in the engine compartment, under the driver or passenger seats, and interior areas that house the spare tire. The vehicle was then subjected to targeted heat treatments of 40°C, 50°C, and 60°C. Each temperature was replicated four times and held at the required temperature for 15 minutes.

These results showed that adult BMSB are killed after exposure for 15 minutes to 50°C or 1 hour or more exposure to 45°C. These lethal high temperature levels are consistent with many other insects (Hammond 2015).

While the schedule specifies using the coldest location in the vehicle for temperature monitoring, experience in New Zealand has proved this can be problematic for some items. A 33% margin has been added to the schedule time to cover the difficulty in locating a temperature probe in all places where BMSB may hide. The recommended schedule is 50°C for 20 minutes in the coldest location in the vehicle, for vehicles weighing less than 3,000 kilos. The most common import from the USA are new SUVs that weigh less than 3,000 kilos.

With vehicles and machinery larger than 3,000kg, experience in New Zealand has proved the larger mass to be more difficult to heat, and to locate every cold spot for temperature monitoring. A margin of 50% has been added to the schedule time due to the difficulty in locating a temperature probe in all places where BMSB may hide. The recommended schedule is 50°C for 30 minutes in the coldest location in a vehicle weighing more than 3,000 kilos. The most common imports from the USA in this category are new trucks, tractors and excavators.

4 Conclusion

The new treatment schedules provide an equivalent level of efficacy against BMSB as the current schedules in the IHS: *Vehicles, Machinery and Tyres*:

- Methyl bromide fumigation at 48 g/m^3 for 24 hrs[3] at 10-15°C, 30% end point reading; or
- Methyl bromide fumigation at 16g/m^3 for 12 hrs at 15°C or above with a 50% end point reading; or
- Sulfuryl fluoride fumigation at 16 g/m^3 for 12 hrs at 10°C or greater with a 50% end point reading; or
- Heat treatment at 50°C for 20 minutes for vehicles weighing <3,000kg and 50°C for 30 minutes for vehicles weighing >3,000kg in the coldest location.

These new schedules will align (apart from the >3,000kg which is absent) with the current requirements for the same cargo destined for Australia. These schedules may not control other

[3] Default to existing schedule as no new data.

pests on this pathway such as *Latrotectus spp*. (widow spiders). The new treatments will be included in the Approved Biosecurity Treatment Schedule in time for the implementation of the new IHS.

Reviewed by:

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