



Photo: John Obermeyer, Purdue Extension

Effects of ozone on the common bed bug (*Cimex lectularius*)

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Background

The feasibility of using gaseous ozone to manage insect pests has received increased attention in recent years. Research in this area has focused primarily on stored product pests (Kells et al. 2001, Sousa et al. 2008, McDonough et al. 2011). Given the resurgence of bed bugs in the U.S. and other countries over the last decade, the question of whether ozone could be used in bed bug integrated pest management programs has been raised. Research designed to address this question is currently underway in our laboratory. Data presented here show that adult male bed bugs are susceptible to ozone, depending on the concentration of ozone used and the length of time that insects are exposed. Two devices capable of delivering ozone to laboratory fumigation chambers were used for this study; one delivered a high ozone concentration with short exposure times, and a second utilized a low ozone concentration with long exposure times. The overall goals of this research are to 1) determine the time and ozone concentration needed to reach 100% mortality in all bed bug life stages, and 2) learn more about the mode of action of ozone in insects and strategies insects might use to survive ozone exposure.

Materials and Methods

High ozone concentration and short exposure time

- A bed bug strain collected in Indianapolis, IN in 2009 and maintained in the laboratory was used for all experiments.
- Ozone was delivered continuously in a flow through chamber held inside a laboratory fume hood at room temperature.
- Insects were scored as alive, knocked down, or dead at 0, 24, and 48 h after treatment.
- One ozone concentration and five exposure times were tested.

Low ozone concentration and long exposure time

- A bed bug strain collected in Indianapolis, IN in 2009 and reared in the laboratory was used for all experiments.
- Experiments were carried out in a bench top fumigation chamber at room temperature and 80% relative humidity.
- Each trial was conducted in the presence of either 1% or 2% hydrogen peroxide vapor.
- Insects were scored as alive, knocked down, or dead at 0, 24, and 48 h, and seven d after treatment.
- One ozone concentration and three exposure times were tested.

Conclusions

- Preliminary experiments showed that adult male bed bugs were susceptible to relatively short periods of ozone exposure when high concentrations of ozone were used. 100% mortality was achieved when bed bugs were exposed to 1800 ppm ozone for 150 min (Fig. 1).
- When a low concentration of ozone in the presence of 1% hydrogen peroxide was tested, 100% mortality was observed when insects were exposed to ozone for 48 h (Fig. 2).
- Bed bugs exposed for 48 h to 80 ppm ozone and 2% hydrogen peroxide did not result in 100% mortality (Fig. 3). Based on this, additional tests are being conducted with insects exposed to ozone for 72 h.
- Experiments are being carried out to measure mortality in bed bug immature life stages following ozone exposure.

Acknowledgements

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Results

Adult bed bug mortality

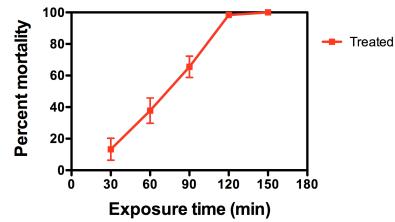


Figure 1. Results of a preliminary experiment showing adult male bed bug mortality 48 h after exposure to 1800 ppm ozone. Each data point represents three replicates with 30 insects per replicate.

Adult bed bug mortality

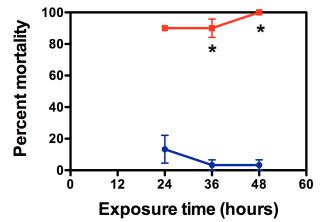


Figure 2. Mortality of adult male bed bugs seven d after exposure to 80 ppm ozone and 1% hydrogen peroxide. Each data point is an average of three replicates with ten insects per replicate. Asterisk indicates significant difference between treatment group and control ($P < 0.05$).

Adult bed bug mortality

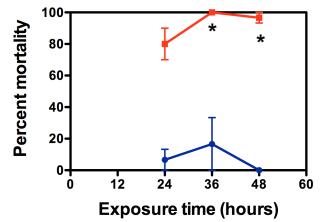


Figure 3. Mortality of adult male bed bugs seven d after exposure to 80 ppm ozone and 2% hydrogen peroxide. Each data point is an average of three replicates with ten insects per replicate. Asterisk indicates significant difference between treatment group and control ($P < 0.05$).

References

- Kells, S., Mason, L., Maier, D., Woloshuk, C. 2001. Efficacy and fumigation characteristics of ozone in stored maize. *Journal of Stored Products Research* 37(4): 371-382.
- McDonough, M., Mason, L., Woloshuk, C. 2011. Susceptibility of stored product insects to high concentrations of ozone at different concentration intervals. *Journal of Stored Products Research* 47(4): 306-310.
- Sousa, A., Faroni, L., Guedes, R., Totola, M., Urruchi, W. 2008. Ozone as a management alternative against phosphine-resistant insect pests of stored products. *Journal of Stored Products Research* 44(4): 379-385.