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Potential of dosimeter tubes for monitoring phosphine fumigations

Daniel Brabec*, James Campbell, Frank Arthur, William Morrison

United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, 1515 College Ave., Manhattan, KS 66502, USA.
*Corresponding author's email: Daniel.brabec@usda.gov

ABSTRACT

Monitoring fumigation events is important for validating that a fumigation is adequate for controlling stored product insects. A variety of gas monitoring instruments are available. Some methods provide hourly data of the fumigation. Dosimeter tubes provide a single measurement representing the total dosage for the entire fumigation event. Dosimeter tubes are relatively inexpensive and easy to use. The total dosage is given as units of the measurement in ppm×h and represents the phosphine concentration × time. Two models of commercially available dosimeter tubes were evaluated (high range and low range). The high-range model, LPG-1, had a maximum range of 200,000 ppm×h. The low range model, LPG-2, had a maximum range of 20,000 ppm×h.

The dosimeter tube measurements were compared to a system that collected hourly phosphine concentration data using Wi-Fi sensors. The basic experimental factors included holding times of 24, 48, 96 h, and phosphine concentrations of 0, ~100, ~200, ~700, ~1400 ppm, and three replicates. The trials were conducted in sealed barrels. Wi-Fi phosphine sensors were placed in each barrel along with the dosimeter tubes to monitor the concentrations with time. Bioassays were included in all testing and contained adult lesser grain borer, *Rhizopertha dominica* (Fab.) and adult red flour beetle, *Tribolium castaneum* (Herbst). The bioassays of each species included two strains: one phosphine susceptible strain and one phosphine resistant strain.

Results of the experiment showed some of the limits of the dosimeters. The scale of the dosimeter tube was non-linear with wider spacing in the first decade of the scale. For the high range tube, they were more readable to 100,000 ppm×h. Also, model LPG-1, provided comparable C×T values for events less than 70,000 ppm×h. The LPG-1 dosimeter measurements were with ± 25% of the Wi-Fi system data. However, the low-range dosimeter tubes, LPG-2, tended to overestimate the C×T values by 50 to 100% for fumigation events less than 20,000 ppm×h. The insect bioassays provided some reference for level of control. The phosphine susceptible insects were controlled at C×T dosages of ~5000 ppm×h. But the phosphine resistance insects had varied control of 60 to100% at C×T levels of ~20,000 ppm×h.

Keywords: Concentration × time, Wi-Fi sensors, Insect resistance