

Title Time matters: delayed toxicity of pirimiphos-methyl on *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) and its effects on efficacy estimation of residual treatments

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Abstract

Three time-related toxicity parameters of pirimiphos-methyl were compared using a common pest of stored cereal and grain products, *Tribolium castaneum* (Herbst). The effective exposure time sufficient to knock-down half of the beetles was much shorter than the median knock-down time from a continuous exposure test (8.6 min and 80 min, respectively, at the same insecticide concentration). The difference between these two measures can be attributed to delayed toxicity of pirimiphos-methyl. Pirimiphos-methyl was effective against *T. castaneum* at a low application rate of $0.0047 \text{ g a.i. m}^{-2}$, when beetles were exposed on the treated surface for short time intervals. The median post-exposure knock-down time for animals placed for 20 min on insecticide-treated surface and then kept on an untreated surface was 180 min. Our results suggest that actual effective exposure time might be a more realistic efficacy measure of pirimiphos-methyl at a given dose than LT50 (median lethal time for continuous exposure), and that the timing of the toxic effects should be included more often in residual toxicity testing.