Fumigation toxicity of phosphine against sawtoothed grain beetle, *Oryzaephilus surinamensis*

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Storage insect pest sawtoothed grain beetle, *Oryzaephilus surinamensis*, is one of the important secondary pests encountered in grains and packaged commodities. It is emerging as one of the important storage pests due to the development of resistance against phosphine fumigants in many countries. Several studies were carried out to ascertain the susceptibility of this pest to phosphine fumigation from India. Dose–response probit assays conducted against larval (second and fourth instar) and adult stages of *O. surinamensis* revealed significant dose-dependent and time-dependent variations in these stages. The adults were relatively less susceptible to phosphine (LC_{50} = 36.84 ppm) than the larval stages (LC_{50} = 13.12, 18.68 ppm respectively, for second and fourth instar at 72 h exposure). Comparative toxicity of phosphine at 24, 48 and 72 h exposures revealed that extended exposures led to linear decrease in lethal concentrations irrespective of life stage of the pest. The discriminating dose bioassay at 0.04–0.2 mg l^{-1} phosphine with 20 h exposure revealed weak resistance to phosphine in this population. The present study confirmed the tolerance of *O. surinamensis* to phosphine as comparable with that reported from other countries. Large-scale sampling of field populations of *O. surinamensis* from different geographical regions will update the current levels of resistance in field populations of *O. surinamensis* from India.

Keywords: Bioassay, fumigation, *Oryzaephilus surinamensis*, phosphine, toxicity.

raisin, dates and almonds[2,3] and packaged food products[4]. Large-scale availability of milled grains in bags for retail consumers has led to the proliferation of this pest in recent times probably due to ineffective fumigation along the supply chain nodes[5].

Phosphine is considered a safe and eco-friendly fumigant for managing storage insect pests infesting a wide range of commodities, viz. cereals, pulses, oilseeds, spices and other processed foods[5]. Phasing out of methyl bromide has resulted in over-reliance on phosphine for storage pest management. Moreover, phosphine is more popular because of its efficacy, low cost, low residue and fast dispersion[6,7]. However, factors like improper air tightness of the storage structures during fumigation, substandard gas-proof sheets, sand snakes, high frequency of application, shorter exposure period and improper gas concentration have resulted in the development of resistance against this fumigant in several storage insect pests around the world[8–13]. In India, phosphine resistance has been widely recorded in major storage insect pests in the past two decades[8–10].

Development of phosphine resistance has been noticed in populations of *O. surinamensis* from several countries. During the early 1990s, a low level of phosphine resistance was recorded in the *O. surinamensis* population collected from New South Wales, Australia[14]. Similarly, populations from Brazil also showed a low level of resistance[15]. Records of phosphine in *O. surinamensis* resistance have also been reported in Asian countries like India[16], Thailand[17] and in Greece (Europe)[18], and more recently in Cali-