Studies on effectiveness of certain methyl bromide alternatives against some stored products insects in qastight bins

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This study was conducted at the laboratory of stored products pests of the Plant Protection Department, Faculty of Agriculture at Moshtohor, Tukh, Qualyubia, Zagazig University and supported by the National project of integrated pest management for post-harvest pests financed by EEC-counterpart funds, Ministry of Agriculture and land Reclamation, Egypt.The objective of this study was to investigate the effectiveness of certain methyl bromide alternatives i. e. controlled atmospheres (CA) of various carbon dioxide concentrations; CA of very high nitrogen content, phosphine gas produced' from metal phosphide (aluminium or magnesium) and combinations of phosphine and carbon dioxide against some stored product-insects inside gastight bins.Insects tested were the adults and immature stages of the rice weevil Sitophilus oryzae (L.); lesser grain borer Rhizopertha dominica (F.) and the red flour beetle Tribolium castaneum (Herbst.) as well as active and diapausing larvae of Khapra beetle Trogoderina granarium Everts.The chosen treatments as methyl bromide alternatives were tested inside gastight steel bins each of 0.5 m3 volume and was filled with ca. 450 kg wheat grains.The bins were designed and constructed by the airplane Factory at Hawaii and were situated on the roof of the building of the Plant Protection Department of the Faculty of Agriculture at Moshtohor, Tukh- Qualyubia- Egypt.The obtained results could be summarized as follows:- 1-Efficacy of controlled atmospheres (CA) of certain carbon dioxide concentrations a Yainst the tested insect species at various gain temperatures:-The results of the efficacy of controlled atmospheres containing around 30, 60 and 80 % CO2 at grain temperatures of 15 ± 2°C and 26 ± 2°C against the adults and immature stages of S. oryzae, R. dominica and T. castaneum as well as the active and diapausing larvae of T. granarium showed that insect mortalities were concentration and exposure period-dependent. Mortality Values increased with the rise of concentration, in the CA and period of exposure. The efficacy of the tested CA of CO2 against the various insects was also, greater at higher grain temperature than at lower one.In general, the pupae of the various insects were highly tolerant to the CA of CO2 than the other insect stages. Meanwhile, the diapause larvae of 7'. granarium were less susceptible to the CA of CO2 than active one. The susceptibility of the .tested insects to the CA of CO2 varied according to insect species and stage of development. For example, the lethal time required to achieve 99% kill for the tested stages of various insect species when exposed to CA of 60 ± 5% CO2 at grain temperature of 26 ± 2°C were 7.6; 26.7; 12.9 and 30.7 days for the adults, eggs, larvae and pupae of S. oryzae, respectively. The corresponding values for R. dominica were 9.1; 17.5; 15.5 and 27.1 days for the adults, eggs, larvae and pupae, respectively. In case of T. castaneum, these values were 5.6; 8.7; 13.0 and 27.2 days for their different stages, respectively. As for T. granarium,the time needed for 99 % mortality at the above mentioned temperature and CA of CO2 was 47.7 and 48.4 days for the active and diapause larvae, respectively.2-Efficacy of CA of 99% N2 against the tested insect species at various train temperatures:-The results of the efficacy of CA of 99 % N2 at grain temperatures of 15 ± 2°C and 26 ± 2°C against the adults and immature stages of S. oryzae, R. dominica and T. castaneum as well as the active and diapausing larvae of T. granarium indicated that the efficacy of the CA of 99 % N2 was temperature and exposure period-dependent. Insect

mortality increased with the increase of the period of exposure and it was also, greater at the higher grain temperature than at lower one.• Susceptibility of the insects to the CA of 99 % N2 varied according to insect species and stage of development. For example, the lethal times required to achieve 99 % mortality for the different stages of insect species at 26 ± 2°C were 10.6; 13.1; 38.5 and 46.7 days for the adults, eggs, larvae and pupae of S. oryzae, respectively. The corresponding figures for R. dominica were 30.1; 37.2; 29.8 and 126 days for the adults, eggs, larvae and pupae, respectively. For T. castaneum, these values were 23.2; 18.3; 18.3 and 24.3 days for the adults, eggs, larvae and pupae, respectively. As for the active and diapause larvae of T. granarium, these values were 21.3 and 27.8 days, respectively.These results revealed that the pupae of the various tested insects were more tolerant to the CA of 99 % N2 than the other stages. Also the diapause larvae of T. granarium were less susceptible.to the CA of 99 % N2 than active one.developmcit. i r the time required to achieve 99°A) killfor die vai ions ;Itir,es of lin' insects were •1: •1 •1 mid 9 I days for the adults, eggs, larvae and pupae of S. orTztre, respectively. The corresponding values for R. dominica were 3.2; 3:0; 3.() and 8.1 clays for the adults, eggs, larvae and pupae, respectively. For T. castancum, these values were 2.6; 4.3; 5.8 and 5.7 day's for the adults, eggs, larvae and pupae, respectively. As for T. granarium, these figures were 5.1 and 9.2 days for the active and diapause larvae, respectively.These data showed clearly that the pupae of S. oryzue and R. dominica were highly tolerant to phosphine at 26 ± 2°C than their other stages. While in case of T. castaneum pupae and larvae were less susceptible to phosphine than the adult and egg stages. Also, the diapause larvae of T. granarium were highly tolerant to phosphine than active one. 4-Efficacy and combined action of phosphine with carbon dioxide against the tested insect species at various grain temperatures:-The results of the efficacy and combined action of phosphine (100 and 200 ppm) with various CO2-concentrations (30; 60 and 80 %) at a wide range of grain temperatures (14 —32°C) against the various stages of S. oryzae, R. dominica and T. castaneurn as well as the active and diapausing larvae of T.granarium showed clearly that the efficacy of phosphine alone increased with rising the grain temperature and the period of exposure. Also phosphine was more effective at higher concentration (200 ppm) than at lower one (100 ppm). Meanwhile, insect mortalities resulted from the combinations of phosphine and carbon dioxide were generally greater than those obtained from each gas alone and were also exposure period-dependent.Co-toxicity values resulted from the mixtures of phosphine plus carbon dioxide showed in most cases additive and/or potentiation effects with the various insects at various exposure periods with the exception of the larvae of T. granariuni, whereas the mixture of 200 ppm phosphine plus 80 ± 5% CO2 had shown an antagoniStic effect at short exposure periods of I and 2 days..Thus, combinations of phosphine and carbon dioxide could be used as an effective alternative to replace methyl bromide grain fumigation against stored product insects in airtight bins. This method has the advantages of enhancing the efficacy of each gas alone and reducing the exposure period required for complete kill especially for the most tolerant insect stages such as pupae and larvae found inside grain and the diapause larvae of T. granarium.