Studies on development of resistance to phosphine and carbon dioxide in some stored products pests

Zaghloul Abd El-Fattah Ibrahim Halawa

The main objective of the present work was to study the development of resistance in two mite species infesting stored products, namely, the grain and flour mites Aleuroglyphus ovatus, Troupeau and Tyrophagus putrescentiae (Schrank), to phosphine, carbon dioxide and their mixtures, in comparison with one of the pulse insects, namely Callosobruchus maculatus (Fab.).Also some biological characteristics of the obtained resistant strains of C. maculatus were investigated in the laboratory.This study was performed at the Plant Protection Department, Faculty of Agriculture at Moshtohor, Zagazig University .The obtained results are summerarized under the following topics1. Development of resistance in the two mite species (A . ovatus and T. putrescentiae) to phosphine:-Adult populations of the two mite species A. ovatus and T putrescentiae were exposed in the laboratory for 17 generations to a fixed concentration of phosphine (200 vpm) at 26+1 °C, 85 5% RH at varying exposure periods in order to select strains resistant to PH3.Selection pressure was carried out at the median lethal dose (L.C.T50) inducing mortalities between 50-70%. The susceptibility of the achieved strains was compared with the parent strain. Results showed that the lethal times needed for a certain mortality were somewhat longer in the 17th generation of A. ovatus and T. putrescentiae, than of the parent strains.At the 17th comparison of sensitivity betweenselected strains and the parent strains indicated a very low resistance factors at LT50 levels of x 1.2 and x 1.3 for A. ovatus and T. putrescentiae, respectively. This result revealed that the two mite species are capable to develop low resistance to phosphine.2. Development of resistance in the two mite species (A. ovatus and T. putrescentiae) to carbon dioxide:-Adult populations of the two mite species A. ovatus and T. putrescentiae were exposed in the laboratory for 17th generations to an atmosphere containing 46% carbon dioxide at 26+1 °C and 85+5% RH at varying exposure periods in order to selected strains resistant to CO2.Selection pressure was carried out at the median lethal time (LT50) inducing 50-70% mortalities.Results showed a fluctuation in the tolerance for the various generations of the two mite species.At the 17th generation, comparison of the susceptibility between selected strains and the laboratory strains showed a very low tolerance factor at LT50 of x 1.3 fold for T. putrescentiae.No significant difference in the sensitivity of the 1 7th generation of A. ovatus and the parent was observed.This result indicated that T. putrescentiae is capable to develop low resistance to an atmosphere containing CO2.3.Development of resistance in the two mite species (A. ovatus and T. putrescentlae) to a combination of phosphine + carbon dioxide :Adult populations of the two mite species A. ovatus and T. putrescentiae, were exposed in the laboratory for 17th generations to a combination of 100 vpm PH3 + 23% CO2 at 26±1°C 85+5% RH. at varying exposure periods in order to select strains resistant to a combination of PH3 + CO2. Selection pressure was carried out at the median lethal time (LT50), inducing mortalities between 50-70%. The susceptibility of the obtained strains was compared with the parent strains.Data showed that the lethal time values needed to achieve certain kill were obviously higher in the 17th generation of the two mite species than of the laboratory strains (Parents).The tolerance ratios in the 17th generation of A. ovatus and T. putrescentiae, fluctuated from generation to another when compared at the LT50 and LT90-levels with the parent strains. The 17th. generations indicated a

low resistance factor of X 1.4 and 1.8 fold at LT50-level for A. ovatus and T. putrescentiae, respectively. The obtained result indicated that A. ovatus and T putrescennae have the ability to develop low resistance to a mixture of P1-13 + CO2. 4.Development of resistance to phosphine, carbon dioxide and a mixture of phosphine + carbon dioxide in C maculatus: 4.1. Phosphine:Adult populations of C. maculatus were exposed in the laboratory for 9th generations to a fixed concentration ofphosphine (40 vpm) at 26+1°C and 60+5% RH at varying exposure times, in order to select strain resistant to PH3.Selection pressure was carried out at the medium lethal dose L.C.T50 inducing mortalities between 50-70%.Results showed that the lethal times needed to obtain a given mortality for C. maculatus were significantly higher in the 9th generation, than of the laboratory strain.At the 9th generation, comparison of the susceptibility between selected strain and the parent strain showed resistance factor at LT50 of 2-fold. This result revealed that C. maculatus is capable to develop resistance to phosphine.4.2 Carbon dioxide : Adult populations of C. maculatus were exposed in the laboratory for 9th generations to a controlled atmosphere containing 23% CO2 at 26±1°C and 60+5% RH at varying exposure periods in order to select strain resistant to CO2. Selection pressure was carried out at the median lethal time (LT50) inducing mortalities ranged from 50-70%. The susceptbility of the obtained strains was compared with the parent strain.Results showed that the lethal times achieved for a certain kill were longer in the 9th generation of C. macu?atus than of the parent strain. At the 9th generation, the selected strain indicated a resistance factor of 2.2 times, when compared at the LT50-level with the parent strain. This result revealed that C. maculatus is capable to develop resistance to an atmosphere containing 23% CO2. 4.3. PH3+CO2:Adult populations of C. maculatus were exposed in the laboratory for 9th generations to a combination of 40 vpm PH3 + 23% CO2 at 26±1°C and 60+5% RH at varying exposure periods in order to select strains resistant to combination of PH3 + CO2. Selection pressure was carried out at the median lethal time (LT50) inducing mortalities varied between 50-70%. The susceptibility of the obtained strains was compared with the parent strain.Results obtained showed that the lethal times needed for a certain mortality were somewhat longer in the 9th generation of C. maculatus than of the laboratory strain. At the 9th generation, comparison of sensitivity between selected strains and the parent of C. maculatus, showed a low resistance factor of X 1.5 at LT50 levelThis result indicated also that C. maculatus is capable to develop resistant to a combination of PH3 + CO2.5- Comparison of Capability of the two mite species in developing resistance to the forementioned gases with that of the cowpea beetle C maculatus:Data indicated that tolerance ratio (TR) in the 17th generation of A. ovatus was 1.2, 1.1 and 1.4 for PH3-TS, CO2-TS and PH3 + CO2-TS, respectively. In case of T. putrescentiae, it was 1.3, 1.3 and 1.8 for PH3-TS, CO2-TS and PH3 + CO2-TS, respectively.At the 9th generation in case of C. maculatus the values were 2.0, 2.2 and 1.5 for PH3-TS, CO2-TS and PH3 + CO2-TS, respectively.This results indicated that the capability of C. maculatus in development of resistance to phosphine, carbon dioxide and their mixtures was greater than of the two mite species A. ovatus and T. putrescentiae.6. Biological characteristics of the selected strains of C maculatus :Some biological parameters of the 9th generations (F9) of C. maculatus selected with the median lethal dose of phosphine and the median lethal time of carbon dioxide and their mixtures were studied in the laboratory at 30±1°C and 75+5% RH, in comparison to that of the parental stock (laboratory strain).Data showed that there were no significant differences between the laboratory strain and the three selected strains (PH3-TS, CO2-TS and PH3 + CO2-TS) of C. maculatus in average pre oviposition period, average developmental period, longevity of female, longevity of male and sex ratio.But, a significant difference was found in the oviposition period of the various selected strains. The oviposition period of the laboratory strain was significantly longer than of the CO2-TS, PH3 + CO2-TS and PH3-TS. Meanwhile, it was somewhat similar to that of CO2-TS. On the other hand, the average hatching rate of the laboratory strain was declined for PH3 + CO2-TS, PH3-TS and CO2-TS, respectively. It was also noticed that the emergence rate (%) of adults for the laboratory strain was obviously higher than of the PH3-TS and PH3 + CO2-TS. During the observation period of ten days, the average total number of eggs laid per-female for the laboratory strain was significantly higher than of the phosphine resistant strain and the strain tolerant to a combination of phosphine + carbon dioxide. But this value was similar to the laboratory strain in case of carbon

dioxide tolerant strain.