MECHANISM OF CERTAIN ENZYMATIC DEFENCE SYSTEMS IN RESISTANCE OF PEACH FRUIT TO INSECTICIDES

By

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B. Sc. Agric. Sc. (Pesticides), Ain Shams University, 1997
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ABSTRACT

Hassan Ismail Shehab: Mechanism of Certain Enzymatic Defence Systems in Resistance of Peach Fruit to Insecticides. Unpublished Ph.D. Thesis, Department of Plant Protection, Faculty of Agriculture, Ain Shams University, 2011.

Peach fruit flies, Bactrocera zonata (Saunders), were treated as a residual contact of four insecticides, of which two organophosphates (fenitrothion and malathion), one carbamate (methomyl), and one pyrethroid (fenvalerate), under laboratory conditions. Subparental lines of each generation treated with the same insecticide were selected for 10 generations and were designated as x-r lines (x, insecticide; r, resistant). The parent colony was maintained, under the same conditions, as the susceptible colony. The line treated with fenvalerate exhibited the lowest increase in resistance (9.38-fold), whereas the line treated with malathion showed the highest increase in resistance (up to 78-fold) compared with the susceptible colony.

Three field populations of the insect, under experimentation, were collected from Behira, Gharbia, and Giza governorates of Egypt, and tested for their adult susceptibility to the for mentioned insecticides by residual contact. Marked regional variations to insecticide susceptibility were observed. The highest level of resistance was recorded in malathion and methomyl populations, while the lowest was observed with the pyrethroid fenvalerate. However, resistance to fenitrothion ranked in between. Behira strain which exhibited high level of resistance followed by Gharbia, while Giza strain came last. These results indicate the rotational use of these insecticides should result in continued satisfactory control against field populations of this serious insect pest.

Biochemical analysis indicated that elevated glutathione S-transferases (GSTs), superoxide dismutase (SOD), and catalase (CAT) activity, to gather with depletion of glutathione (GSH) level conferred resistance to both malathion and methomyl, but partially to fenitrothion.

The laboratory resistance to the insecticide tested together with the undertaken may provide useful tools and/or information for forthcoming insecticide management strategy to control such fruit fly in the field.

Keywords: Peach fruit fly; *Bactrocera zonata*; insecticides resistance; insecticides; Biochemical analysis; Superoxide dismutase; Catalase; Glutathione S-transferase.

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INTRODUCTION

The family Tephritidae, includes flies usually known as fruit flies, is one of the dipteran families with the largest number of species. As of July 2000, 4352 species (grouped into 481 genera) were recognized worldwide, many of which are important as agricultural pests.

It is a polyphagous species attacking some 40 species of fruits and vegetables (**White and Elson-Harris, 1992**) and has also been recorded from wild host plants of the families Euphorbiaceae, Lecythidaceae and Rhamnaceae (**Syed *et al*., 1970; Kapoor and Agarwal, 1983**).

Fruit flies (Diptera: Tephritidae) are important pests of fruits, vegetables and ornamental plants. The peach fruit fly, *Bactrocera zonata* (Saunders) is one of the most harmful species of Tephritidae. It causes large amounts of damage in Asia (**Butani, 1976; Agarwal *et al*., 1999).**

Bactrocera zonata is native to India where it was first recorded in Bengal (**Kapoor, 1993**). It is present in many countries of tropical Asia: India, Indonesia (Sumatra, Moluccas), Laos, Sri Lanka, Vietnam, Thailand (**White and Elson-Harris, 1992**), Burma, Nepal, Bangladesh, and probably all of south-east Asia (**Kapoor, 1993**). The species has been captured in traps in California (**Carey and Dowell, 1989**).

It has spread to other parts of the world, in particular to several countries in the Near East and to Egypt. In recent years, *B. zonata* has become a widespread pest in Egypt, in addition it has been intercepted in Israel. *B. zonata* is consider a threat to countries in the Near East and North Africa, while a lesser extent to Southern Europe_**(El-Minshawy *et al*., 1999).**

Bactrocera zonata is causing crop losses of 25 to 100 percent in peach, apricot, guava and figs. In recent years, it has increased its host range, especially on fruit **(Butani, 1976; Butani and Verma, 1977)**.

Insecticide resistance is a major problem in the control of insects; Insect has developed resistance to nearly all insecticide used against it.

Multiple mechanisms seem to be involved in the development of insecticide resistance. Resistance may result from behavioral adaptations, alternation of the target site, increased metabolic detoxification, increased excretion of the parent compound, and/or reduced cuticular penetration (**Oppenoorth, 1985**).

The evolution of insecticide resistance in insects tends to be rapid because selection is strong, populations are large and generation period is short. With the threat of insecticide resistance looming larger, it is absolutely necessary to investigate the factors responsible of this critical phenomenon (**Hemingway *et al*., 1993**).

Pesticides beside leading to hyperexcitability of the nervous system, and cause various side effects, e.g. change DNA structure (**Griffin and Hill, 1978**), may also generate reactive oxygen species (**Bagchi *et al*., 1995**). Pesticides and other xenobiotics may increase the level of free radicals **(Freeman and Crapo, 1982**) and influence (mobilise) an antioxidant defence system (**Zikic *et al.*, 1996**) in tissues and cells. Animals have evolved antioxidant defense systems, with both enzymatic and nonenzymatic components, to protect from the serious damaging effects of reactive oxygen species (ROS) on cellular macromolecules. Three levels of protection have been considered; (1) prevention of ROS formation, (2) termination of free radical chain reactions using radical scavengers or antioxidants and/or (3) repair of cellular components after damage has occurred (**Jacobson *et al*., 1989; Storz *et al*., 1989**).

Specific enzymes directly detoxify ROS; superoxide dismutase (SOD) catabolizes $O_2^{\cdot -}$ whereas catalase (CAT) degrades H_2O_2 (at high and low concentrations of H2O2, respectively). (**Jacobson *et al*., 1989; Storz *et al*., 1989**). Antioxidants can soothe neurotoxic effects of insecticides (**Bagchi *et al*., 1993 & 1996, Minakata *et al.*, 1996**).

The aim of the present study is to investigate the present toxicological status of the Egyptian field populations (Behira, Gharbia, and Giza governorates) and their susceptibility towards insecticides of different compounds groups (organophosphates, pyrethroids and carbamates). Also throw more light on certain responsible biochemical factors on their susceptibility and/or resistance towards the tested insecticide groups.

Accordingly; the activities of superoxide dismutase (SOD), and catalase (CAT), together with the activity of glutathione S-transferase (GST), and the level of glutathione reduced (GSH), were all investigated.