BIOLOGICAL EFFECTS OF SOME NATURAL AND CHEMICAL COMPOUNDS ON THE POTATO TUBER MOTH, *PHTHORIMAEA OPERCULELLA* (ZELLER)

Thesis

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Dedicated to

My parents and My Husband

بسم الله الرحمن الرحيم

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INTRODUCTION

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The potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) is an ubiquitous pest in the subtropical and tropical zones. It is widely spread in Egypt specially in northern areas of lower Egypt. It attacks several cultivated solanaceous plants including potato (*Solanum tuberosum*), tobacco (*Nicotiana tabacum*), egg plant (*Solanum melonguene*), tomato (*Lycopersicom esculentum*), and bell pepper (*Capasicum annuum*). It has also been reported on several wild plant hosts of the following genera; *Solanum, Datura, Nicotiana, Fabina, Hyoscyamus, Physalodes, Lycium* and *Nicandra* (Cunninghan, 1969).

The preferred hosts, however, are potato and tobacco plants (Balachowsky and Real, 1966); but potato is considered the main host to this insect in different parts of the world (Haines, 1977). It causes serious damage to potato crops in both field and storage. Because of its economic importance many workers in different parts of the world have studied its biology and control. It has eight generations per year in Egypt, and its life cycle ranges from 18 to 21 days (El- Sherif, 1966). Damaged potato plants are characterized by brown blistered areas in the leaflets, resulting in the death of some plant parts. Moreover, tunnels constructed in the potato tubers facilitate the growth of fungal and bacterial diseases (Salama et al., 1972). Therefore, several control measures have been developed for its control.

In recent years there has been a great deal of research aimed at finding techniques for the control of insects which would ease our long - standing dependence on the use of insecticides. As a result, we find many publications dealing with the detection, extraction and characterization of materials(mostly from plants) which elicit behavioural responses of insects (Byrne, 1969). Many different chemicals are involved as antifeedants, some of them are of plant origin, a few have a general effect, preventing feeding by all insects which have been so far tested, but the majority are effective only against some species (Chapman, 1974).

In the continous search for new pest control agents, plants are considered one of the most rich sources (Abdallah et al., 1986); natural pyrethrins and synthetic pyrethroides are famous and good examples. Active substances extracted from plants may not only act as toxicants, but also as insect growth regulators (Bowers et al., 1972); as repellent or synergists (Su and Harvort, 1981) or as phagodeterrents (Meisner et al., 1982). Some plant oils are also effective as control agents (Schoonhoven, 1978; Mariappan and Sexena, 1984; and Sharaby , 1988).

Several attempts have been made to monitor the insecticidal activity and other insectistatic effects in extracts of different plant species against various insects (El-kabbany, 1980 ; Ahmed, 1983; and Barakat et al., 1985). The undesirability and potential dangers of applying large and uncontrolled quantities of insecticides to potato tubers destined for human consumption must be recognized.

Aim of Work :

The present study aims at identifying and testing potential components for use in integrated potato tuber moth control programmes; and later on putting these together in appropriate combinations that can minimize or even exclude the use of toxic insecticides. It covers the following points:

1) Description and distribution of the chemoreceptors on the different parts of the moth including antenna, proboscis, tarsus, female ovipositor, and male copulatory organs, by using optical and scanning electron microscopy.

2) Behaviour of the potato tuber moth towards some natural and commercial chemical substances.

3) Biological effects of certain natural and chemical substances on the different stages of the insect and their role in protecting potato tubers in storage.

II. REVIEW OF LITERATURE

1. Moth chemoreceptors :

Insects are equipped with sensory receptors enabling them to perceive different stimuli. The receptors involved include varying properties; visual, mechanical, gustatory, and olfactory characteristics (Staedler, 1978). In general terms, the chemoreceptive activities of insects may be divided into three chemical senses:- distance chemoreceptors or olfaction, contact chemoreceptor or gustation and those of general or common chemical sensitivity (Romoser, 1973).

1.1. Olfactory chemoreceptors :

The antennae are generally considered to be the main organs of smell in insects (Dethier, 1963) and they would be expected to be involved in responses to olfactory repellents.

Basic studies on the antennal chemoreceptors were carried out by using light microscope. For example, Salama (1968) and Salama et al. (1984) found that the antennae of *Spodoptera littoralis* (Boisd) moth represent the seat of olfaction where short basiconic, large styloconic and trichoid sensilla as well as olfactory pits are distributed.

Sharaby et al. (1978) described the olfactory receptors on the antennal segments of *Heliothis armigera* (Hübner) moth.

Sharaby et al. (1980) made a survey for the chemo-sensilla located on the antennae of the moths, *Pectinophora gossypiella* (Saund), *Earias insulana* (Boisd) and *Agrotis ipsilon* (Hübn.).

Behavioural studies of tested species revealed that the seat of olfaction lies on the antennae. Types and distribution of antennal receptors of lepidopterous moths were examined by scanning electron microscopy and described by Callahan (1969) *Heliothis zea* (Boddie); Jefferson et al. (1970); *Trichoplusia ni* (Hübner). *Heliothis zea*, and *Prodenia ornithogalli* (Guenée); Flower and Helson (1971) *Heliothis armigera*; Cornford et al. (1973) *Ostrinia nubilalis* (Hübn.); Flower and Helson (1974) eight species of noctuid moths:- *Agrotis ipsilon*, *Graphania morosa* (Bütler), *G. mutans* (Walker), *G. ustistriga* (Walker), *Leucania unica* (Walker), *Persectania atristriga* (Walker), *P. aversa* (Walker), and *Pseudaletia separata* (Walker); Ono (1978) *Phthorimaea operculella* (Zell.); Grula and Tylor (1980) *Colias eurytheme* (Boisd.) and *C. philodice* (Boisd.); Van der pers et al. (1980), *Yponomeuta spp.*; Mayer et al. (1981) *Trichoplusia ni*; Guperus (1983) *Yponomeuta vigintipunctatus* (Ketzius); Salama et al. (1987) *Heliothis armigera* and El- Sayed (1990) *Plodia interpunctella* (Hübn).

Ono (1978) reported that three kinds of sensory hairs are present on the antennae of the potato tuber moth:- Sensilla trichodea occur all over the antennae, though more receptors are found on the male than on the female antenna; while sensilla chaetica and sensilla coeloconica are located on the ventro- lateral side of each segment.

1.2- Contact chemoreceptors:

Salama (1968) made a survey on the chemoreceptors located on the proboscis and tarsus of *Spodoptera littoralis* by using optical microscope.

Goldwarde and Barnes (1973) described gustatory sensillae on the proboscis of *Laspeyresia pomonella* (L.) by using scanning electron microscope. These were sensilla stylocenica, chaetica and basiconica; in addition, the food canal itself possesses a few sensilla .

Sharaby et al. (1980) described the sensilla on the proboscis of three lepidopterous insects namely, *Pectinophora gossypiella*, *Agrotis ipsilon*, and *Earias insulana*. Behavioural studies of the tested species confirmed that gustation is restricted to proboscis and moths tarsi.

Kristensen and Nielsen (1981) studied the configuration and distribution of the sensilla on the double-tube proboscis of the neopseustid moths.

Salama et al. (1987) described the distribution of the proboscis and tarsi chemoreceptor sensilla of *Heliothis armigera*. They mentioned the presence of a rasp- like structure over the length of the proboscis.