SENSORY MANIPULATION : AN OPENING DOOR TO FUTURE ECONOMIC MANAGEMENT OF HELIOTHIS

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1. INTRODUCTION

A very serious situation faces growers due to increasing insecticide resistance, the fall-off in development of new chemicals and the rising costs of insecticides from overseas. This is fueling a renewed interest in the basic biology of Heliothis and other pests. The ecological factors controlling the distribution and abundance of the pest and its natural control agents and the behavioural factors influencing feeding, mating and egg-laying are clearly fertile areas for the origination of new, non-insecticidal strategies. However, an important limiting factor in most ecological and behavioural studies is the lack of information on the sensory biology of Heliothis and its control agents. More information on sensory systems would help a broad spectrum of other research and development projects including plant resistance and bio-control studies. This short paper supplements a recent essay on the subject (Rice, M.J. 1986. Semiochemicals and sensory manipulation strategies for behavioural management of Heliothis spp Ochsenheimer (Lepidoptera: Noctuidae). In P.H. Twine and M.P. Zalucki (Editors), Proceedings of the Second Australian

Heliothis Ecology Workshop. D.P.I., Brisbane. Pp 27-45).

2. FOUNDATIONS OF BASIC SENSORY BIOLOGY

The environment has an infinite range of gradations of potential sensory information. Heliothis has a limited sensory capacity. The insect is the product of the operation of natural selection on a narrow range of specialised information recognition systems. Tactile, auditory, olfactory, gustatory, visual and thermal sensory modalites are differentialy developed. Little is yet known and the receptors concerned are in need of much research, to establish the sorts of information that the Heliothis behaviour programmes depend upon. With such data to hand we will be well on our way to introducing several new sensory manipulation strategies.

The successfull application of sensory biology to the management of Heliothis in the field is not only impeded by the paucity of information an sensory receptors per se but also by our out dated understanding of the nature of sensory "reactions". More cognisance needs to be taken of the central nervous system mechanisms that interpret the multifarous sensory input and those that determine which are to be given attention. Future studies will need to include research on sensory processing and decision-making circuits, avoiding the traps of tropismic and motivational attitudes. An "information processing" approach to Heliothis sensory physiology will subtend many advances in ecoethological theory and will open the door further for the development of a whole suite of innovative pest management procedures.

Very little is currently known of the sensory biology of

Heliothis. To fill this gap in our knowledge the following seven components of sensory biology will have to be assembled:

i. morphological, topographical and ultrastructural typing of sensilla, their sensory neurones and accessory structures;

ii. electrophysiological characterisation of the adequate stimuli and dose/response relationships of each type of sensory neurone;

iii. determination of the biochemical and/or biophysical bases of specificity in sensory neurones;

iv. tracing of sensory axons into the ganglia and determination of their central connections;

v. elucidation of the central, primary processing of multimodal sensory input;

vi. identification of the attention system that preferentially opens the central processor to specific sensory inputs, out of the multitude of information pouring in at all times;

vii. identification of comparator central systems that fit actual sensory input against anticipated input to make ongoing decisions.

Such information is urgently needed for the larva as well as for male and female adult Heliothis.

3. PRACTICAL IMPLEMENTATION.

As soon as the adequate stimuli for a particular behavioural response have been isolated, it is possible to commence a sensory manipulation strategy (vide the pheromone work). However, much

basic biology is needed to enable each strategy to be implemented in exactly the right way. Improvements will be made as more and more of the functioning of the c.n.s. sensory processing is determined. Eventually sophisticated control programmes will be based on a multiplicity of sensory manipulation strategies, involving a range of stimuli:- incitors, attractants, stimulants, disrupters, blockers, repellents and deterrents. Because insects do not think but only react, we will be able to direct their behaviour, once we have cracked their communication system.

As already outlined in theory (Rice 1986 op cit.) and recently tested in small scale field trials (Pyke, Rice, Sabine and Zalucki in this Conference Working Papers), the Push-Pull Strategy (P.P.S) offers the best immediate opportunity for Heliothis management with semiochemicals. The technique involves kairomones that attract (pull) Heliothis moths to a killing bait used simultaneously with an allomone (push) formulation sprayed on the cotton. Theoretical considerations suggest that resistance will be minimised by the simultaneous use of kairomones and allomones.

The P.P.S. is only one of a large range of possibilites afforded by sensory manipulation with, for example: pheromones, ultrasound, photic stimuli and contact stimuli. Much basic work, linked to small-scale field trails, is needed to enable sensory manipulation to emerge as a reliable means of Heliothis management. Because it is compatible with most insecticides and with parasites and pathogens, sensory manipulation probably has a bright future. Appropriate funding for sensory studies of Heliothis will speed the development and implementation of these

technology based pest management strategies.

PROTOCOL FOR THE DEVELOPMENT OF A PUSH/PULL STRATEGY AGAINST HELIOTHIS SPECIES IN COTTON