INTEGRATED PEST MANAGEMENT OPTIONS FOR THE AUSTRALIAN COTTON INDUSTRY

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INTRODUCTION

Integrated pest management (IPM), or integrated pest control as it was originally known, is not a new concept. It was defined at an FAO symposium in 1965 as `a pest population management system which utilises all suitable techniques in a compatible manner to reduce pest populations and maintain them at levels below those causing economic injury'. The need for IPM arose because of the problems associated with the use of broad spectrum pesticides, particularly the development of resistance in pests, residues in produce and environmental contamination. The main aim of IPM is to reduce the use of broad spectrum pesticides, but it does not exclude the strategic use of pesticides.

The Australian cotton industry is currently heavily dependant on a wide range of chemical pesticides to control insect and mite pests. The use of these pesticides is extremely sophisticated by world standards, being based on detailed pest monitoring, highly efficient application and supported by a comprehensive resistance management strategy for major pests. The industry has progressed a long way from calendar spraying, but IPM is still in an embryonic stage. Some advances have been made, including the use of the biological insecticide *Bacillus thuringiensis* (Bt), cultivation at the end of the season to destroy overwintering pupae of *Helicoverpa (Heliothis) armigera,*

and the use of `soft chemicals' early in the season to encourage mite predation.

FUTURE OPTIONS FOR IPM

The Australian cotton industry has only made minor progress towards implementing IPM mainly because the alternatives to pesticides have not been cost effective. However, this equation is likely to change over the next few years with the development of new technology for pest management, increasing costs associated with the use of conventional pesticides, mainly due to the development of resistance in *H. armigera*, and increasing concerns over environmental contamination from agricultural chemicals.

The potential components of IPM programs for the Australian cotton industry are reviewed below.

Transgenic cotton

Transgenic cottons will undoubtedly provide the basis for IPM programs in cotton after the year 2000 and genetically engineered cotton varieties that express Bt toxins are already being tested in Australia. Results are promising and it appears that commercial use of Bt cotton will be widespread within 10 years. This development should result in a significant reduction in the use of pesticides for the control of *Heliothis* and could have added benefits in reduced problems with mites due to increased predator activity. It is important to recognise, however, that over-dependence on Bt cotton could result in the development of resistance in *H. armigera*. Research is currently underway to identify other insecticidal genes for use in transgenic varieties and develop management practices to minimise the possibility of resistance.

Trials to date have indicated that Bt cotton is resistant to attack from

Heliothis throughout most of the season. However, late in the season the Bt expression falls, allowing a small number of survivors. This could facilitate the development of resistance in *H. armigera* and additional control techniques will be needed to ensure that most of the survivors are eliminated.

Conventional plant breeding

Although the major advances for pest management in cotton are likely to be through transgenic varieties, conventional plant breeding should also provide useful support through morphological and chemical traits.

Predators and parasites

For some years research has been carried out on the mass rearing and release of parasites (*Trichogramma* spp) for control of *Heliothis*. These parasites are now available commercially and several releases were made in cotton last season. The levels of control were disappointing and clearly a number of questions need to be resolved before the technique is considered as a viable option for inclusion in IPM programs.

A wide range of *Heliothis* predators are found in unsprayed cotton, but numbers are reduced to insignificant levels in commercial cotton by the use of broad spectrum pesticides. Even in unsprayed cotton, the ability of predators to respond to sudden influxes of *Heliothis* is limited. This was clearly demonstrated in organic cotton trials last season. To overcome the problem, a novel approach is being evaluated. The aim is to attract predators into the crop with food–sprays and maintain populations at effective levels. Bt sprays are non disruptive and can be used to augment predation, while naturally occurring parasites may provide additional *Heliothis* mortality. Trials over the past two

seasons have provided encouraging results and next season blocks of organic cotton will be used to avoid spray drift. The effects of `strip cropping' with lucerne is also being investigated in these trials as an additional means of encouraging predators.

Biological insecticides

The pesticide manufacturers are increasingly looking to develop biological insecticides, particularly for *Heliothis*. The major problems to date with biological insecticides have been their relatively low toxicity to pests, slow rate of action and lack of residuality. Current research in Australia on the nuclear polyhedrosis virus is endeavouring to overcome these problems by genetic engineering and improved formulations. The importance of biological insecticides in IPM programs for the Australian cotton industry, both pre and post the introduction of Bt cotton, is unclear. However, they could well provide a very useful adjunct to transgenic cottons in future IPM programs.

Pheromones

Pheromones act by disrupting mating and have proved effective against some moth species in other crops. However, success has been dependant on mating occurring in the crop and the use of slow release pheromone dispensers. A significant level of mating before movement into the crop does not automatically preclude the use of pheromones for *Heliothis* control in cotton, but successful control under these circumstances would have to be based on area-wide treatment which would be logistically difficult and costly to implement. In addition, the standard plastic pheromone dispensers would be difficult to use in cotton and could contaminate the crop, while sprayable

formulations have not been effective to date. The situation concerning the movement of mated female *Heliothis* into cotton is currently being investigated.

New synthetic pesticides

The future development of synthetic pesticides for *Heliothis* control is not particularly encouraging. The pyrroles are a new group of chemicals and at least one is active against *Heliothis* with no cross resistance problems. This compound is also effective against mites, but it appears to be broad spectrum and may not be compatible with IPM programs that utilise beneficial species. New insect growth regulators (IGR) may well be developed over the next few years for use against *Heliothis*. They could slot into IPM programs as does chlorfluazuron (Helix®), the only IGR currently used in cotton.

The situation regarding sucking insects is more promising with several new pesticides in the pipeline. Hopefully, one of these chemicals will be active against mirids and non disruptive to beneficials. Propargite (Comite®) is a specific miticide which is currently giving effective control of mites and is compatible with IPM. Other specific miticides such as abamectin and tebufenpyrad could also be effective in cotton and are non disruptive to beneficials. These chemicals are already being used in other crops.

Cultural practices

Cultivation at the end of the season to reduce overwintering *H. armigera* pupae should be a component of any IPM program in cotton, pre or post transgenic varieties.

CONCLUSIONS

- **The Australian cotton industry must reduce its dependence on conventional pesticides, mainly because of insecticide resistance in *H. armigera* and environmental concerns over chemicals.**

- **The universal adoption of sound pest management practices by the industry could currently reduce overall pesticide use by 10% and assist in maintaining the effectiveness of pesticides.**

- **Encouraging results have been obtained with food attractants for predators and this approach could provide the basis for an IPM program in the near future.**

- **In the long term, transgenic varieties will be the key factor in pest management for the Australian cotton industry.**

- **Sole dependence on Bt cotton will lead almost certainly to the development of resistance in *H. armigera* and it is essential that an IPM approach is adopted.**

- **Sustainable and cost effective IPM programs can be developed in Australia that will reduce current pesticide use in cotton by 50–80% within 10 years.**