AREA-WIDE MANAGEMENT OF HELIOTHIS – RESULTS OF CURRENT STUDIES

David Murray, Melina Miles and Julie Ferguson
Queensland Department of Primary Industries, Farming Systems Institute and
Australian Cotton Cooperative Research Centre, PO Box 102, Toowoomba Q 4350

Introduction

Area-Wide Management (AWM) of heliothis (*Helicoverpa* spp.) is not a new concept. Knipling and Stadelbacher (1983) discussed the rationale of attacking heliothis populations during the first spring generation and this approach has been investigated since 1990 in the Mississippi Delta (Hardee and Bell 1996, Streett *et al.* 1998). In Australia, Titmarsh (1992) was the first to advocate control of the first spring generation as a management approach on the Darling Downs, but it was Sequeira (1998) who put words into action in the 1997/98 season with a regional management program in the Emerald Irrigation Area. The driving force for this action was the need to develop a pre-emptive resistance management strategy for the area to facilitate the introduction of INGARD cotton. Key components of this program were the use of early-season and late-season trap crops. It is this research that has been the catalyst for similar plans to deal with the heliothis crisis on the Darling Downs (Murray *et al.* 1998) and elsewhere in Australia.

Under the AWM programs implemented in Australia, *Helicoverpa armigera* (Hübner) is the primary target because this species has developed resistance to most currently used insecticides and presents a dilemma for mid and late season management in cotton and grain crops. While large immigrations of *Helicoverpa punctigera* (Wallengren) from inland Australia may take place during late winter/spring in some years, the tactics employed against *H. armigera* also should be valid against *H. punctigera*. The thrust of AWM is an overall reduction in *H. armigera* population levels. Various tactics have been incorporated into AWM strategies, and the mix of tactics varies from region to region. No single tactic will form the basis of AWM and no AWM strategy will be universally suitable.

Is AWM required or is it a diversion from real insect control in cotton?

Until recently, heliothis has been managed field by field or farm by farm, with little or no regard for what happened on neighbouring properties. There is a growing appreciation that heliothis is a pest of the farming system, and as such there is much to be gained by a regional or AWM approach.

Many *H. armigera* over-winter locally in our temperate cropping regions, but in tropical areas, breeding may take place year round. Spring provides the platform for population increase. Heliothis develop on many weeds and most of our summer and winter crops, so there is potential for these to act as nurseries for heliothis. The contribution of different crops to the heliothis problem is very seasonal and location dependent. The result of successive generations of heliothis developing on abundant host plants during spring and summer is unrelenting pest activity by late summer and autumn. Couple this high pest pressure with declining performance of ageing insecticide groups because of resistance, and a crisis situation is developing.

AWM is not a diversion from real insect control in cotton and grain crops. It is a fundamental approach that incorporates the principles of IPM across the agroecosystem. History has shown time and time again that pest management reliant on a single approach is doomed to failure. We should heed history's lessons. We should also appreciate the sociological content of AWM that brings together community partners and hopefully benefits all involved.

Can AWM be successful and are there any successes in Australia so far?

One AWM 'success' in broad acre cropping is pea-weevil management in field peas. In South Australia, an integrated management package was developed for this pest that attacked the pest at 3 bottlenecks in the population (Baker 1993). When adopted across an entire area in one region, the pea-weevil population declined dramatically over a period of 3-5 seasons. As a result the growers started to relax their control/management activities and the pest pressure has again risen to a damaging level. There is a lesson to be learnt from this experience!

The Mississippi Delta has followed a similar pattern. The research demonstrated that AWM was a cost effective preventative suppression approach (Streett *et al.* 1998), but it seems that the sound performance of transgenic cotton (Bollgard in USA) has dampened the need and enthusiasm for an AWM approach.

In Australia the 1999/2000 season is an example of what could be achieved with successful AWM. There are some spectacular examples of highly profitable cotton production with minimal or no insecticide use. Unfortunately we don't know all the factors that led to the generally lower heliothis activity in many districts last season, but if we knew how to tweak the right knobs, maybe we could repeat this experience. Therein lies our challenge.

AWM is a 'best bet' approach based on our current knowledge and understanding of heliothis biology and ecology and the farming system. The AWM strategy implemented on the Darling Downs suggests tactics that aim to reduce

- the survival of over-wintering insecticide-resistant *H. armigera* pupae

- the early-season buildup of heliothis on a regional/district scale
- the mid-season population pressure on heliothis-susceptible crops

There is still much we don't know, and for this reason researchers have stressed that AWM strategies are in a research phase. Care should be exercised in their widespread implementation. Despite this warning, there has been an overwhelming enthusiasm to embrace this approach, or at least some of its tactics.

The thrust of AWM is not eradication of the pest. It aims to reduce pest infestations to levels that can be managed by natural enemies and more selective products. Only when this fails should we resort to more disruptive tactics. There are many possible measures of success of AWM. Reduced insecticide input (fewer sprays and fewer mixtures) could be one overall indicator and this obviously leads to lower costs, but years of experience tell us that these costs are highly variable form farm to farm and district to district, both within seasons and between seasons, so this is not necessarily a reliable measure. Further complications arise in trying to define a 'control' area for comparison with the AWM group.

AWM does not necessarily imply fewer sprays. It should lead to better management of lower pest numbers and improved decision-making. The basis for these benefits is an improved understanding of the pest and its natural enemies and their interactions with host plants in the farming system. It may be that just as many sprays are applied, at least in some seasons, under AWM, but conventional pesticides and expensive mixtures are replaced by other options e.g. biopesticides, food sprays and behaviour modifiers. Success may be difficult to measure in the short term. It may simply be the fact that in 10 or 20 years time profitable farming enterprises are still operating. Pest management will be just one of the factors determining this outcome.

What pests are being addressed with AWM in Australia? Are there any achievements to date?

H. armigera is the primary target for AWM, but if we take a holistic view, our target is biodiversity in the farming system. We are also concerned about other pests such as spider mites and aphids that are generally regarded as induced or secondary pests. Insecticide resistance in these pests also poses management problems. Seasonal conditions may raise the importance of other pests such as green mirids and tipworms, and their management may aggravate secondary pest problems and resurgence of primary pests. Reducing the use of disruptive insecticides may lead to previously minor pests such as green vegetable bug being elevated to major pest status. Equally important in the biodiversity stakes are the predators and parasites that can potentially contribute so much to the pest management equation.

Some AWM groups have worked well together to achieve desirable outcomes e.g. Boggabilla group. However, as already outlined, the measure of 'success' is confounded by many factors. There has been a spirit of cooperation in many groups, but ultimately participants will need evidence of benefits to maintain their enthusiasm for AWM. The pilot project on the Darling Downs indicates that potential for an AWM appears good, given the enthusiasm of the growers, and the opportunities the diverse farming system presents. What is needed now is to further develop the currently 'rudimentary' AWM into a strategy that delivers reliable season-long suppression of the *H. armigera* population.

What level of participation is required for AWM to succeed?

The disruptiveness of non-compliance depends somewhat on what is not being complied with. For example, if in-crop management of the pest is good, then the contribution of the field/s to the over-wintering population could be minor. As a result a failure to pupae-bust and spring trap crop may be insignificant on a regional scale. However, the expectation is that there will be economic benefits to implementing AWM strategies that will make them beneficial to individual growers rather than onerous.

The success of AWM is the community approach to the pest problem and the communication that is fostered. Neighbours are talking and thinking laterally about how they can do things better. Action taken by individuals will have limited benefits because what happens on one farm is influenced by the neighbours, and the neighbours' neighbours, and so on. The 'sphere of influence' for AWM has not been determined. It is obviously influenced by the mobility of the moth and the risk presented by migratory events that could displace moths hundreds of kilometres overnight.

We don't know what participation level is needed to achieve the desired result, but clearly the higher the level of participation, the greater should be the expected benefits. Coupled with this is the size of the area. Because heliothis moths are highly mobile, a small area in the middle of an extensive plain could be inundated through 'local' moth movement over tens of kilometres. 'Local' movement should less affect large areas, but as the area increases so too does the difficulty of dealing with large groups and maintaining communication and flow of information between the participants.

Does drift from outside the AWM group become a problem?

Drift is an important issue, both within and outside the AWM group. Highly disruptive products like the pyrethroids have far reaching effects that are reflected in decreased biodiversity in the agroecosystem. The experiences of one AWM group provided evidence of this. The first pyrethroid spray applied to one upwind property led to a chain reaction of events downwind that signalled an end to a more selective approach. During the 1999/2000

season, a group on the Jimbour Flood Plain met on 29 December to delay even further the first use of pyrethroids. The fact that the IRMS permits pyrethroid use after a specified date (10 December in the case of the Darling Downs in 1999) is not a signal that more selective options should be abandoned.

Do AWM members have to follow similar cropping programs and how big can an AWM group be in geographic terms?

At this stage it is unclear what tactics will comprise an effective AWM strategy. However, if we consider that the aim is to target *H.armigera* at susceptible stages of its life cycle and bottlenecks of its population dynamics, then it will be necessary to have a coordinated implementation of specific tactics at certain times during the season. Irrespective of other activities, good in-crop management should be implemented as required in individual crop/farm situations to prevent these being nurseries for heliothis. There may be some benefit in coordinating the use of certain chemical groups, pyrethroids being one example.

AWM as implemented on the Darling Downs is designed for the farming system where there is a diversity of cropping activities. Diversity may in fact favour its success by providing more opportunities to attack pest populations and foster natural enemies. However, it may be easier to implement AWM under a monoculture system without the complexities of pest management in different crops. Fundamentally, participants in an AWM group should follow a coordinated pest management approach.

AWM is not a finger pointing exercise. Most importantly it is a community program, aiming to provide participants with information that can reduce the heliothis problem not just on their farm, but across the whole area.

The appropriate size for an AWM group can only be determined when we have better information on the scale of movement of *H. armigera*. In other words, some idea of the geographic bounds to 'local' *H. armigera* populations. Once this is established, and hopefully these answers will come from the microsatellite DNA studies (Graham 2000), it will be clearer over what scale AWM tactics need to be implemented to manage the local population.

Long distance movement, such as between growing districts, has the potential to derail AWM groups. Case studies have indicated the potential for migratory movements on this scale (Murray 1995), but the frequency of such events is not known. For such events to occur, they require the synchrony of many factors. Microsatellite DNA studies (Graham 2000) coupled with GIS and modelling tools (Rochester 1999) could provide evidence to verify these movements.

Conclusion

It should be evident that AWM is not yet a science. Some of what is being implemented under the umbrella of AWM is not established scientific fact. There is a sound technical base for many elements of AWM e.g. pupae busting, while for some elements the research is in relative infancy and some assumptions have been made e.g. trap crop type, layout, location, etc.

AWM is very much in a developmental stage. The participative research approach being taken with AWM means that the enthusiasm with which growers have taken up the 'experimental' tactics is outstripping the rate at which research can answer the questions that arise. The development of additional tactics that complement the spring trap cropping and pupae busting require detailed research. At the same time we need to develop tools to measure the impact of the different tactics, and total AWM strategy on pest pressure, chemical use and profitability of the system.

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