Want fewer sprays? Insecticide impacts on beneficial insects in broadacre field crops and integration of natural enemies into management strategies.

Dr Melina Miles, Queensland Department of Agriculture and Fisheries, Toowoomba

Key words

integrated pest management, beneficials, natural enemies, insecticides, practical

GRDC code

CES2204-001RTX – IPM for Grains

Take home message

Insect pest management in the Australian grains industry is, for the most part, either reactive or prophylactic and highly reliant on insecticides to resolve pest outbreaks. Since the 1950s, IPM has been promoted as the way industries can reduce their reliance on insecticides for pest management. The Northern grains region has a high awareness of the importance of crop monitoring and use of economic thresholds (where they exist), and the use of selective/soft options is common. There are relatively few growers or agronomists who deliberately implement IPM strategies year in year out. Whilst real and perceived challenges exist, focusing on key principles and being pragmatic about what is practicable are useful starting points for a management strategy that is less reliant on insecticides.

Background – IPM and the role of natural enemies (and other options)

If I implement IPM, does that mean I can't use insecticides?

If I have more natural enemies (beneficials), does that mean I won't need to spray?

Successful integrated pest management (IPM) is often thought to use no insecticides and that control of pests is achieved through the activity of natural enemies. This is not the case, and IPM is an approach that seeks to harness the contribution of a range of options to minimise the likelihood of damaging pest outbreaks occurring (e.g. crop type, crop variety, planting time, agronomy, cultivation, stubble management, weed/host management, natural enemies). In the event of a pest outbreak, then crop monitoring, economic thresholds and insecticides are important options. The IPM concept is illustrated in Figure 1. Importantly, what the pyramid demonstrates is that there are a number of components that underpin successful pest management that we rarely acknowledge or deliberately tap into.

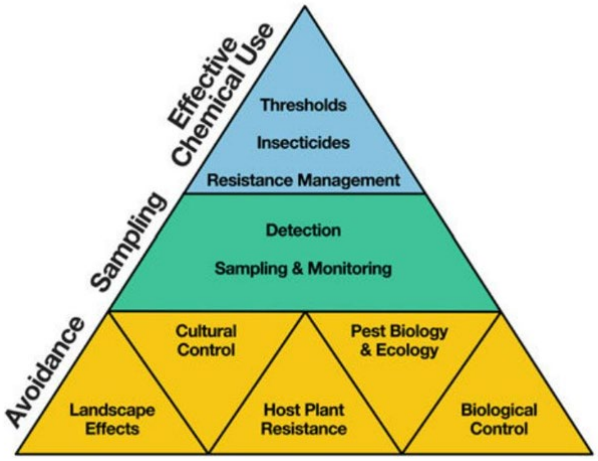

Figure 1. The classic IPM pyramid (Naranjo 2001).

Challenges with harnessing the contribution of natural enemies

In 2018-19, a number of Northern region agronomists were interviewed to identify what their current pest management practices were, and what they thought they needed in order to do more than simply monitor and spray. The incorporation of natural enemies into decision making (e.g. thresholds) was one of the priority areas (Table 1).

Table 1. Comparison of current pest management practices of northern region agronomists and identified information/capacity gaps in managing invertebrate pests with a greater emphasis on the contribution of natural enemies. (Miles *et al.* Economic thresholds review 2019).

Pest	Specific issues	Background/context/justification as presented by agronomist participants
Incorporation of natural enemies (NE) into thresholds	Quantify the impact of key natural enemies	The impact of NE on pests is central to factoring them into decisions. Look at the potential of biocontrol in short season broadacre crops too (e.g. mungbeans). Priority pests identified as aphids and armyworm.
	Sampling guidelines for NE	Can NE be effectively sampled at the same time as the pests?
	Deployment of nursery crops in the landscape	Is it possible to manipulate the NE populations in the landscape? Increasing abundance of NE?
	Improved understanding of NE and biology, ecology	Where are NE in the landscape? In weeds, in crops, in native vegetation?
	Information on impact of insecticides on NE	Need information on the relative impact of the different insecticides on NE. Would be considered in making spray decisions.
	Education/training in how to incorporate NE	In order to factor NE into decisions, growers and agronomists need to know how to use sampling data for both the pest and NE.
Typical current practice	Crop motoring	In conjunction with pest monitoring
	Use of thresholds	Not available
	Control management	Factoring in for aphids where parasitism and predators are visible and recognisable (mummies, ladybirds, hoverflies, lacewings)
	Other	

It is evident from the number of issues identified as current barriers to being able to practically incorporate natural enemies into their decision making, that there are significant gaps in our knowledge of natural enemies. Macfayden *et al.,* (2019) in their paper (Identifying critical research gaps that limit control options for invertebrate pests in Australian grain production systems, Austral Entomology) said:

"For most natural enemies, the impact in terms of reduction of pest numbers has not been quantified, with very few studies including both pests and natural enemies together.

There is large variability in the level of control provided by natural enemies between years and regions, and the factors leading to this variability are not well understood."

Before you throw your hands up and turn the page, I am of the opinion that the grains industry can make advances with invertebrate pest management if we focus on the things that are in our control

and do them well. The benefits of this approach will include reduced risk of missing pest infestations, applying sprays only when there is a significant risk of crop loss, lessened risk of insecticide resistance, maximising the contribution of natural enemies and the economic benefits that arise from these outcomes.

Focus on the things that are in your control and do them well

Plan for an IPM approach

a. Be aware of the risks for specific crops (e.g. key pests, drivers of pest abundance, seasonal outlook)
b. Minimise risks where possible (e.g. planting early/late to avoid FAW, midge resistant sorghum varieties)
c. Be familiar with available economic thresholds and recalibrate yourself each season for changes in crop value and costs of control
d. Monitor regularly enough to catch infestations before crop loss occurs and to re-check before making decisions to spray
e. Use the least disruptive option if spraying is required.

Avoid the use of "just-in-case" insecticides

There are a number of practices that are commonplace in the Australian grains industry that are detrimental to IPM. Most notably, the prophylactic use of insecticides that have broad impact on pests and beneficials (natural enemies, pollinators, decomposers). When insecticides are included with herbicides or fungicides "just in case" they will kill beneficials and may be of no benefit in terms of pest control. These practices increase the risk of outbreaks of other pest species that are no longer suppressed by the activity of the natural enemies in the crop. I am sure that native armyworm outbreaks in winter cereals are more frequent following widespread spraying for aphids. Similarly, aphid outbreaks in sorghum are more likely in years when midge is sprayed with synthetic pyrethroids.

Recently, information on the relative impact of insecticides on natural enemies, for products registered for use in grain crops, has been made available online (Beneficials chemical toxicity table 2023). This guide provides information on the relative toxicity of insecticides to assist in making choices that preserve beneficial populations when pests need to be sprayed.

Incorporating natural enemies into decision making

Given the major gaps in our knowledge of natural enemies, how can their potential contribution be quantified? I am not sure that it is necessary to quantify their contribution directly. If you are adequately monitoring the pest population, you will have information on whether it is declining, stable or on the increase. To some extent it doesn't matter exactly what is responsible for keeping a pest infestation below the economic threshold, but you can be confident that in a crop that hasn't been sprayed, natural enemies are playing an important role.

Many of the important natural enemies are not very visible in crops (e.g. parasitoid wasps, fungal diseases). To determine what impact these are having on pest populations it is necessary to collect susceptible pests, like eggs and caterpillars, and rear them until the presence/absence of the natural enemy is determined. Currently, the time and cost of doing this is considered prohibitive, but with advances in technology it may be possible in the future to make these assessments in the field.

Knowing more about which natural enemies have the biggest impact on key pests and knowing how to predict whether they are likely to supress the pest population sufficiently to avoid requiring a spray would increase grower and agronomist confidence in delaying sprays and selecting softer options if spraying is necessary.

Can natural enemy numbers be incorporated into economic thresholds?

Economic thresholds describe the relationship between crop damage and the crop response to this damage (loss, compensation etc). The relationship is typically dependent on the density of the pest that causes a defined amount of damage and consequently loss. Natural enemies impact the survival of a pest and the growth rate of a pest population. If the impact of the natural enemies can be quantified, it may be possible to adapt economic thresholds to take this into account – but we are a long way from being able to do that now.

Summary

By implementing simple best management practices for insect pest management – regular crop monitoring, correct identification, use of economic thresholds, consideration of natural enemy activity, use of least disruptive products – growers and agronomists are in a good position to harness the contribution of natural enemies in their crops. There are clear knowledge gaps that, if addressed, would increase confidence in a broader suite of tactics for managing, not just controlling, invertebrate pests in grain crops.

Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the author would like to thank them for their continued support.

References

Cesar Australia (2023) Beneficials chemical toxicity table. https://cesaraustralia.com/resources/beneficials-toxicity-table/

Macfadyen S, Moradi Vajargah M, Umina P, Hoffmann A, Nash M, Holloway J (2019) Identifying critical research gaps that limit control options for invertebrate pests in Australian grain production systems. Austral Entomology. 58(1):9-26.

Miles M, Hopkinson J, Volp T, McDonald G, Umina P, Maino J, Perry K, van Helden M, Baker G, Severtson D, Micic S, Macpherson I, Bowden P, Cameron P, Congreve M (2019) Economic thresholds for the major pests reducing profitability in the Australian grains industry. Final report to GRDC. Project code 9174838.

Naranjo S (2001) Conservation and evaluation of natural enemies in IPM systems for *Bemisia tabaci*. Crop Protection 20 (9).

Contact details

Melina Miles
Queensland Department of Agriculture and Fisheries
203 Tor St, Toowoomba 4350
Ph: 0407 113 306
Email: melina.miles@daf.qld.gov.au

Date published

March 2024