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# IPM in Coastal Soybeans and Beyond

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## Abstract

*The adoption of the 'go soft early' Integrated Pest Management (IPM) strategy in coastal soybeans is paying dividends, with reduced silverleaf whitefly and soybean aphid activity in recent seasons. The switch to biopesticides early season has boosted beneficial insect populations in soybeans, and has undoubtedly? maximised the effectiveness of the recently introduced whitefly parasite, Eretmocerus hayati. While the lack of soft options for podsucking bugs remains an IPM challenge, delaying bug sprays till early podfill reduces the risk of flaring whitefly. Indeed, the adoption of the 'go soft early' IPM strategy has been hastened by the risk of whitefly attack. Networking between researching and industry groups has been a pivotal factor in the uptake of IPM.*

## Introduction

The spread of soybeans as a break and cash crop into coastal Queensland sugarcane areas has presented the industry and researchers with a number of significant pest management challenges. These include the threat of flaring silverleaf whitefly (SLW), for which there are no viable pesticide options in soybeans, and managing high densities of podsucking bugs, which severely reduce seed quality, and which can only be managed at present with non-selective pesticides. Other challenges include a lack of IPM skills and knowledge in new production areas, an abundance of leaf eating caterpillars which inflict visually noticeable but frequently not yield threatening damage, and the ever present soybean aphid, the naturally enemies of which can be confused with a leaf eating caterpillar. Furthermore, the move by the soybean industry towards edible soybeans, which have a far lower tolerance of bug damage in particular, has increased the pressure to develop effective pest management strategies for coastal production areas.

However, the challenges outlined above have brought dual benefits: First, they have provided the impetus for RD&E that benefits for the entire industry, and, secondly, they have provided a focus on the need for IPM, i.e. an integrated approach to insect pest management that does not rely soley on insecticides to reduce insect damage. For example, the advent of SLW, and the dire predictions made for soybeans in Queensland, increased the need for soft options and validated thresholds for all pests.

## Materials and Methods

A multi-pronged approach has been taken to address the above challenge of developing IPM strategies for coastal soybeans, and promoting their adoption:

The key feature of the industry's approach was to:

- Decide on an overall IPM strategy based on our current knowledge.
- Promote the most effective IPM tools currently available.
- Identify gaps in our collective IPM capacity/and knowledge
- Address IPM management gaps by targeted research and extension
- Back up (validate) these IPM guidelines with 'hard' data from past and current trials.
- Link with industry to secure 'in-kind' collaboration and additional funding.

## Results/Discussion

*Overall IPM strategy/message*

The IPM strategy being widely promoted is to "go soft early". The strategy recommends only using biopesticides during the vegetative stages (against caterpillars) and to avoid non-selective or 'hard' pesticides for as long as possible. In essence, the strategy promotes a multi-pest approach, with silverleaf whitefly regarded as the over-riding 'IPM enforcer'.

The aim is to foster a build up of predators and parasites to keep early pests in check and to buffer the crop against pest attack during later crop stages. The assumption is that if damaging populations of 'flareable' pests such as whitefly and aphids are not present by early podfill, or are suppressed until then, there will be insufficient time in soybeans for these pests to flare to damaging numbers. This assumption is backed by data and observations showing that, as soybeans progress through podfill, they become increasingly unattractive to whitefly and soybean aphids. (Note: flaring occurs when pest populations dramatically increase after 'hard' pesticides remove the beneficial insects keeping them in check.)

However, intervention may be required during podding, especially against podsucking bugs, populations of which peak during late podding. Podsucking bugs cannot be ignored as they can drastically reduce seed quality, as well as yield. In the early years of coastal soybean production, uncontrolled high podsucking bug populations resulted in many crops not even meeting crushing standards, let alone edible standards (2% seed damage MAX).

### Effective IPM tools

*Biopesticides for caterpillars*

The 'go soft early' approach has been made possible by the registration in soybeans of two caterpillar biopesticides, namely VivusGold (a helicoverpa virus) against helicoverpa, and Dipel (Bt) against loopers and helicoverpa. Both are highly specific to caterpillars (though the virus only kills helicoverpa) and have no impact on beneficials. While biopesticides don't always give a 100% kill, DPI&F data (Rogers pers. com.) shows that up to 10 helicoverpa larvae can be tolerated in vegetative soybeans with no yield loss, indicating that near 100% control is not always necessary.

*New generation softer caterpillar pesticides*

Two new generation caterpillar pesticides, Steward (indoxacarb) and Tracer (spinosad) with moderate selectivity are now registered in soybeans. The recommended strategy is to reserve these pesticides until the more critical podding stages, as biopesticides traditionally give a lower and slower kill. Both are far more selective than the older carbamate products such as methomyl (e.g. Marlin) and thiodicarb (Larvin) and are far less toxic to humans (an important factor in closely settled coastal regions).

Because these products and the biopesticides must be ingested by the caterpillars to work, thorough spray coverage is essential for best results. Spray volumes used on the coast are typically high, being in the range of 200-300L/ha, which has contributed to the excellent control achieved to date in most crops. It must be acknowledged that registrations for these products and the biopesticides have been secured with data and support from past and current GRDC-funded grains and pulse IPM projects.

*Beneficial insects*

Very high beneficial insect populations have been observed in coastal soybeans. Major predators include ladybirds, hoverfly larvae and predatory bugs, and have undoubtedly been a key factor in the stabilising of soybean aphid populations on the coast. Key parasites include *Trichogramma* sp. wasps (caterpillar egg parasites), including the highly effective *T. pretiosum*, and the recently introduced (by Paul deBarro, CSIRO) silverleaf whitefly (SLW) parasite *Eretmocerus hayati*. The latter is now well established in the Bundaberg and other regions. High levels of whitely parasitism by *Eretmocerus* sp. have been observed to the point where potentially damaging SLW populations have been checked or reduced in soybeans. Low SLW activity has been reported from other coastal regions.

*Selective option for Monolepta beetles*

A submission is currently before the APVMA to extend the label for indoxacarb (Steward) to cover this pest at the rate registered for soybean looper (200mL/ha). This submission is based on data generated showing that this rate, or even lower, gives effective Monolepta control, and greatly reduces the risk of subsequent helicoverpa attack compared with non-selective option such as trichlorfon (Lepidex). Another IPM option for Monolepta is to only treat the parts of a crop that are heavily infested, as infestations are often confined to only one edge or corner of a block.

**IPM gaps:**

*Soft options for podsucking bugs*

Unfortunately, trials have shown that there are no highly selective bug pesticides, either registered or unregistered. Registration has been completely withdrawn for endosulfan which was moderately selective, having relatively little impact on parasitic wasps, but a marked impact on predatory bugs.

Of the currently registered products, the only really effective option against (most) podsucking bugs is deltamethrin (Decis) which, being a synthetic pyrethroid, is extremely hard (non-selective) on most beneficials. The only option therefore is to delay spraying as long as possible without jeopardising seed quality. This means holding off until early podfill, a recommendation which is supported by DPI&F data showing that early bug damage does not affect harvested seed quality.

*No effective options (hard or soft) for redbanded shield bug*

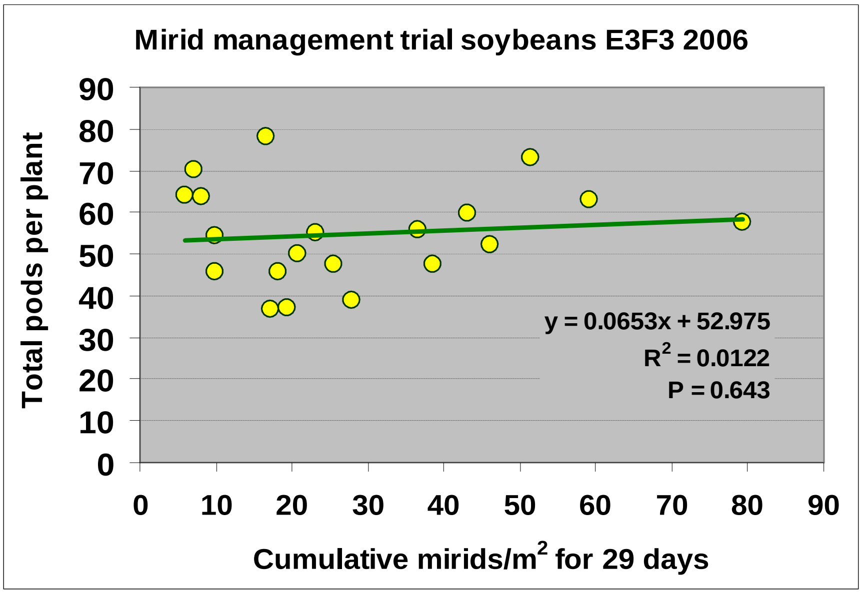
DPI&F trials last season confirmed that none of the pesticides currently registered for green vegetable bug, including deltamethrin, give control of redbanded shield bug (*Piezodorus oceanicus*). However, control can be moderately improved to 40% by the addition of 0.5% salt to spray tank mixes (Figure 1). Further trials are planned this season to determine if this level of control can be improved with higher salt rates.

*The damage potential of mirids in soybeans*

Because of their reputation in other pulse crops (especially mungbeans), mirids are greatly 'feared' in some soybean growing regions such as the Darling Downs, with populations as low as $1/m^2$ being sprayed. . However, this fear would appear to be unfounded. DPI&F trials over the past two seasons show that mirid (*Creontiades* sp.) populations up to $3/m^2$ have no impact on podding in cultivars A6785 and Bunya. This would seem to justify the current threshold set of $4/m^2$ for determinate soybean cultivars as grown in northern Australia, and will be further verified when current trials are assessed for yield.

Avoiding unnecessary mirid sprays is an important IPM strategy as spraying at flowering increases the risk of whitefly attack. Because of their determinacy, northern cultivars are inherently at lesser risk from mirid damage than indeterminate cultivars that are grown in southern Australia. For this reason, mirid thresholds for soybeans in southern Australia need to be based on trial data from southern soybean cultivars.

**Figure 1:** Relationship between mirid activity and podset in A6785 soybeans infested with mirids (*Creontiades* sp.) at densities averaging $2.5/m^2$ and as high as $4/m^2$ in individual plots.




**Soybean IPM extension:**

*IPM training workshops*

Two very successful workshops were held in the summer of 2006 in the Bundaberg and Isis regions of south east Queensland, in conjunction with a SRDC-funded initiative by Women in Sugar. These workshops have been comprehensively reported on by Women in Sugar elsewhere in these proceedings.

However, it should be noted that the aim of these courses was to improve participants' confidence in IPM, to take the fear out of pest management, and to build significant IPM capacity and networks in a new soybean production region. A key message for researchers from the participants is that the information provided in such courses needs to be as digestible as possible, while not compromising on content. Post course uptake and continued IPM interest suggests the basic format has been successful. Similar IPM courses are planned for soybean and other pulse growers in southern Australia (when it rains). These workshops are part of GRDC funded National Invertebrate Pest Initiative (NIPI), and will network with Australian Oilseeds Federation (AOF) and Pulse Australia representatives in southern Australia.

***Pu**lse Break Crop IPM reference manual*

A major output from the IPM workshops has been the publication of a comprehensive Pulse Break Crop IPM reference Manual. While this manual has a focus on coastal soybeans, it can easily be adapted to other regions with different pest spectrums.

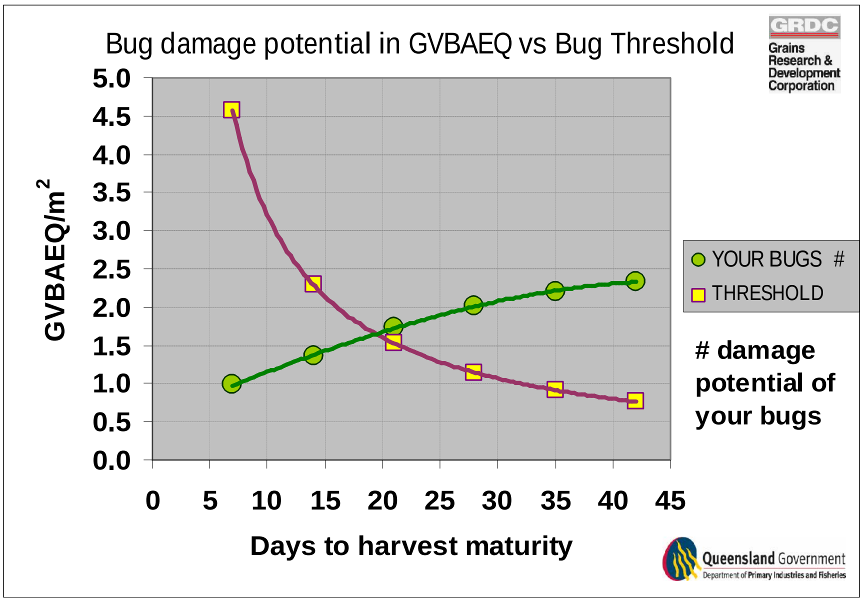
*Podsucking bug threshold models*

Determining the true damage potential of podsucking bug complexes of different ages and species is a major problem for consultants and growers, particularly as the potential damage and the thresholds themselves are influenced by the size of the crop (seeds per unit area) and the crop's proximity to harvest. In essence, the closer the crop to harvest, the less time bugs have to cause a given amount of damage, and so the higher the threshold. In addition, the closer it is to harvest, the less time young bugs (early instars) have to reach a more damaging size, and so the damage potential of late infestations with a large proportion of small nymphs is lower still. Such scenarios are not uncommon as current pesticides don't always give total control of egg rafts under leaves in the lower crop canopy.

Finally, because bug thresholds in edible soybeans are based on % damage, the more seeds in a crop, the lower the % seed damage for a given bug population. With the added complication of at least moderate mortality for young bug nymphs, 'on the spot' threshold calculations are impossible in the field armed with merely a pen and paper.

However, a sophisticated threshold model has been developed that factors in all the above variables. All the user has to do is punch in the number of nymphs (each instar) and adults of each bug species, plus their crop's row spacing, plants per row metre, pods per plant, and seeds per pod. The model then calculates and graphs the damage potential of your bugs in green vegetable bug adult equivalents (GVBAEQ), and also the threshold for your crop, at periods ranging from 42 days to 7 days from harvest (Figure 2). The model is user-friendly for researchers but needs some refinements before commercial release.

**Figure 2:** Bug damage potentials and thresholds for a crop with three (3) 2nd instar, one (1) 3rd instar and 0.2 adult green vegetable bugs per square metre, and with 3,000 seeds per square metre. Note how the bug thresholds and damage potentials are inversely influenced by time to harvest.




*Soybean insect identification including 'new pests' in coastal soybeans*

The increased use of biopesticides heightens the need for correct caterpillar identification, as VivusGold only acts against *Helicoverpa*, and Dipel (Bt) is the only biopesticide option for other caterpillars such as loopers. In addition in coastal regions, there are many ‘new’ caterpillars such as *Mocis* sp. and *Pantydia* sp., which are brown caterpillars and which can be confused with helicoverpa larvae (by non-entomologists).

One of the objectives of the IPM courses has been to provide scouts with simple identification guidelines, which don’t rely solely on colour (which can be extremely variable). These and many more soybean pests are described and illustrated in detail in the ‘Summer Pulse Pest” chapter (written by Hugh Brier) in the forthcoming CSIRO publication ‘Insect and Allied forms in Australian Field Crop and Pastures” (in press). Correct insect identification remains an ongoing IPM issue as surveys in other regions show that 75% of consultant agronomists can’t immediately identify 50% of the common pest and beneficial insects in the crops they are scouting.

## Conclusions

Evidence of the IPM strategy’s success in soybeans to date is the low incidence of SLW and soybean aphids in the majority of crops in recent seasons. This switch to biopesticides against caterpillars early in the life of the crop has resulted in the build up of massive beneficial insect populations. The reduction in early ‘hard sprays’ has also undoubtedly maximised the effectiveness of the newly released SLW parasite (*Eretmocerus hayati*). While soybeans are well armed with IPM options for caterpillars, they still lack genuinely soft but effective options for podsucking bugs. Having soft options equivalent in IPM fit to a biopesticide, or even a low rate of indoxacarb, would preserve the large populations of beneficial insects present in many crops by podding, and allow them to move onto other less advanced crops, or to overwinter.

It is emphasised that any future soft bug options must also be effective to meet the more stringent quality requirements for edible grade soybeans. However, the bug damage threshold model above (Fig. 2) gives IPM practitioners some leeway, at least for late infestations. The challenge will be to match the recent high standards in grain quality achieved as a result of greatly improved bug management (particularly in coastal regions). For example, over 70% of crops in the Bundaberg/Isis regions made the edible grade in the 2005/06 season, a massive improvement from the early soybean years when many crops failed to meet even crushing standards, largely as a result of inadequate insect pest management.

Finally, the widespread adoption of IPM in coastal soybeans is a tribute to the many growers, industry and scientific personnel networking with project DAQ00086 throughout eastern Australia. While this paper focuses on coastal soybeans, the IPM threat posed by SLW on the coast has proved a boon for IPM, and there are messages for other regions with different IPM threats such as mites.

**Acknowledgements**

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