NORTHERN FOCUS

COVERING NORTHERN NSW AND QUEENSLAND

THE RESEARCH VIEW

Canopy management in the northern grains region

By Richard Daniel, Northern Grower Alliance

In the past, much of the research on topdressing nitrogen (N) in the northern region has focussed on the role of in-crop N to respond to seasons in which yield potentials have increased significantly due to above average rainfall.

In these situations, research has shown that good responses can be achieved especially when good rainfall is received after N application (*Australian Grain* July–August 2007). Recently though there has been significant interest in the role of 'canopy management' principles for crop production in the northern grains region.

What is canopy management?

The concept of canopy management has been primarily developed in Europe and New Zealand – both distinct production environments to those typically found in most grain producing regions of Australia, and especially the northern grains region.

Canopy management includes a range of crop management tools to manage crop growth and development to maintain canopy size and duration to optimise photosynthetic capacity and grain production.

One of the main tools for growers to manage the crop canopy is the rate and timing of applied fertiliser N.

The main difference between canopy

...ii ▷

One of the main canopy management tools is the rate and timing of applied nitrogen.

Consultants' Corner

Consultants' Corner is an initiative by *Australian Grain* highlighting current GRDC-funded research with a particular focus on the commercial implications of adopting cutting-edge research.

TABLE 1: Nitrogen timings

Treatment	At sowing (SB)	Stem elongation (GS31)	Flag leaf emergence (GS39)
No N	—	—	—
Single applications	100% N	—	—
	—	100% N	—
	—	—	100% N
Split applications	50% N	50% N	—
	—	50% N	50% N
	50% N	—	50% N

TABLE 2: Overview of canopy management trials

	2006	2007	2008
Location	Caroona	Caroona	Spring Ridge
Sowing date	27th June	14th July	29th May, 3rd July
Variety	Ventura	Ventura	EGA Gregory and Ventura
Starting Nitrate-N (0–90cm)	25 kg N/ha	74 kg N/ha	78 kg N/ha
Previous crop	2005 Sorghum	2006 Sorghum	2007 Sorghum
Total N applied	110 kg N/ha	140 kg N/ha	160 kg N/ha
In-crop rainfall	234 (123 mm irr.)	285 (150 mm irr.)	450 mm (incl. irr.)

TABLE 3: Influence of nitrogen timing on grain yield for main sown wheat (Ventura) from 2006–08

Nitrogen timing	Yield (t/ha)	Protein (%)	Screenings (%)
2006			
Nil	1.6	8.9	7.8
100% SB	3.7	11.8	7.7
100% GS31	3.3	12.5	6.6
100% GS39	2.3	14.2	5.3
50% SB + 50% GS31	3.7	11.7	7.3
50% GS31 + 50% GS39	3.3	13.0	6.6
50% SB + 50% GS39	3.5	12.1	5.7
LSD (5%)	**0.2**	**0.3**	**0.8**
2007			
Nil	2.6	11.8	3.8
100% SB	3.5	12.5	4.4
100% GS31	3.4	13.3	4.4
100% GS39	2.9	14.4	3.5
50% SB + 50% GS31	3.7	13.0	4.1
50% GS31 + 50% GS39	3.2	13.7	3.6
50% SB + 50% GS39	3.6	13.4	3.3
LSD (5%)	**0.2**	**0.3**	**0.7**
2008			
Nil	2.2	13.5	9.8
100% SB	4.7	13.4	8.5
100% GS31	4.4	14.4	8.9
100% GS39	3.4	15.1	9.9
50% SB + 50% GS31	5.4	13.5	9.0
50% GS31 + 50% GS45	4.3	15.0	8.8
50% SB + 50% GS45	4.8	13.6	9.6
LSD (5%)	**0.4**	**0.5**	**0.5**

◁i...CANOPY MANAGEMENT

management and previous N topdressing research is that all or part of the N inputs are tactically delayed until later in the growing season. This delay tends to reduce early crop canopy size but this canopy is maintained for longer, as measured by green leaf retention, during the grain filling period.

So can it work under Australian conditions – especially the shorter growing season of northern NSW? Results from southern regions have certainly showed some potential especially in areas with high yield potential and therefore higher N inputs – but further research was required to test and validate the principles in northern NSW.

RESEARCH

Since 2006 trials have been conducted by a collaborative research group including NSW DPI, Northern Grower Alliance, AgVance Farming, and Nick Poole from the Foundation for Arable Research – NZ. This work funded by GRDC has focussed on the interaction between delayed N applications in high yielding crops on the Liverpool Plains.

To test if canopy management principles did improve crop performance in northern wheat crops, trials were established under overhead irrigation systems to supplement water supply at the critical growth stages when urea was applied to the soil surface. N was applied at three times through the season – combinations of seedbed (SB), during early stem elongation (GS31) or after flag leaf emergence (GS39). Details of the research sites and treatments are in Tables 1 and 2.

Further research by NSW DPI and Northern Grower Alliance is also assessing the role of different N fertilisers and measuring the losses of N due to volatilisation.

WHAT WE FOUND

From 2006 and 2007 the response to tactically delaying N until later in the growing season was relatively consistent for main to late sown, short season crops (cv. Ventura). In both years delaying or splitting fertiliser N did not result in significant grain yield increases compared to seedbed N. But, grain yield was maintained when N was split between SB and GS31. Delaying all N until after GS31 or splitting with GS39 applications resulted in lower grain yields but higher grain proteins.

...iv ▷

FIGURE 1: Effect of delayed N on crop dry matter (kg DM/ha) of early sown wheat (EGA Gregory) in 2008

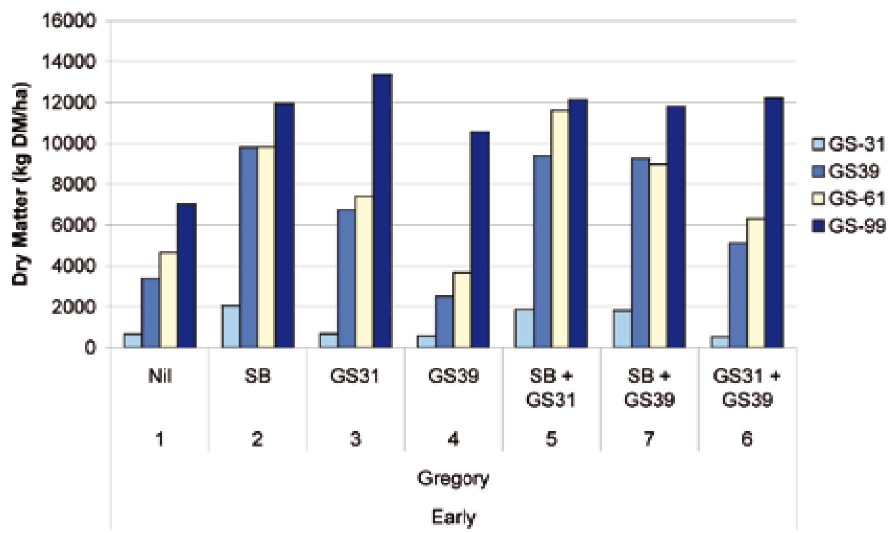
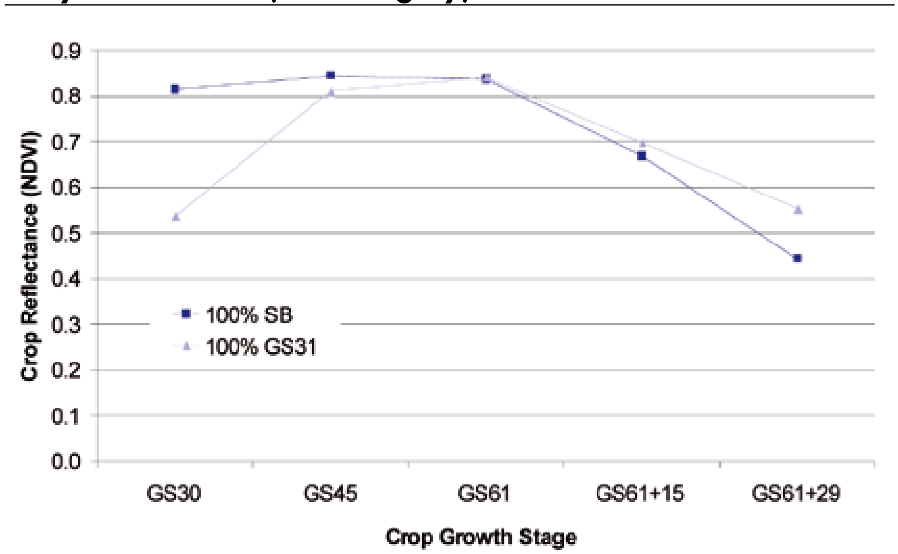


FIGURE 2: Effect of delayed N on crop reflectance (NDVI) of early sown wheat (EGA Gregory) in 2008



◁ii...CANOPY MANAGEMENT

In 2008 the responses when all N was delayed were much the same as in 2006 and 2007 with no advantage in delayed N (Table 3). But there was a 12 per cent increase in grain yield when applied N was split between SB and GS31.

Over the three years with late June or July sowings there has been an average 0.3 tonnes per hectare benefit to splitting N between SB and GS31 over the standard SB treatment (yield neutral in 2006, plus 0.2 tonnes in 2007 and plus 0.7 tonnes per hectare in 2008).

The results from the main sowing time in 2008 were encouraging but one of the key questions after 2006 and 2007 was what the response in early sown long season crops would be. In 2008 EGA Gregory was sown on May 29 to assess these responses.

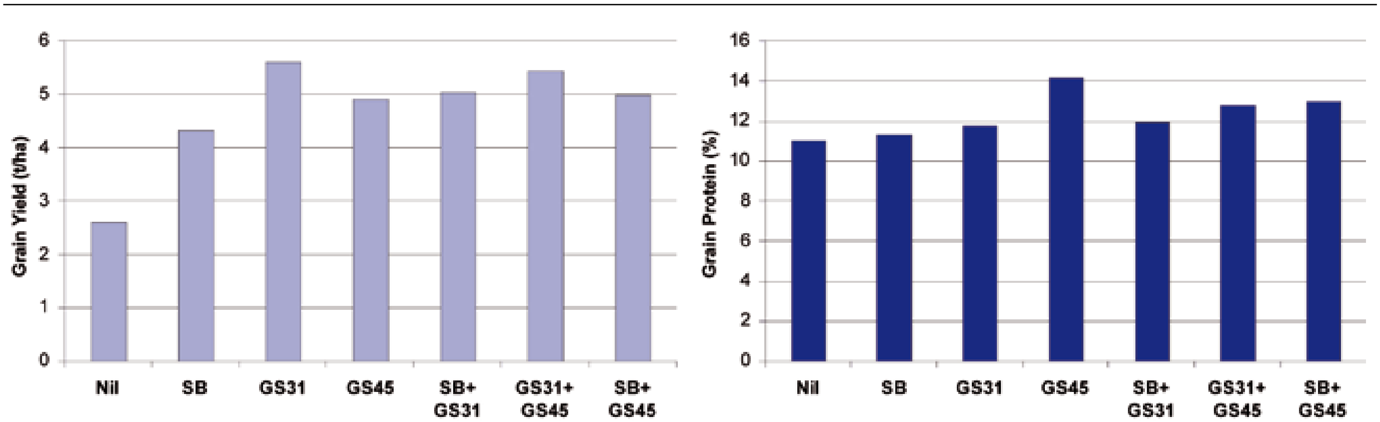
Surprising result

The magnitude of the response was somewhat surprising. As in previous years the site was strongly responsive to N. In fact, canopy size as measured by crop dry matter showed a threefold reduction by delaying N until GS31 (Figure 1). After flag leaf emergence and at flowering the canopy of the delayed treatments were still significantly smaller then the SB applied N. But by crop maturity all delayed N treatments, except when all N was applied after GS39, had reached higher peak dry matter levels compared to the SB applied N treatment.

These large differences in canopy size translated into very strong grain yield and protein responses (Figure 3).

For the longer season EGA Gregory all delayed N treatments resulted in signifi-

FIGURE 3: Effect of delayed N on grain yield and protein of early sown wheat (EGA Gregory) in the 2008 season



cantly higher grain yields compared to the SB applied N.

The highest yield was found when all N was delayed until GS31 with over one tonne per hectare extra yield, a result that appeared to be linked to the crop canopy staying greener for longer during grain fill (Figure 2). This increase in yield was accompanied by increased grain proteins for all delayed treatments, the greatest of which was when all N was applied after flag leaf emergence at booting (GS45).

N VOLATILISATION

The risk of N volatilisation remains a significant concern when applying in-crop N – particularly in northern NSW where lower rainfall incidence compared to southern regions and the presence of soil carbonates significantly increase the risk of N loss.

Despite the risk factors being well understood there is little quantitative information available on the effect of soil properties, different N fertilisers, and most importantly, field conditions on potential losses of N.

NSW DPI with the Northern Grower Alliance have been conducting lab based comparisons of the effect of differing soil properties and N fertilisers on the potential losses of N due to volatilisation.

The lab based work has verified that the presence of calcium carbonates at the soil surface significantly increases the potential losses of N while some N fertiliser products can reduce the potential losses (such as urea ammonium nitrate liquid, liquid ammonium nitrate and urea treated with a urease inhibitor – GreenUrea) (Figure 4).

Field based estimates of volatilised N are to commence in the coming spring under a GRDC funded project.

TO SUM UP

Results from three years of supplementary irrigated research have provided important pointers for the use of canopy management principles in northern NSW.

Tactically delaying N is a management system that allows flexibility to respond to seasonal conditions and manage climate variability. Research has shown that N fertiliser has been able to be delayed until stem elongation (GS31) without yield loss and usually with increased grain protein when conditions are suitable.

This means that growers are able to apply a portion of the expected N requirement and then assess yield potential, as influenced by soil water and seasonal forecasts, later in the season and respond accordingly.

To date the best results with this approach have been seen in early sown – long season varieties with high yield potential which are very N responsive with high N fertiliser inputs.

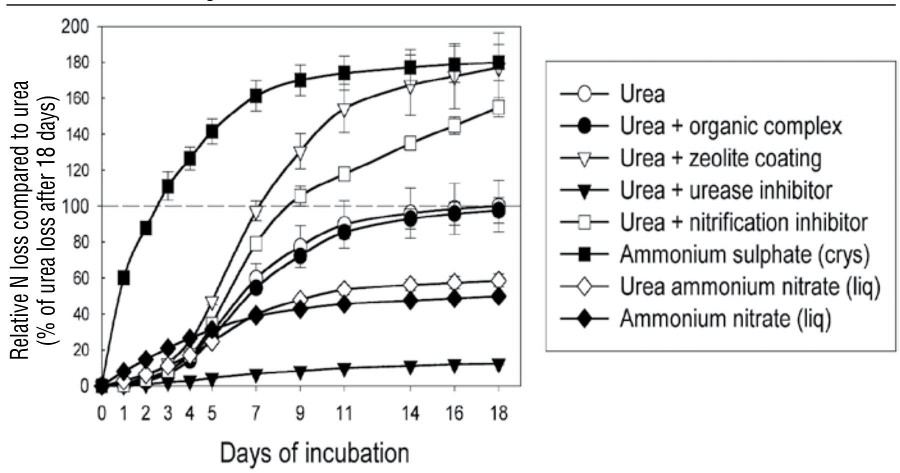
Further research in 2009 is looking at repeating these impressive responses and looking at the use of tactically delayed N in durum crops to improve yield and protein. Along with these primary aims the research group is also looking at using crop reflectance to assist in making N fertiliser decisions.

To date, crop reflectance (measured as normalised difference vegetation index – NDVI) at key growth stages has shown strong relationships to crop structure and yield.

A series of 'Soil 2 Grain' workshops are planned to keep growers and advisors up-to-date with the latest results and guidelines from the GRDC funded project (SFS 00017) on Canopy Management and Disease Management in cereal crops.

For further information contact Guy McMullen
E: guy.mcmullen@dpi.nsw.gov.au or
Nick Poole E: poolen@far.org.nz ■

FIGURE 4: Cumulative volatilisation loss of nitrogen (N) applied as fertiliser to the surface of an alkaline soil containing seven per cent $CaCO_3$



THE COMMERCIAL VIEW

By Peter McKenzie, Agronomist – AgVance Farming, Quirindi

The need to maximise dollar return on inputs is an essential part of farming and growers are constantly pressured by the cost/price squeeze.

Canopy management is generally viewed as a tool to maximise plant water use and to try to ensure adequate soil moisture reserves for grain fill. It means many different things to different people, but by far the most popular view of canopy management in Australia is manipulation of nitrogen application to alter plant biomass throughout the growing season.

With fertiliser, particularly nitrogen, being one of the largest input costs in growing a crop on the Liverpool Plains, it stands to reason that we should be pushing the boundaries of maximising the grain produced, per unit of nitrogen applied.

When starting a season with a full profile of moisture you can apply nitrogen with a degree of confidence of achieving the predicted yield. But adverse seasonal conditions will still result in excess application of nitrogen. When starting the season with less than a full profile, the harvested yield can vary by up to five tonnes per hectare which begs the question: Can we adapt southern canopy management principles to the northern cropping region?

Peter McKenzie in a Liverpool Plains sorghum crop.

Where does it fit for us?

Based on the results of three years of trials carried out by AgVance Farming, NSW DPI and NGA under the watchful eye of Nick Poole (FAR, New Zealand) it was concluded that delaying all nitrogen until Z30–31 had a detrimental effect on main season wheat plantings.

Yield was maximised on the treatments where all of the nitrogen was applied up front, or split 50:50 (between planting and Z30–31). NSW DPI/NGA demonstrated in one trial last season this may be different for longer season varieties, but this still needs to be proven over a number of years.

Based on the past three season's research, my current management approach is to establish a target yield level we believe we can achieve based on some back of the envelope water use efficiency calculations, using available moisture and predicted rainfall for the up coming season.

Generally, a full profile of moisture receives sufficient nitrogen up front to provide the entire crop requirement to the predicted yield level. If in the event yield potential is higher due to favourable seasonal conditions, there is generally opportunity to apply small amounts of nitrogen later to increase yield as the season progresses – but this usually isn't necessary.

In a lower moisture profile situation, my approach is to apply nitrogen at a rate less than the target yield level requirement and top the nitrogen up later in front of rainfall, as opportunities present themselves.

This requires careful planning and preparation on the grower's behalf, in order to take advantage of impending rainfall, sometimes in short timeframes.

The 50:50 split application of nitrogen extends the period that nitrogen can be applied through the season without the 'cliff face' drop in yield if nitrogen isn't applied at precisely Z30–31. Effectively it improves the margin of error available to the grower if rainfall isn't forthcoming at Z30–31.

Where growers are set up for and using precision agriculture, I apply a 70:30 approach when there is a full soil moisture profile and a 50:50 approach where soil moisture is likely to be limiting.

This is where a proportion of the predicted nitrogen requirement is held back until after NDVI imaging has taken place and nitrogen applied based on NDVI results. This also requires a high level of grower organisation and planning.

The limitations of tactical nitrogen application

The main limitation to such practices in the north is the ability to reliably apply nitrogen in front of a rain event, to enable roots to access soluble nitrogen in the root zone.

An analysis of rainfall events comparing Clare, South Australia and Wagga, NSW to Quirindi shows only 30 per cent of the opportunities to apply nitrogen as our southern counterparts and the predictability of rainfall events more than three days in front of rain is very unreliable.

Predicted rain fronts may pass without yielding a single drop therefore, dependably applying nitrogen throughout the season is risky. This becomes increasingly difficult as you head north and west of the Liverpool Plains to areas around Moree and Walgett.

Foliar nitrogen application has gained popularity in recent years, but this is only suitable for relatively low rates of nitrogen addition. In the likelihood of higher nitrogen input requirement, a system to apply nitrogen into the wet soil profile, after a rainfall event, at efficiencies that are economic, need to be devised to take full advantage of this system.

To date, I don't believe these technologies have been developed for agriculture. As technologies such as NDVI imaging and paddock management in zones are more refined and are more widely adopted, the addition of nitrogen later in the crop cycle will become more and more relevant and will force the development of equipment to make such a system work.

While our traditional thoughts of canopy management are based on southern experiences, we are developing our own guidelines for the northern cropping zone. The aim of improving the bottom line at the end of the season through manipulation of our most costly input is taking shape based on solid trial work and in-paddock experiences.

Adoption of these techniques throughout the northern cropping zone would be further aided by development of efficient, in-soil nitrogen application equipment.

IPM in the northern region

By Kate Charleston, Queensland Primary Industries and Fisheries, DEEDI, Toowoomba

The total grain cropping area of north eastern Australia (from Dubbo to North Queensland) is estimated at five million hectares. Wheat and coarse grains are grown on 92 per cent of this area with the remainder taken up by oilseeds and pulses.

Integrated pest management (IPM) in grain cropping farming systems has been promoted for over 30 years. The term IPM is used here to refer to the integration of tactics to manage pests, rather than a sole reliance on insecticides.

IPM is now well established in grain growing regions of north eastern Australia and many key IPM tactics have been widely adopted.

DRIVING FORCES FOR IPM

The late 1970s is used as a reference point for the start of IPM in north eastern Australia. This period marked a new era in pest management with the introduction of synthetic pyrethroids. These insecticides were cheap and effective against a broad range of pests.

Synthetic pyrethroids were widely adopted by industry yet within six years insecticide resistance developed and dramatically reduced efficacy against the primary field crop target *Helicoverpa armigera*.

Within a decade this pest developed high levels of resistance to many insecticide groups. These broad spectrum insecticides also decimated natural enemies which are often important in suppressing pest populations.

This crisis highlighted the vulnerability of the northern grains region to the dangers of relying solely on insecticides for the control of pests. It provided the impetus for the development of IPM recommendations, area wide management strategies, multi-pest strategies and the search for more selective insecticides and biopesticides.

A more recent driving force for IPM has been the arrival in Australia of silverleaf whitefly (SLW) in 1994. This pest poses significant threats to soybeans, sunflowers and navy beans. With no effective insecticides for the control of SLW, the only management option is to maximise the effectiveness of natural enemies.

IPM OBJECTIVES

The major objective of pest management has been to replace older, less selective insecticides with more selective products that allow natural enemies to contribute to pest control and suppress outbreaks.

The IPM strategy also includes the development of a range of techniques and options that reduce risk of pest attack.

Complementing IPM is the insecticide resistance management strategy. This strategy aims to limit the number of generations exposed to pesticides, rotate insecticide groups and restrict the number of sprays per season.

...viii ▷

Sucking pests like these green vegetable bugs cannot be controlled with selective insecticides. (Photo by D. Ironside)

ONGOING R&D

IPM remains high on the agenda of grain producers in the northern region and to meet this need the GRDC plans to continue funding IPM research.

Over the past decade, considerable progress has been made in the development, implementation and adoption of IPM tactics for some major insect pests. But the only available management options for other major pests, particularly pod-sucking bugs and pod-borers, have the potential to derail IPM because they are highly disruptive to beneficial insects.

Additional major IPM issues include the resistance threat to the new generation pesticides targeting *Helicoverpa armigera*, the likely deregistration of dimethoate (the only effective mirid and aphicide in grain crops), and the need for multi-pest IPM to reduce the risk of flaring SLW by eliminating prophylactic spraying.

Ongoing RD&E is clearly needed to address these issues.

◁vii...IPM IN THE NORTH

IPM TOOLS AND STRATEGIES

Insecticides

Insecticides are important tools in controlling pest outbreaks quickly. The development of more selective insecticides that are less disruptive to natural enemies is driven by resistance issues and de-registration of older products with residue, health and environmental concerns.

But for some pests (for example, sucking pests), there are currently limited or no selective options.

Economic thresholds

Economic thresholds are one of the cornerstones of IPM. They help rationalise and target reduced insecticide use. This reduces the impact on natural enemies, selection for resistance and the risk of environmental and health problems.

Economic thresholds for many pests have progressed from subjective recommendations (spray when pests reach damaging levels) to nominal fixed thresholds (such as, two larvae per metre) to more recent dynamic thresholds. These dynamic thresholds identify pest-crop scenarios where economic damage is not inflicted.

Sampling

Sampling reliability is critical to determine the type and number of pests present in the crop and whether these warrant control. Standardised beat sheet sampling has now been widely adopted in the grains industry and replaced a range of methods such as sweep nets and visual sampling.

Conservation of natural enemies

There is now considerable evidence that pests can flare rapidly when insecticides kill natural enemies.

Conservation of natural enemies is assisted by research into economic thresholds for a range of pests. This research has shown that the control of many primary pests, like sucking pests, can be delayed until the crop is at lesser risk from secondary pests like SLW.

Classical biological control

Australian grain economics (low crop value, large area and high labour cost) generally preclude the rearing and release of exotic and native natural enemies. The relatively small areas of many of the pest susceptible pulse crops such as soybeans also make commercial investment unlikely.

Nevertheless a range of introduced parasitoids have made a significant impact on insect numbers. Parasitoids like *Trichogramma spp.* that target helicoverpa eggs have been very effective yet parasitoids for other species are less successful. The release, in 2004, of *Eretmocerus hayati* for the control of SLW shows good establishment in SLW regions although its impact is yet to be determined.

Natural enemies such as *Trichogramma pretiosum* are very effective parasitoids of Helicoverpa eggs. (Photo by Brad Scholz)

Biopesticides

The pest crisis of the 1990s led to a renewed interest in bio-control options such as viruses, bacteria and fungi. Nucleopolyhedrovirus (NPV), a highly specific virus that only controls helicoverpa and *Bacillus thuriengiensis* (Bt) a bacteria that controls many caterpillar pests are two that have been commercialised and widely used.

Cultural control

Cultural controls, as pest management tools, have been widely adopted in grain farming systems. Common practices include; cultivation to destroy overwintering pupae, crop rotations and weed management to reduce alternative hosts. Some practices less widely used include; adjusting sowing rates to compensate for pest damage, using press wheels to reduce soil insect access to seed and irrigation management to keep surface soil moisture.

Area wide management (AWM)

On many grain farms insect pests are still managed on a field by field basis with little regard for neighbouring properties. AWM has been implemented on the Darling Downs where groups of growers managed the local population of helicoverpa by acting together on a broad geographic scale. Some of the approaches used in AWM include the planting of sacrificial crops to reduce early season populations and promote natural enemies by using selective insecticides.

This regional approach may provide benefits in managing other pests which are locally generated, for example SLW.

PROMOTING IPM

Pivotal to the adoption of IPM are the strong links between researchers, extension, consultants, growers and industry bodies. These links allow rapid dissemination of information, provide researchers with feedback about practical aspects of IPM and highlight IPM issues of greatest concern.

One very effective means of promoting IPM has been to offer IPM courses to growers and consultants.

WHERE TO FROM HERE...

The lack of effective insecticides and/or biopesticides for sucking pests in grains remains a major constraint to IPM implementation, particularly in pulse crops.

Other IPM alternatives such as trap cropping, host plant resistance and cultural control techniques also need further investigation. A reliable SLW rating scheme and sampling research into problematic pests will also provide much needed data to manage such pests.

The future of IPM in the grains industry is dependent on an ongoing partnership between researchers and practitioners of IPM – and good communication.

This overview is a summary of a paper by Hugh Brier, David Murray, Lewis Wilson, Adrian Nicholas, Melina Miles, Paul Grundy and Austin McLennan published in the Australian Journal of Experimental Agriculture 48 (12): 1574-1593.

This research was funded by the GRDC. ■

NEW COLLABORATIVE PROJECT

The GRDC is funding a new collaborative project between CSIRO Entomology, Queensland DPI&F, DAFWA and the University of Queensland.

In agricultural landscapes in north, south and west Australia, they are investigating how grain pests are affected by the composition of the landscape by:

- Identifying source habitats of pests and natural enemies;
- Assessing their movement between habitats such as native vegetation and crops; and,
- Working out how long it takes pests and their natural enemies to colonise crops and how this is influenced by the landscape in which the crops are grown.

The research will identify the features of landscapes that suppress pests and will align IPM guidelines for pest management at several scales – field, farm and landscape. It is hoped the results will help reduce farmers' reliance on broad-spectrum insecticides, and, at the same time consider the broader public benefits of biodiversity and conservation.