

## WINTER CEREAL APHIDS – A RESEARCHER’S VIEW

*Melina Miles. Queensland Primary Industries & Fisheries, DEEDI*

- The impact of aphids on winter cereals (yield and quality) is the result of a complex relationship which involves the timing of infestation, aphid density, where on the plant the aphids feed, and crop physiology at the time of infestation.

The most critical issues we face in managing cereal aphids currently is the lack of local knowledge about the likely impact of infestations on yield and quality (the damage thresholds). It might seem surprising that there has been very little work done on cereal aphids in Australia, but historically cereal aphids have been occasional pests and their potential impact considered minor.

The growing concern about aphids in barley and wheat begs the question “What has changed?”. Have the yield expectations for the crops changed? Are they being monitored more closely? Have there been changes in varieties or agronomy that have made crops more attractive or more susceptible to aphids?

### **How do aphids impact on winter cereals?**

Overseas, and in the higher rainfall grain production regions of Australia (e.g. southern WA and Victoria) Barley Yellow Dwarf Virus (BYDV) is transmitted by aphids, and is a key factor in yield loss. In Australia’s northern region, BYDV is thought to be less common and less likely to contribute significantly to yield loss (although there has been little testing for BYDV in the northern region).

In the absence of BYDV, aphids affect cereal plants by direct feeding, effectively creating a nitrogen sink, diverting nitrogen away from the developing and filling grain. Aphids use the nitrogen for their growth and reproduction.

### **Based on overseas experiences there are some general points that can be made about the impact of aphids in winter cereals:**

#### **Early aphid infestations** (from seedling)

Root and shoot growth may be impaired as a result of aphids competing for nitrogen (N). Inadequate N for the crop may make the crop more vulnerable to the impact of an aphid infestation.

Prolonged infestation can reduce tillering, affect seed number, and result in earlier leaf senescence. Controlling aphids generally results in a recovery of the rate of root and shoot development, but there can be a delay in time to maturity.

#### **Late aphid infestations**

There is no impact on yield after grain has filled and is maturing (soft-hard dough).

Infestations that occur during booting to milky dough, particularly where aphids are colonising the flag leaf (flag-1 in barley), stem and ear, result in yield loss. Generally, the distal grains in the head fail to fill. Infestations at this stage in which aphids colonise the leaves, particularly lower in the canopy tend to result in grain with reduced N (protein) rather than a loss in yield. Aphids are intercepting the N being relocated from leaves to the filling grain.

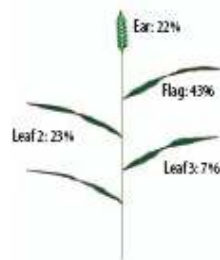
## Starting point for aphid management

If we consider the overseas data, and what we know about IPM basics, there are some 'rules of thumb' that we can apply to the management of aphids in winter cereals, whilst we gather local data.

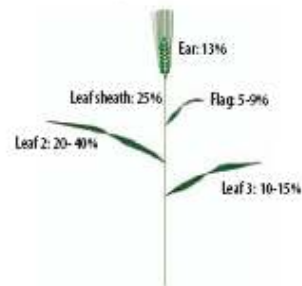
- 1) Aphids are historically a sporadic pest. We have had a run of seasons (3-4) with relatively high aphid numbers. Aphids are likely to be abundant in seasons following a relatively mild and wet winter and spring; conditions that allow populations of aphids to build up on weed hosts. Seed dressings are a prophylactic treatment. They provide a benefit in seasons when aphids are abundant, but not in seasons when aphids are not problematic.
- 2) Aphid species, including all those we encounter in winter cereals in Australia, have developed resistance to a wide range of insecticides overseas. There is no data on resistance in these species in Australia. However, the widespread and repeated use of neonicotinoid products (e.g. imidacloprid seed dressings), carbamates (e.g. pirimicarb) and organophosphates (e.g. dimethoate) poses a risk to the longevity of these products. Cotton aphid is found in winter cereals, and the choice of insecticide to manage cereal aphids may have implications for ongoing resistance management of cotton aphid.
- 3) The early treatment (tillering and earlier) of aphid populations with broadspectrum insecticides, e.g. synthetic pyrethroids and organophosphates has the potential to flare aphids by killing the numerous natural enemies that suppress populations (e.g. ladybeetles, hoverflies, lacewings). Treating early inevitably results in the application of further treatment/s prior to grain fill.
- 4) Whilst aphid infestations decline naturally, the period of crop development during which they tend to peak is sensitive to their impact. The figure below illustrates the contribution of the upper leaves, stem and ear to the yield of wheat and barley (GRDC Winter Cereal Crop Growth Guide, 2005). This is consistent with overseas data that show aphid impact on yield is high when they are present high in the canopy from boot to head emergence.

Approximate yield contribution of top three leaves in cereals (based on UK/NZ data)

1. Winter wheat



2. Winter barley



- 5) Distribution in crop and implications for sampling. Early in the infestation the distribution of aphids may be higher around the edge of the crop. Early infestations are highly patchy and more sampling is needed to determine the average density of the infestation. Sampling individual tillers provides a more uniform measure than trying to assess density per plant or per unit of row/area. At low density, a sample of at least 30 tillers per field will be needed to assess distribution (across the field and within the crop canopy) and aphid numbers. At higher densities, when the population becomes more uniform across the field, fewer samples will be needed to make the assessment.

## Summary

We need to better understand the relative impact on yield of early infestation (prior to stem elongation) and later infestations. Ongoing QPIF research is focussing on determining under what conditions (crop stage, aphid species, density, pattern of infestation) yield and quality losses occur. Research is also addressing the development of reliable sampling strategies and control options for the different species. A better understanding of the relationship between natural enemy numbers and their potential to contain aphid outbreaks would assist considerably with decision-making, particularly early season.

### **Acknowledgements**

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### **Contact details**

Dr Melina Miles

QPIF, Department of Employment, Economic Development and Innovation

PO Box 102, Toowoomba 4350

Phone: 07 46881369

Fax: 07 46881199

Email: [melina.miles@deedi.qld.gov.au](mailto:melina.miles@deedi.qld.gov.au)

## **Aphids in Barley - The Commercial View**

**by Stephanie Belfield HMAg Pty Ltd**

Five years ago when aphids starting appearing in barley crops in NNSW, especially around North Star, we dismissed them as an inconvenient pest that made our legs sticky and dirtied the windscreen. Upon discussing with researchers the potential impact of aphids on barley yields, everyone I spoke to drew a blank with next to no work having been conducted in cereals in the northern grains region. The common response was that they transmit viruses such as Barley Yellow Dwarf Virus (BYDV) and otherwise would need to be a large population to affect the crop.

That season passed with the odd crop sprayed for the pest and no real idea whether it was economic or not. The unusual aphid pressure was put down to seasonal events and not expected to be a frequent occurrence. However, it was not a one-off and next year they were back. The industry was still none the wiser as to economic thresholds and how much emphasis to place on this pest.

At the time I was NSW DPI District Agronomist for Moree East which meant I was conducting variety evaluation trials around the region. In these trials I was noticing

the aphids were worse in varieties affected by net blotch. It was a case of the chicken or the egg- which was there first? I deduced the net blotch was there first and the aphids were preying on sick plants. In severe cases this combination of afflictions resulted in stunted plants and delayed or reduced head emergence. It was becoming increasingly obvious we needed to control these suckers.

Unanswerable questions remained as to the most effective timing for control, product choice and of course economic thresholds for spraying. Some work had been conducted in WA suggesting thresholds and yield benefits in the range of 10-30% yet with variable results. With the vastly different climatic conditions of northern NSW compared to WA we were unsure of how much heed to pay to these trials but at least it gave us a starting point.

After much pestering and increasing decibels from this region with now several seasons of aphid pressure, we had someone willing to research this escalating problem in our northern farming system. NGA to the rescue ; with strong collaboration from specialists at both NSW and QDPI, 2008 finally saw the first regional management trials undertaken.

Generally aphids are present in low numbers in the crop at early growth stages and build up as the season progresses. Spring aphid flights also provide a large influx of the pest during stem elongation to head emergence. However with the mild winter we are currently experiencing in NWNSW some crops are quite advanced with awn peep late July and early aphid flights in mid July. Is this early build up a sign of increasing aphid pressure or a season abnormality? It means we are left with little choice but to spray early and hope they don't return like usual in September. By then crops will be maturing and appear to be less attractive post head emergence. The current relatively low commodity value of barley presently means two in crop sprays are not usually a viable option.

Sometimes an insecticide can be timed with a fungicide but are usually outside the window for in crop herbicide applications. Last year at growth stage Z39 to Z59 we applied mixtures of dimethoate and alpha-cypermethrin, which combine to give good control with some residual. A softer option is the use of pirimor, however it was in short supply last year. Other practices have included treating seed with insecticide at sowing to give early protection. We are eagerly awaiting more NGA data to build the

dataset before confirming this is economically viable. However early results look promising.

The effect of aphid invasion on yield and quality needs greater clarification. There pests are not limited to barley but often build to concerning levels in wheat crops as well.

There are several species of aphids present in our crops which attack different parts of the plant. We need more information on which species we should be most concerned about. Personally, I feel the corn aphid and the rose-grain aphid that tend to colonise the flag and flag minus one leaves are of great concern. If crops are moisture stressed the aphids colonising the roots and crown become more of an issue.

The continuation of trials means we are all constantly learning more about this problem and look forward to this season's results. The work carried out by NGA is invaluable for growers and advisors in the northern grains region. Their on farm research and continued collaboration with technical specialists in the given field at both NSW and QDPI ensures timely and effective answers to our everyday production queries.

## **APHIDS IN WINTER CEREALS – JUST A NUISANCE OR AN ECONOMIC PEST?**

**By Richard Daniel NGA**

### **Break out messages**

- *High levels of aphid pressure (~35-95 aphids/tiller in Untreated) occurred naturally in all four trials*
- *Untreated aphid numbers rapidly built up from early September but also rapidly declined ~3-4 weeks later*
- *Seed treatment provided significant aphid control for ~70-90 days from planting and resulted in an average yield benefit of 10% or 330 kg/ha (range 7-16% or 239-439 kg/ha)*
- *Foliar insecticide control of 'crown' colonising aphids was not effective*
- *Foliar insecticide control of 'foliage' colonising aphids was effective and generally resulted in similar yield benefits compared to the seed treatment*
- *A foliar insecticide application when aphid numbers were declining did not provide good aphid control or any yield benefit*
- *Despite the higher yields, seed treatment generally resulted in lower grain quality but did not affect final grain quality grade at any site*
- *Seed treatment resulted in an average net benefit of \$37/ha (range \$25-50/ha) assuming a grain price of \$125/t on-farm*

## Background

In November 2007, NGA consultative committees in both the Goondiwindi and Moree/ Narrabri districts raised the issue of aphids in barley as a problem of increasing regional importance. Although aphids have historically been a fairly minor issue in winter cereals, recent commercial experience was that the frequency of 'bad aphid years' was climbing together with a general increase in aphid observations. The industry was seeking answers to two key questions:

1. How much impact are aphids causing in barley?
2. What management strategies should be considered and when should they be employed?

## The approach

The original plan in 2008 was for commercial scale management evaluation, however poor barley prices resulted in reduced planting areas and difficulty in securing suitable sites. Plan B was to conduct four small plot trials in close collaboration with the northern barley agronomy group led by Dr Guy McMullen, NSW DPI. The barley group planted and harvested all trials together with providing grain quality assessment. NGA conducted field monitoring and foliar insecticide applications.

Trials were established at four widely spaced locations: Yallaroi, Bullarah, Spring Ridge and Gilgandra with planting dates from late May to late June. Three varieties were evaluated at each site (Fitzroy, Grout and Gairdner) with four replicates of all treatments. All varieties were planted at equivalent viable seeds per plot with sowing rates of 43-46 kg/ha. Four treatments were evaluated at each site:

- Untreated - seed treated with Baytan<sup>®</sup> (triadimenol) only
- Seed treated with Zorro<sup>®</sup> (triadimenol + imidacloprid) 400 mL/100 kg seed
- Seed treated with Baytan then sprayed with two different foliar insecticide treatments

At Yallaroi and Bullarah dimethoate was applied at two different timings whilst at Spring Ridge and Gilgandra dimethoate and Pirimor<sup>®</sup> were applied at the same timing. Dimethoate was applied at 500 mL/ha in all situations. Pirimor was applied at 150 g/ha at Spring Ridge and at 300 g/ha at Gilgandra.

## What did we find?

### Crop establishment

There was no significant difference in emergence between Baytan and Zorro treated seed in any trial or on any variety, although Zorro treated plots trended to slightly increased establishment counts.

### Aphids

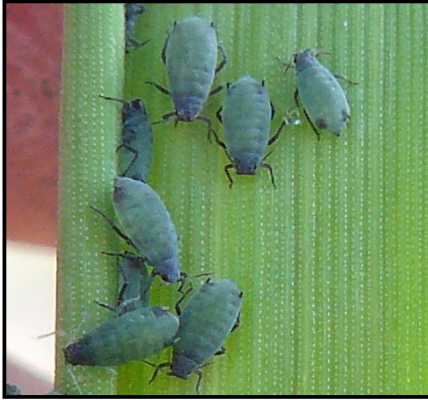
High numbers of aphids (35-95 aphids/ tiller) were found in the Untreated at every trial. In addition multiple aphid species were found in every trial:

- **Oat aphid** (*Rhopalosiphum padi*) - first species detected at most



tiller)  
site.

sites, generally first found in 'crown' region of plant at or near ground level. Individuals or colonies were found later often scattered in the lower to mid canopy. Reddish area at base of abdomen distinctive. Individuals often light coloured when colonising crown but olive green when higher in canopy



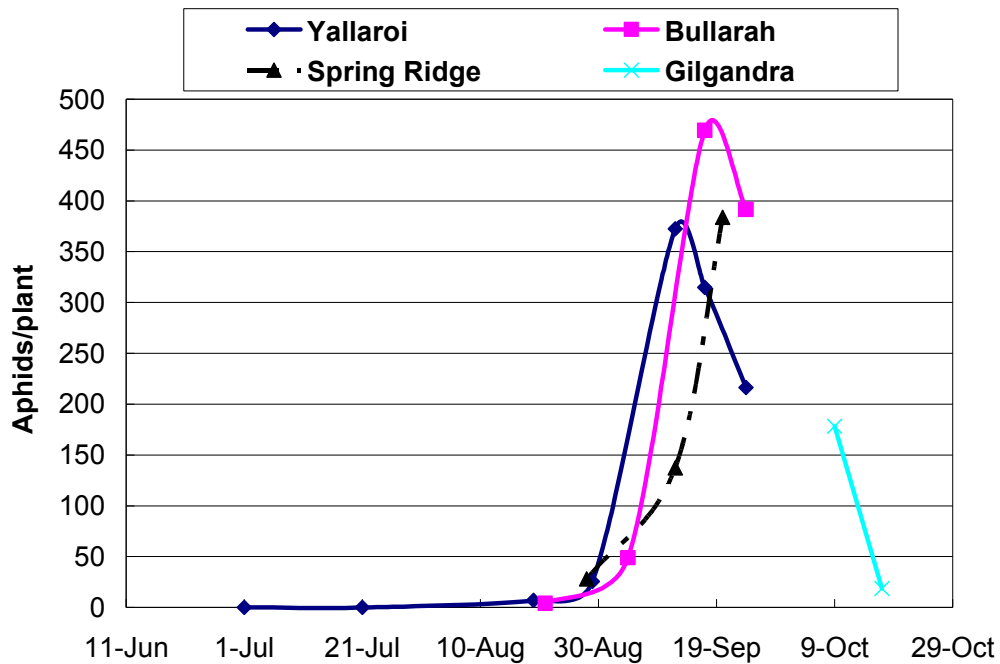
- **Corn aphid** (*Rhopalosiphum maidis*) – found on upper leaf whorls in very dense colonies with rapid build-up and decline in numbers. Uniform in colour and more solid and rectangular in shape. The equivalent of 'aphids on steroids'

- **Rose-grain aphid** (*Metopolophium dirhodum*) - numbers built up later in all trials and often found in colonies on the underside of leaves. Much lighter overall colour with prominent green stripe down middle of back

In 2008 there was a general pattern that aphid numbers built up rapidly from the end of August/ early September with a rapid natural decline at most sites by the end of September/ early October.



*Figure 1: Aphid populations in Untreated*



**How effective were the treatments?**

***Aphid control***

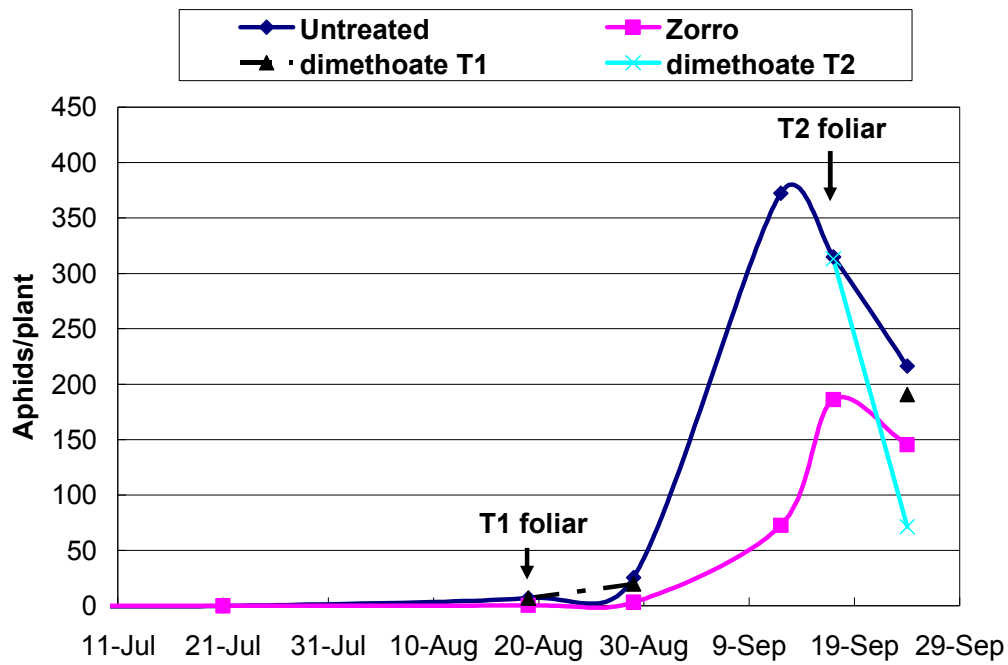
Figure 2 shows the treatment impact on aphid numbers at Yallaroi - the most intensively sampled site. At this site we investigated the impact of an early foliar application (T1) when oat aphids were primarily colonising the plant crown at a population of ~6 aphids/plant. The delayed foliar application (T2) was made 4 weeks later when counts were ~65 aphids/tiller.

Key points

- Zorro provided effective aphid control for ~70-90 days with useful suppression after that period. Zorro appeared to delay the peak in aphid counts compared to the Untreated
- Dimethoate applied to 'crown' colonising oat aphids did **NOT** provide significant levels of control (<50% control at both sites where evaluated)
- Both Pirimor and dimethoate provided similar levels of control (70-85%) in all trials when applied on 'foliar' colonies
- There were no consistent varietal differences in aphid numbers or level of control



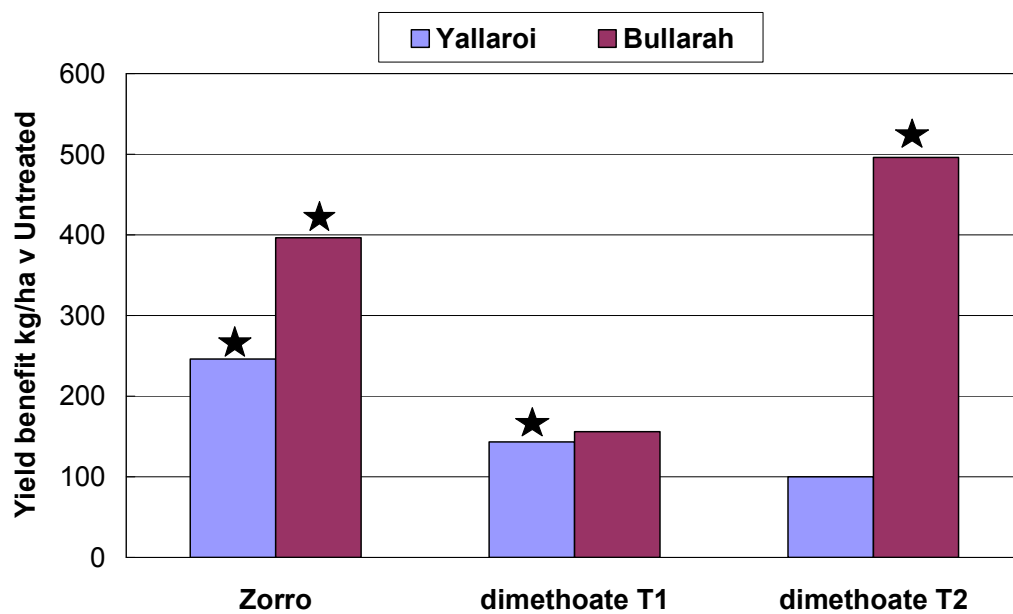
Figure 2: Aphid management at Yallaroi



### Yield

Factorial analysis showed there was no significant interaction in yield for variety x insecticide at any location ie all varieties reacted similarly. All yield results are for the 'overall' insecticide performance.

Figure 3: Yield benefit v Untreated (Yallaroi and Bullarah)

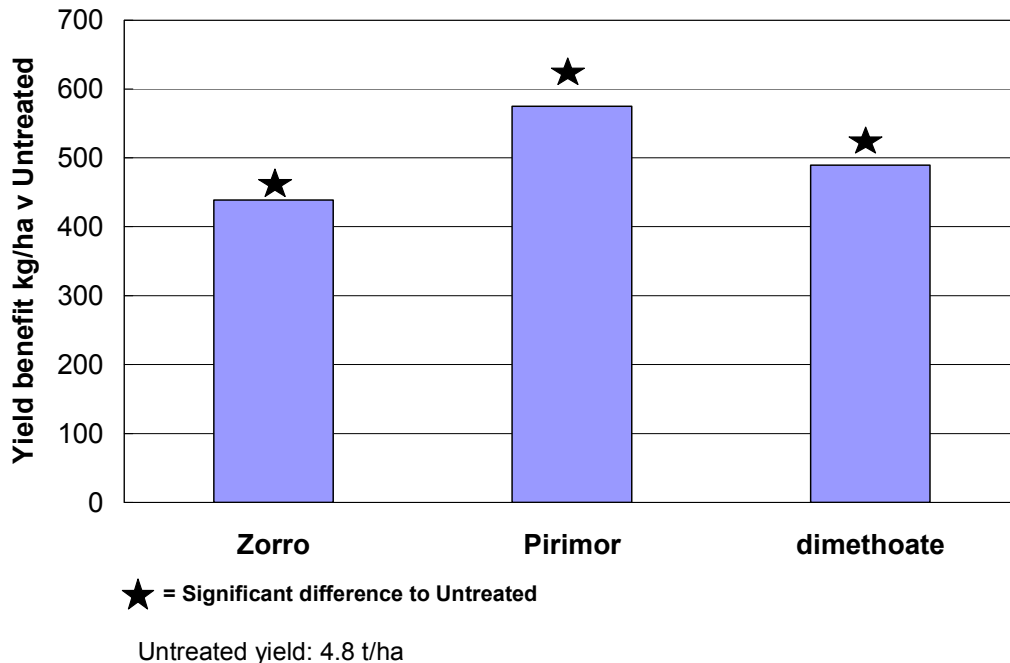


★ = Significant difference to Untreated

Untreated yields: Yallaroi 3.5 t/ha and Bullarah 2.5 t/ha.

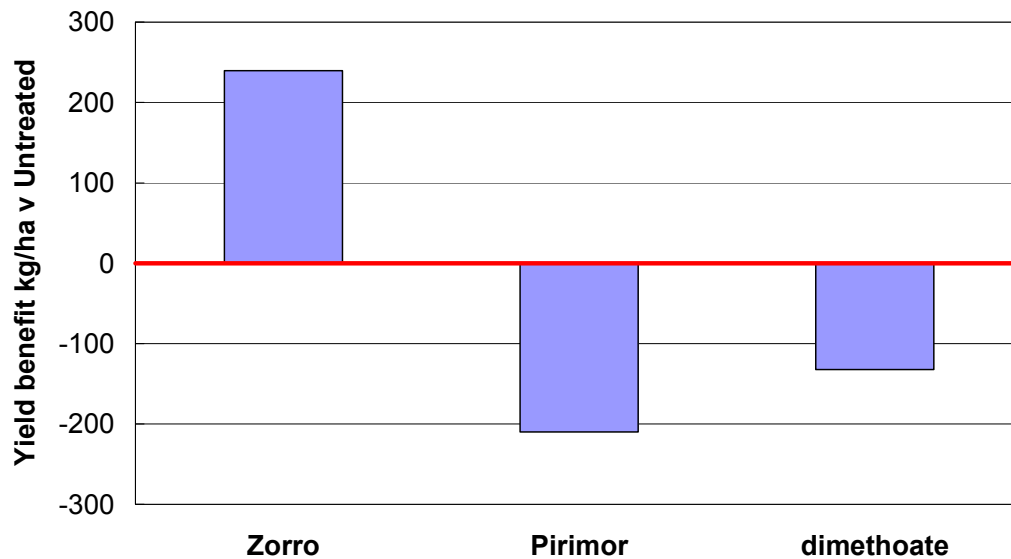
- All treatments recorded higher yields than the Untreated at both sites
- Zorro resulted in a significant yield benefit compared to the Untreated at both sites
- T2 at Yallaroi provided the best final aphid control but was applied when Untreated aphid counts were already declining. This application timing appeared to be **too late** to provide significant yield protection
- More apparent benefit from T2 application at Bullarah. This site had heavier aphid pressure with T2 application at the peak of assessed aphid numbers

Figure 4: Yield benefit v Untreated (Spring Ridge)



- Pirimor (150 g/ha) and dimethoate were applied to a population of ~26 aphids/tiller
- **Foliars were applied as the aphid population was starting to build up**, not already at its peak or declining (Untreated population tripled in the week after application)
- There was no significant difference in aphid control between Zorro and either foliar insecticide
- There was no significant difference in yield between Zorro and either foliar insecticide

Figure 5: Yield benefit v Untreated (Gilgandra)



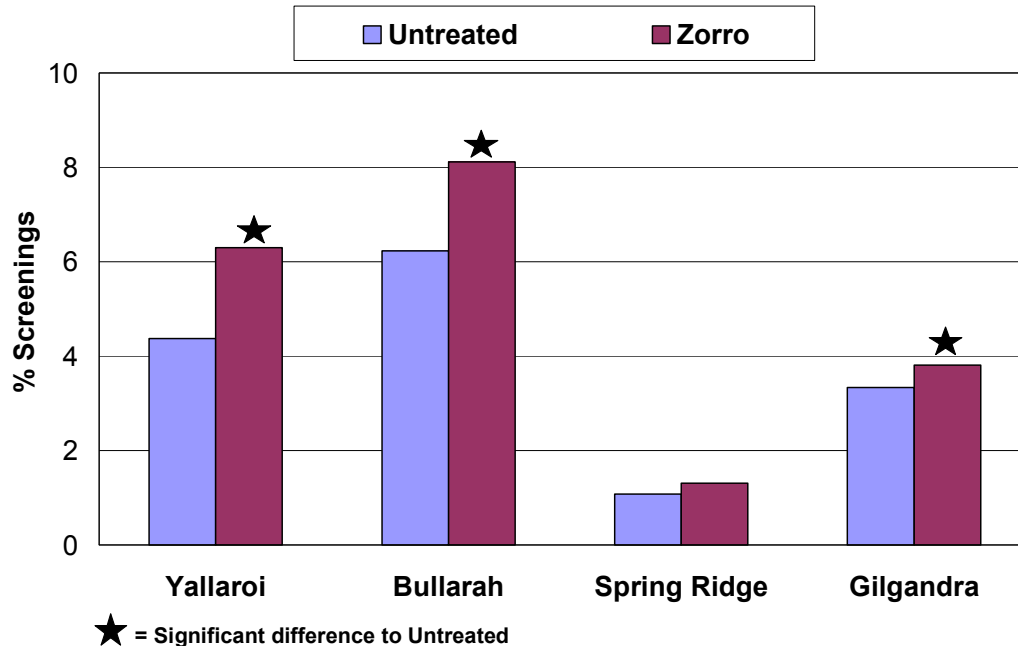
★ = Significant difference to Untreated

Untreated yield: 2.8 t/ha

- Pirimor (300 g/ha) and dimethoate were applied to a population of ~36 aphids/tiller in early October (~3-4 weeks after all other sites) when all varieties had full head emergence
- Intent was to examine for benefits from a very late foliar application
- Aphid numbers crashed in week after application to ~4 aphids/tiller
- Under conditions of rapid population decline, neither foliar insecticide provided significant control
- No treatment recorded significantly different yield to the Untreated.
- The apparent trend to reduced yield from both foliar treatments is likely to be experimental error associated with mechanical crop damage from the very late application.

### Grain quality

Figure 6: Screenings Zorro v Untreated all sites



- Zorro resulted in a clear trend to **increased screenings** at all sites
- Foliar insecticide application on ‘foliar’ colonies trended to **equivalent or marginally reduced screenings** compared to the Untreated

### Quality classification

There was no difference in receival grade for any treatment, on any variety, at any site. At Yallaroi, Bullarah and Gilgandra all treatments were eligible for Feed 1 delivery. At Spring Ridge both Fitzroy and Gairdner were eligible for Malt 1, Grout was eligible for Feed 1.

### Net Cost/ Benefit (\$/ha) v Untreated

	Yallaroi	Bullarah	Spring Ridge	Gilgandra
<b>Zorro</b>	+26	+47	+50	+25
<b>dimethoate ('crown' colonies)</b>	+5	+7	na	na
<b>Pirimor</b>	na	na	+57	-41
<b>dimethoate ('foliar' colonies)</b>	0	+50	+49	-29

Assuming all grain Feed 1 - \$125/t on-farm, Zorro \$160/t seed, seed treatment application \$30/t seed, Pirimor \$7.2/ha at 150 g/ha, dimethoate \$4.5/ha at 500 mL/ha, ground rig application \$8/ha

### Conclusions

This was the first year of detailed regional trial work investigating aphid impact with a range of management approaches. Clearly we do **NOT** know if these results are representative of average conditions. However some general conclusions on the basis of 2008 results are:

### Aphids

- High numbers were found at all sites in 2008 with multiple species at each location
- Populations built and declined very rapidly in 2008

### ***Aphid control***

- Zorro provided consistent levels of aphid management until late August/early September
- Dimethoate application on oat aphids in the plant 'crown' area provided poor levels of aphid suppression
- Pirimor and dimethoate provided equivalent levels of aphid control on foliar colonies

### ***Yield and grain quality***

- Although good levels of benefit were obtained with most treatments, 2008 was a season with high aphid pressure. Results may differ under lower aphid pressure
- There was no indication of barley yellow dwarf virus (BYDV) at any site
- Most consistent yield benefit (~10%) was obtained from the seed treatment Zorro
- However, although not impacting quality classification in 2008, Zorro did result in higher screenings and lower test weight than the Untreated
- The most consistent foliar insecticide results were obtained when sprays were applied early in the 'foliar' population build-up eg Spring Ridge
- The late foliar applications at Gilgandra did not provide any benefit

### ***Economics***

- Zorro provided a mean \$37/ha net benefit (range \$25-50/ha)
- Similar level of benefit from foliar when application apparently well timed

### **Looking forward**

The 2008 activity has provided some information on the benefits and approaches to consider in a high aphid pressure season. However it highlights our limited understanding of the impact of aphids in winter cereals.

NGA have a comprehensive suite of field trials established in 2009, including 8 sites in collaboration with both NSW and QDPI. These trials are aimed at further examining:

1. The yield and economic impact of aphids in winter cereals across a broad geography
2. The benefits and limitations of a range of management options
3. The population dynamics of the different species

Further work is also necessary to better understand the biology of the individual species as well as identifying where and when an IPM approach can assist. This is critical as the last thing we need is to get on an insecticide spray 'treadmill' such as existed in cotton in the 80's and 90's.

### **Contact details**

Richard Daniel

Northern Grower Alliance

Ph: 07 4639 5344

Email: [richard.daniel@nga.org.au](mailto:richard.daniel@nga.org.au)