Integrated pest management (IPM)

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Take home messages

- *Insecticide sprays are effective in controlling crop pests, but do not always provide yield benefits.*
- *Insecticide seed treatments fit into an IPM program and should be considered over foliar sprays as a strategy to combat crop establishment pests.*
- *Canola crops can compensate significantly from early season attack by insects (and mites) if good growing conditions are experienced through late winter and spring.*

Background

Insect and other invertebrate pests represent a significant challenge to sustainable grain production in many parts of Australia. Reliance on 'broad-spectrum' insecticides to control agricultural pests can lead to problems with pest resurgence, the emergence of secondary pests that were not previously problematic and the development of insecticide resistance. Integrated Pest Management (IPM) is a shift away from the conventional practice of routinely applying broad-spectrum insecticides to crops. IPM principals involve a solid understanding of pest biology, beneficial insects and host crop phenology to prevent unacceptable levels of pest damage using a variety of control tactics. At the same time, IPM strategies pose the lowest possible risk to people and the environment.

Although IPM has been adopted by growers in the cotton industry and for several horticultural commodities, there has been relatively little uptake in broad-acre farming systems. With support from GRDC, CESAR Consultants and BCG are undertaking a two year trial at Charlton to determine whether IPM is the best option for farmers managing pests in the region. This trial forms part of a national project involving a total of five replicated trials across southern Australia.

Aim

To give farmers a better understanding of the different pest management tools available and identify which work best in certain circumstances. This knowledge will help reduce farmers' reliance on broad-spectrum insecticides to fight pests.

Method

This trial was set up large scale, with each plot measuring 50m x 50m. Plots were intentionally established in a long-term pasture paddock with no recent insecticide history, in order to maximise the abundance and diversity of invertebrates present at the commencement of the trial. The trial has three treatments:

1) No insecticide input (Control).
2) 'Strategic' approach: insecticides are applied only when needed, following accurate monitoring of pest and beneficial invertebrates combined with assessments of plant damage. When insecticides are needed, the most selective or 'soft' chemical options are chosen.
3) Conventional: insecticides applied according to typical farmer practice in this region.

Invertebrates were assessed in all plots throughout the duration of the growing season, using a combination of collection and assessment methods. These included vacuum sampling, pitfall traps, direct visual searches, sweep netting and extracting invertebrates from soil core samples. In addition, plant-based assessments were conducted during the establishment period; these included plant counts and assessment of the level of pest-feeding damage to plants. Dry matter cuts of plants were taken prior to harvest and then threshed out to calculate harvest index. Yields were measured with a plot harvester by taking three 30m long strips in the central section of each plot.

Location:	Charlton
Replicates:	Randomised block design with 4 replicates
Sowing date:	12 May 2010
Seeding density:	40 plants/m^2
Crop type:	44C79 canola
Seeding equipment:	22.5cm row spacing, knife points, press wheels

Table 1. List of insecticide treatments used in trial at Charlton.

Treatment	Product	Timing	Rate
Control	None	-	-
Conventional Le-mat 290 SL®	Fastac Duo® Post emergent	Bare-earth (PSPE) 100ml/ha	100ml/ha
Strategic	Gaucho 600®	Seed treatment	400ml/100kg seed

Results

Plant numbers were monitored at 7, 14, 28 and 42 days after emergence. Control plots had the lowest plant numbers, then Conventional, while the Strategic plots had the highest at each sampling date (Figure 1). At 7, 14 and 28 days after emergence, there was a significant difference in plant numbers between the Control and Strategic plots (which is indicated by the letters, a and b on the graph). However, there was no significant difference at 42 days after emergence.

Error bars indicate standard error of the mean. Bars with the same letter are not significantly different from each other (at the $P < 0.05$ level, Tukey's-b post hoc test).

Invertebrate numbers were monitored throughout the season using a variety of methods. In pitfall traps that were left open from 35-42 days after crop emergence, numbers of several invertebrate groups varied between the three treatments (Table 2). The differences in plant densities are predominantly due to the feeding activity of the earth mites and lucerne flea. In the Conventional plots, these pests were effectively controlled (by two broad spectrum insecticide applications), whereas in the Strategic plots there were some pests present however the seed treatment meant they did not significantly limit seedling vigour. Beneficial insects such as predatory mites, predatory beetles and spiders were present in relatively low numbers during autumn and winter (Table 2).

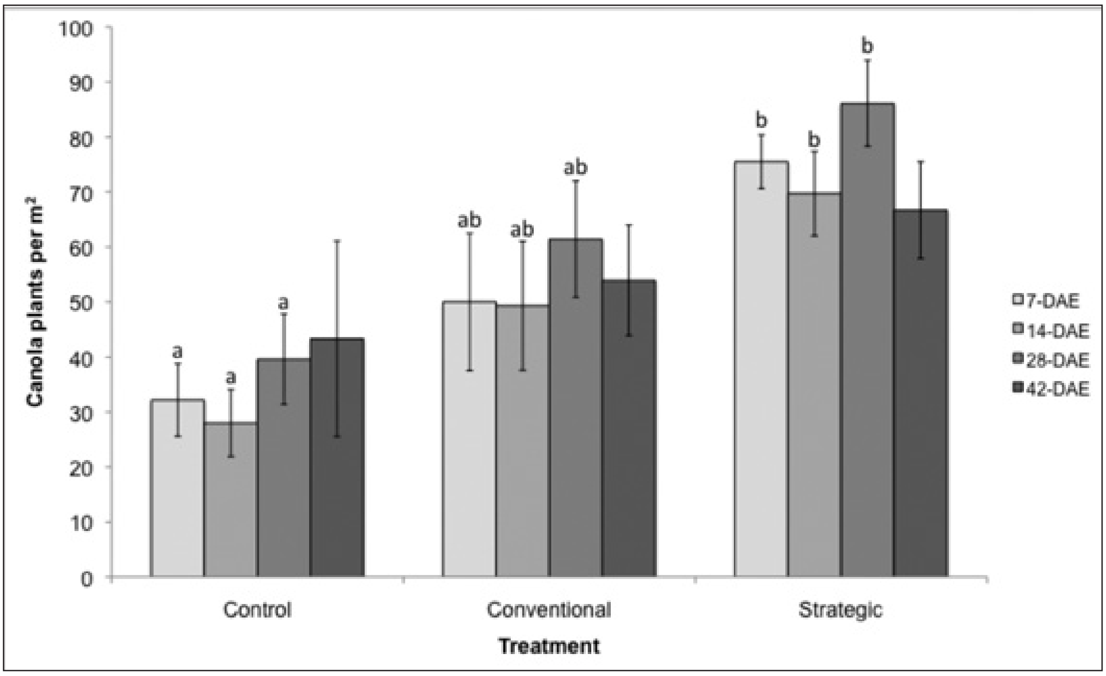

Figure 1. Average numbers of canola plants per square metre in plots at 7, 14, 28 and 42 days after crop emergence.

Table 2. Average numbers of invertebrates collected in pitfall traps from 35 – 42 days after crop emergence. P = pest species, B = beneficial species.

Species	Control	Conventional	Strategic
Redlegged earth mites (P)	62.35	0.11	9.13
Lucerne flea (P)	7.71	0.06	5.79
Predatory mites (B)	2.06	0.83	2.92
Predatory beetles (B)	0.82	0.94	0.96
Spiders (B)	1.53	1.28	1.58
Soil Collembola (B)	145.65	77.44	99.33

The visible damage caused by pests during establishment was measured at 7, 14, 28, 42 and 62 days after crop emergence (Figures 2 & 3). Despite having some pests present, the plants within the strategic plots were comparable with the conventional plots and incurred lower damage than the controls.

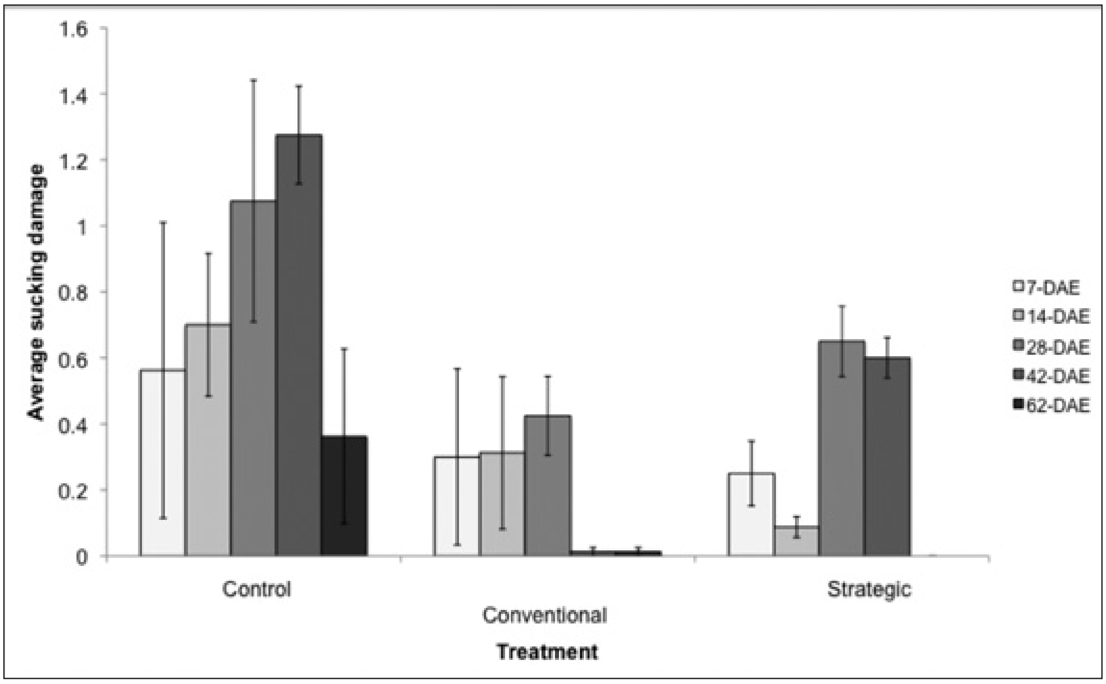

Figure 2. Average pest 'sucking' damage to canola plants (seen as silvering on the leaf surface) at various days after crop emergence. Scores are based on a 0 – 10 scale where 0 = no visible damage, 5 = 50% of leaf surface damaged etc. Error bars indicate standard error of the mean.

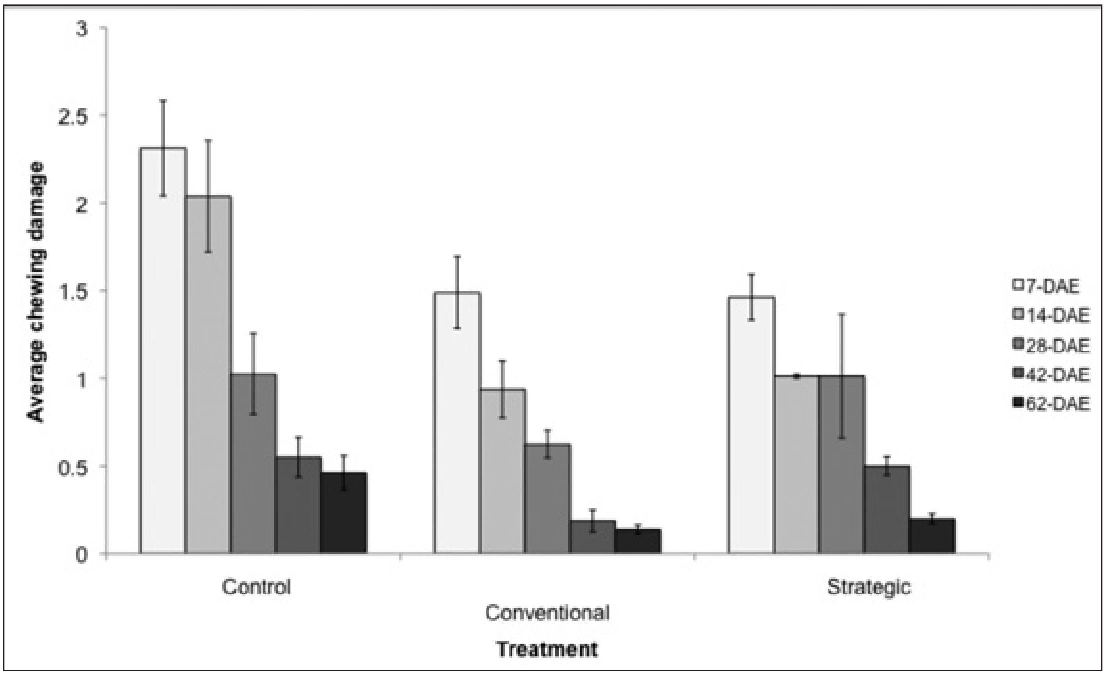

Figure 3. Average pest 'chewing' damage to canola plants (seen as pieces missing from leaves) at various days after crop emergence. Scores are based on a 0-10 scale where 0 = no visible damage, 5 = 50% of leaf surface missing etc. Error bars indicate standard error of the mean.

As a result of excellent spring rainfall, canola plants across all plots grew very well throughout the latter part of the season, and numbers of typical 'spring pests' (e.g. aphids, diamondback moth, native budworm) were quite low across the site and around the region. Numbers of cabbage aphids built up gradually during spring (Figure 4). However at no stage did they reach a level at which spraying was warranted. Consequently, no insecticides were applied to any plots during spring.

In contrast to autumn and winter, numbers of beneficial insects were relatively high during spring, largely because no insecticides were applied to control pests at this stage. For example, an average of 2 – 3 adult hoverflies were collected in six sweeps across all plots on 18 October. Additionally, aphid parasitic wasps showed a similar pattern of build up to that of cabbage aphids (Figure 4). No wasps were found in sweeps taken on two sampling dates in September, but steadily increased from then on, reaching an average of 4 – 7 wasps per six sweeps across all treatments on 10 November. The Strategic and Control plots typically had more beneficial invertebrates than the Conventional plots sprayed with broad-spectrum insecticides.

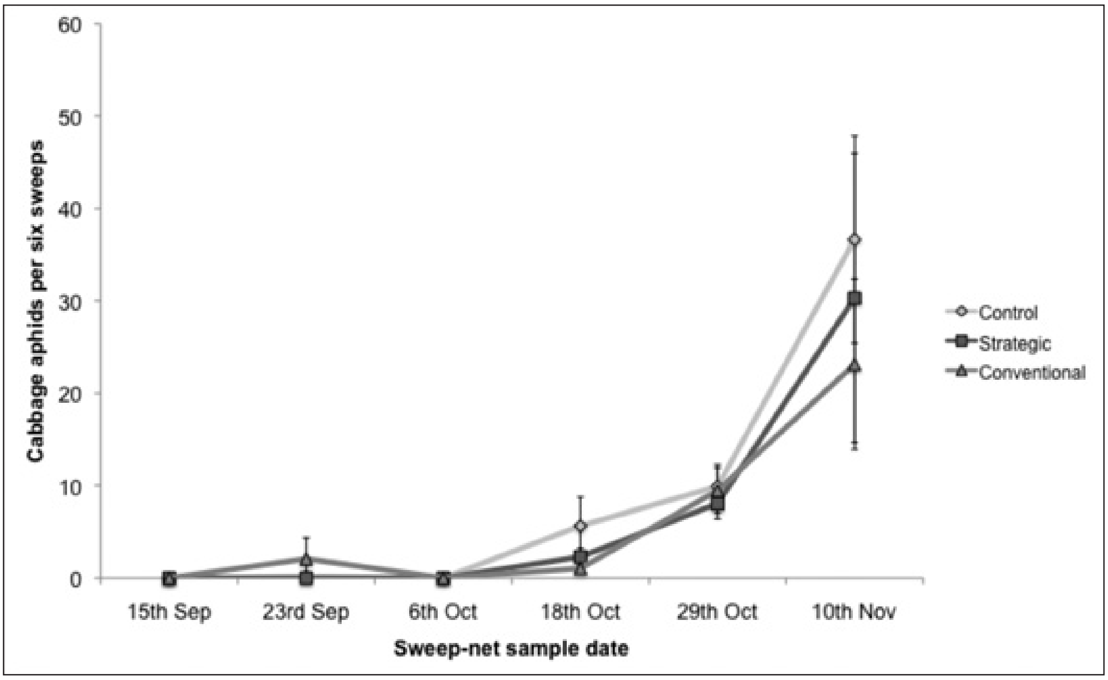

Figure 4. Average number of cabbage aphids (Brevicoryne brassicae) collected in sweep nets at various sampling days during spring.

Harvested yields were variable, with the conventional plots averaging the highest overall, followed closely by the strategic plots (Table 3). However, the differences between the three treatments were not significant. Hand harvests were also collected (prior to the machine plot harvesting) in order to calculate harvest index values. The control plots had significantly higher harvest index values than the strategic and conventional treatments (Table 3). This indicates the canola plants in the controls produced more seed per total plant biomass. It is likely that this is due to lower competition due to lower plant densities in the controls (Figure 1) compared with the other treatments as a result of early season pest feeding damage (Figures 2 & 3). Compensation of canola plants has been observed in several other trials conducted and is not surprising given the seasonal conditions experienced throughout winter and spring at the Charlton site.

Table 3. Average canola yields and mean harvest index for all treatments.

Treatment	Yield (t/ha)	Harvest Index
Control	1.67	0.43
Conventional	1.79	0.38
Strategic	1.70	0.37
P Value	**NS (P = 0.481)**	**P < 0.01**
LSD (P <0.05)	**0.17**	**0.03**
CV	**11.4%**	**13.9%**

Interpretation

Prior to sowing, the pest pressure across the trial was relatively low, probably because of the warm and dry autumn conditions. However, as the season progressed, diversity of invertebrates across the site increased. The main crop pests encountered during the autumn and winter months were earth mites (redlegged earth mites, blue oat mites and bryobia mites) and lucerne flea. A low number of Australian plague locusts were also present but did not cause any noticeable damage. In spring, cabbage aphid numbers built up slowly. However, beneficial numbers were also relatively high and at no stage was spraying required.

Unfortunately, the high amount of rainfall in December is likely to have affected the yield in all plots as harvesting was delayed for several weeks beyond the optimum date and some canola was lost on the ground. Although the Controls had the lowest yield, the difference between the Control plots and the other treatments was less than expected. In a season such as 2010, we were able to see canola recover after pest damage at establishment, meaning the true effect of the strategic approach was not measured.

In addition to the delayed harvesting, the degree of lodging in this trial further influenced the accuracy of yield estimates. In particular, the strategic plots (which had the highest plant densities) showed significant lodging in some plots and this is likely to have led to a larger yield loss. In the hand harvest, a percentage of canola was still lost on the ground so these harvest index values should also be interpreted somewhat cautiously.

Throughout the season there was little difference in plant assessments and pest damage scores between the Conventional and Strategic treatments. However, the Conventional treatment sprays cost $11/ha and the Strategic treatment had a total cost of $1.35/ha, indicating conventional practice may not be the most economical approach for pest management. Routine monitoring, accurate identification of pest and beneficial species and the strategic use of chemicals should be considered by growers and their advisors.

In the 2011 trial, the cost of monitoring and time taken to identify invertebrates will be incorporated into our assessments. These components of IPM are likely to be an ongoing challenge in broad-acre cropping, particularly for larger farms, and need to be investigated thoroughly.

Acknowledgments

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