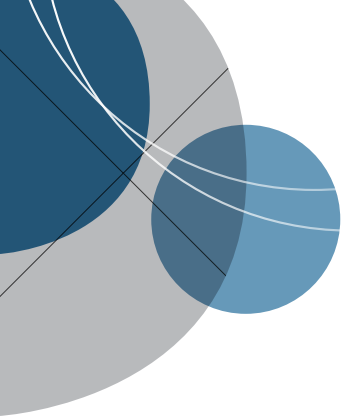




Crop protection

Can parasitoid wasps control aphids in canola?

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Key findings

- Parasitoid wasps need time for their populations to develop.
 - It is important to maintain an environment that supports diverse populations of beneficial invertebrates year-round.
 - Aphid mummification is probably higher than can be observed as parasitism is not obvious for up to two weeks.
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Background

Grain crops are host to a number of invertebrate pest species, but each year only a few species will reach high enough densities to cause significant damage and yield loss. Often, the array of beneficial species, such as predators, parasitic wasps and flies also located within or near the crop, are able to suppress the pest population growth, thus preventing the outbreak. However, growers are currently heavily reliant on chemical responses to pest outbreaks. This is partly due to a lack of information regarding how much influence is exerted by beneficials and the proportion required for pest suppression.

The aim of this experiment, therefore, was to determine how effective parasitoid wasps are at controlling aphid populations. Data obtained from this and other experiments will be used to help develop a model that will incorporate parasitoids and other beneficials into economic thresholds for canola aphids.

Methodology

Site

This experiment is part of a national project with co-incidental experiments in South Australia, Victoria and Western Australia.

All NSW experiments and sampling were conducted in a paddock sown to canola (var. ATR Stingray[®]) on 8 May 2018 located at the Wagga Wagga Agricultural Research Institute (WWAI). As part of another experiment, this paddock was divided into eight equal sized plots (142 × 105 m): half sown with fungicide-treated seed (Jockey[®] Stayer[®]) and the rest sown with insecticide- (Gaucho[®]) and fungicide-treated seed. In order to standardise the experiment across all state sites, all cages were placed within the insecticide seed-treated plots. No other insecticides were used on the crop. Plants were generally at the 4 to 6-leaf stage when the experiment started in July. Due to the dry conditions, plant emergence was rather sparse throughout the paddock.

Cage experiment

To assess how parasitoid wasps (*Aphidius colemani*) affect green peach aphid (*Myzus persicae*), five replicates of six exclusion cages (Figure 1) were set up during early July. Each cage contained three canola plants. Two sets of three sentinel plants, located near the cages, were also marked to serve as the open controls. To avoid any effect to the insecticide-seed treatments, the experiment could not

start until at least eight weeks after sowing. Before the experiment started, all plants were checked and any invertebrates located were removed.

While all other parameters remained the same between the state sites, due to insufficient numbers in the SARDI colony, the wasp species used in NSW (*A. colemani*) was different from that used in other states (*Diaretiella rapae*). Wasps were sourced from Biological Services (Loxton, SA) and the green peach aphids were cultured from a colony sourced from WWAI.



Figure 1. Set of exclusion cages in a canola paddock inoculated with aphids and parasitoid wasps.

Treatments involved varying the density of aphids while maintaining the same number of parasitoids. A total of eight treatments were applied:

1. Low population (LP): 20 aphids.
2. Medium population (MP): 100 aphids.
3. High population (HP): 200 aphids.
4. Very high population (VHP): 500 aphids.
5. Medium closed control (MCC): 100 aphids.
6. High closed control (HCC): 200 aphids.
7. Medium open control (MOC): 100 aphids.
8. High open control (HOC): 200 aphids.

Centre plants within all cages, as well as the external sentinel plants, were inoculated with the desired number of aphids on 12 July 2018 and left to establish for two weeks. At this time, the aphids were counted and any excess removed. Three female wasps were then released into all non-control cages (day 0). Counts of aphid and mummy (parasitised aphid) numbers were conducted on days 14, 28 and 42.

Beneficial diversity within the paddock during the experiment was assessed using pitfall and hanging traps (Lindgren funnels and yellow fly traps). A total of 32 pitfalls, eight Lindgren funnels and eight yellow fly traps were used. These were equally distributed among the four insecticide seed-treated plots. Pitfalls were left open for one week every four weeks, while the hanging traps were open continuously, but sample cups changed every four weeks. All traps contained 100% polypropylene

glycol. On return to the laboratory, samples were washed before being placed in 100% ethanol for storage before identification.

On day 42, after the field aphid count, each set of plants from each cage/sentinels were bagged and placed within Bugdorm cages in the entomology laboratory. These were left for 14 days to provide an accurate measure of the number of wasps emerging from aphids.

Data analysis

Data was compared for significant differences using general linear models (GLM), with Tukey comparisons. Differences were considered significant at $P < 0.05$. Numbers are presented as mean $\pm$ SE.

Results

The number of aphids in all treatments increased exponentially over the course of the experiment, with the rate of increase generally determined by the initial starting number of aphids (Figure 2). At day 42, mean numbers of aphids ranged from 1194 ± 362 in LP to 7659 ± 1392 in VHP, significantly higher than previous days ($P < 0.001$, $F = 47.68$, $DF = 3$; $P < 0.05$, Tukey). While there was a significant effect from the treatment ($P = 0.001$, $F = 3.89$, $DF = 7$), this was only between the extremes (VHP *cf* MOC and LP; HP *cf* LP; $P < 0.05$; Tukey). These results indicate that the parasitoid wasps were not able to control aphid population growth in this experiment. However, results from both the Western Australia and South Australia experiments did show some promise, with significant decreases in MP and HP aphid populations compared with their respective caged controls.

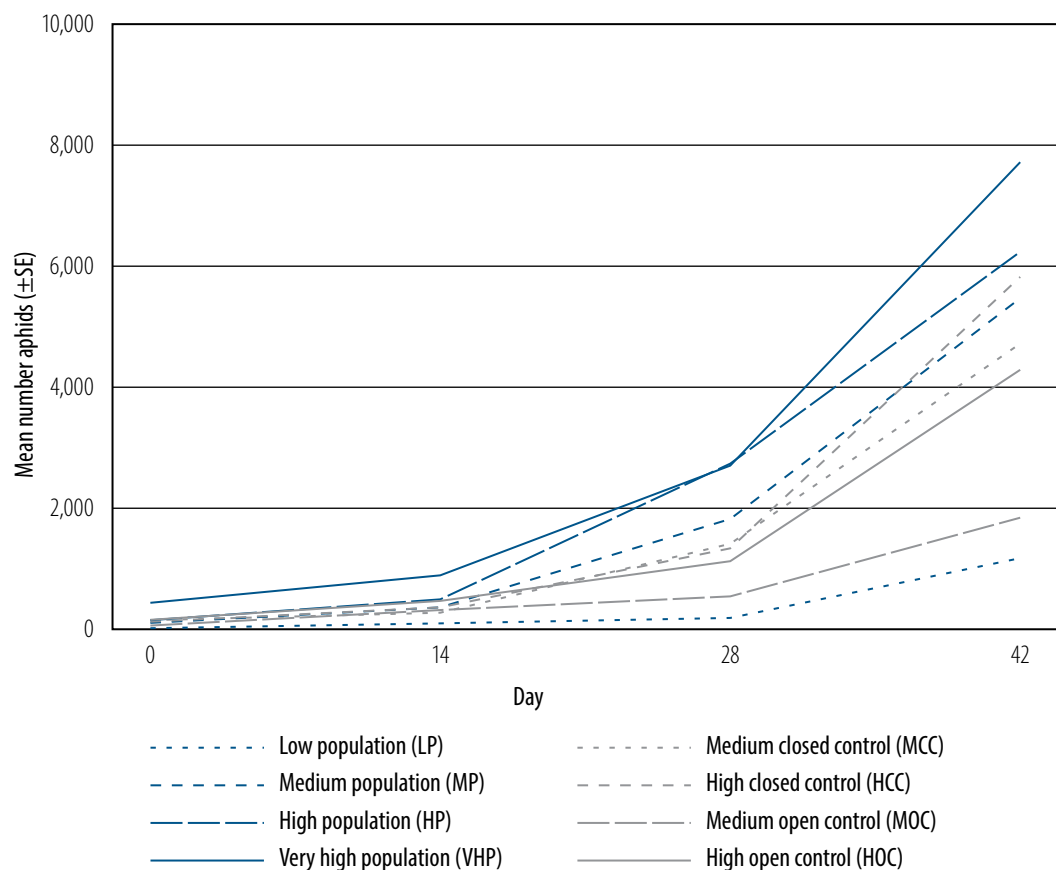


Figure 2. Changes over time in the mean numbers of aphids within each treatment during a cage experiment with canola plants inoculated with three parasitoid wasps.

The number of aphid mummies observed during the experiment also exponentially increased within each treatment. While no mummies were observed on day 14, and only small numbers on day 28, there was a significant increase by day 42 ($P < 0.0001$, $F = 26.98$, $DF = 3$; $P < 0.05$, Tukey; Figure 3). Despite starting with the same number of parasitoid wasps in each treatment, by day 42 significantly more

mummies were found in the VHP treatment (88.8 ± 19.5) compared with the LP treatment (9.6 ± 3.8) and both open controls ($P < 0.001$, $F = 4.77$, $DF = 7$; $P < 0.05$, Tukey). This could indicate that there is a greater potential or stimulus for wasps to inject their eggs when higher numbers of aphids are present. However, by day 42 the percentage of aphids that had been parasitised was only around 1% in all treatments.

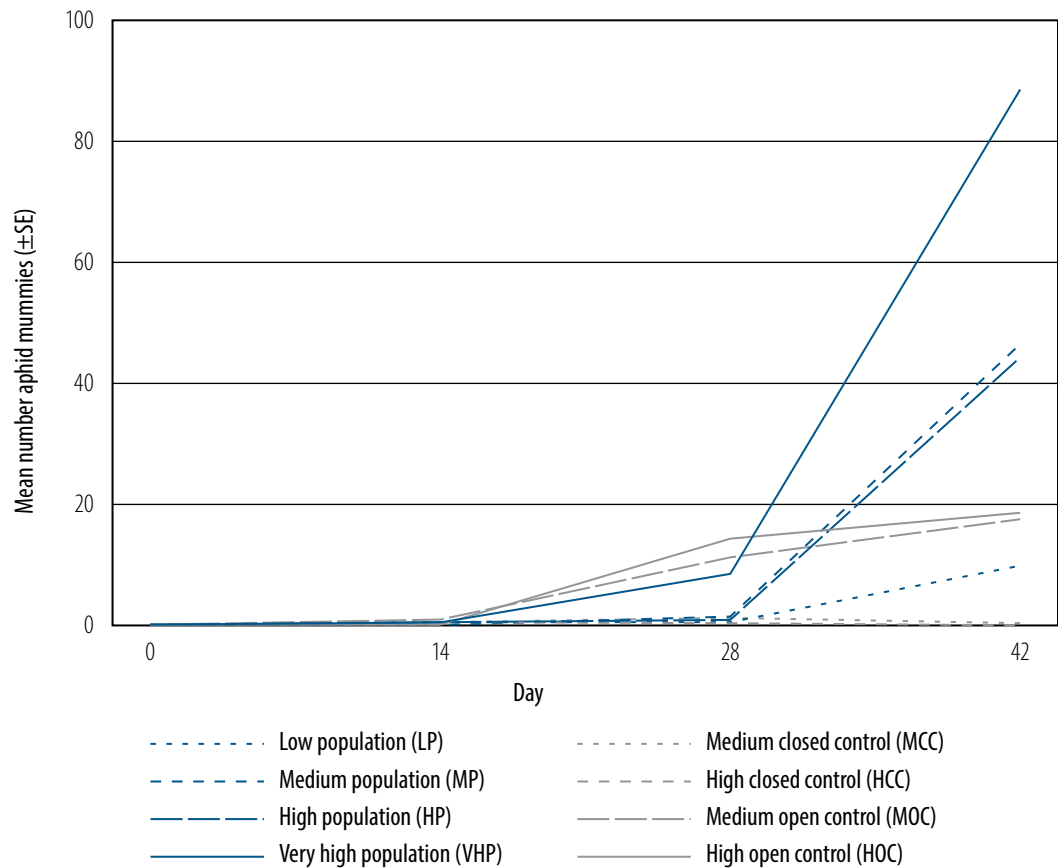


Figure 3. Changes over time in the mean numbers of aphid mummies within each treatment during a cage experiment with canola plants inoculated with three parasitoid wasps.

In the caged treatments, the number of wasps that emerged was only 25–50% of the aphid mummies observed (Figure 4). This was probably due to a combination of wasps already having emerged (i.e. older, empty mummies), and wasps failing to fully develop. However, the reverse was true with the open control plants where up to 20 times more wasps emerged than mummies observed ($P < 0.001$, $F = 9.61$, $DF = 7$; $P < 0.05$, Tukey; Figure 4). It can only be assumed that the aphids on these plants had only recently been parasitised by endemic wasps and so the mummies were indistinguishable from live aphids. It was noticeable during the later stages of the experiment that there was an influx of aphids within the paddock (generally cabbage aphid, *Brevicoryne brassicae*) and this might have resulted in an increased number of parasitoids within the paddock near the experiment's completion. Temperatures had also increased by this stage, which would have resulted in a greater amount of invertebrate activity.

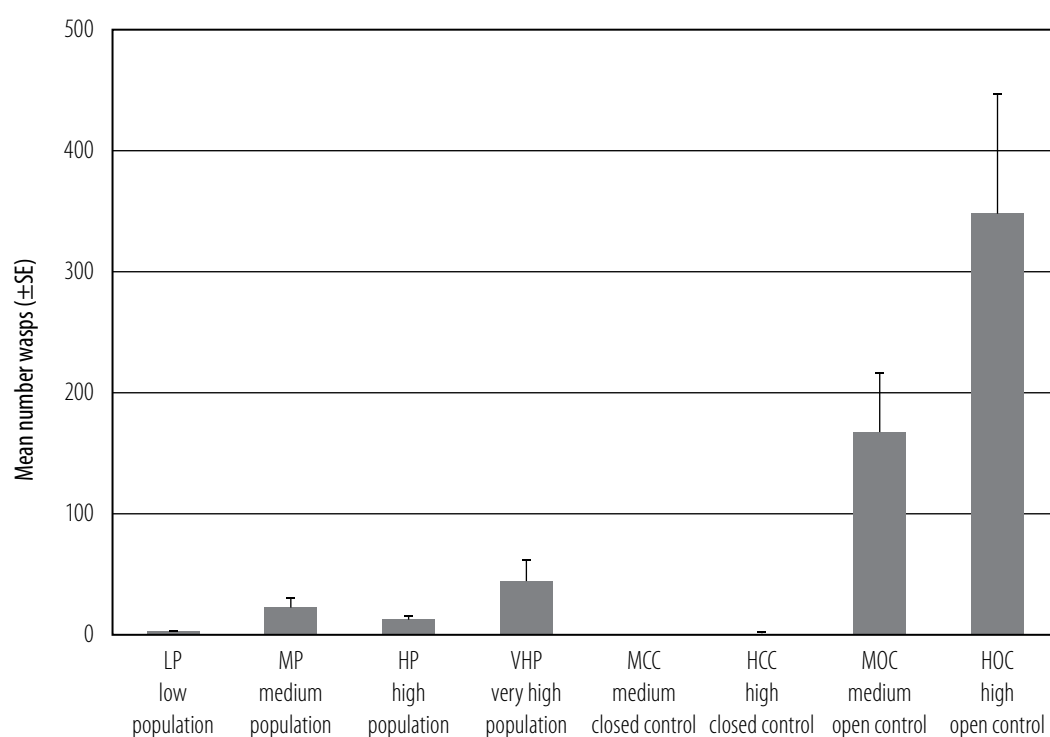


Figure 4. Mean number of wasps to emerge two weeks post-cage experiment.

While parasitoids did not suppress the aphid population during the experiment, mean numbers of aphids in both the open controls were lower than their caged counterparts. Although the high degree of variability between replicates meant these decreases were not significant (MCC vs MOC: $P = 0.078$, $F = 4.07$, $DF = 1$; HCC vs HOC: $P = 0.673$, $F = 0.19$, $DF = 1$), it does indicate some extra level of control within the paddock. This is probably through a combination of predation and parasitism, though to what level each contributes is unknown. Predators, such as predatory mites, spiders, predatory beetles and centipedes comprised over 80% of the beneficials trapped during the course of the experiment (Figure 5). The absolute numbers of beneficial invertebrates were similar during the two sampling periods at approximately 130 per plot. However, the relative proportion differed, with predatory mites decreasing, while spiders, centipedes and wasps increased. The primary wasp species trapped in the paddock was *D. rapae* (over 90% of the samples), different from the one used in the cage experiment. Although both are aphid-specific parasitoids, it is unknown whether *D. rapae*, well adapted to the local conditions, might have been more effective at controlling the aphid populations. Both South Australia and Western Australia observed some aphid population suppression with *D. rapae*. However, Victoria also used *D. rapae* and, like NSW, was less successful. Consequently, other factors could be involved, such as the environmental conditions.

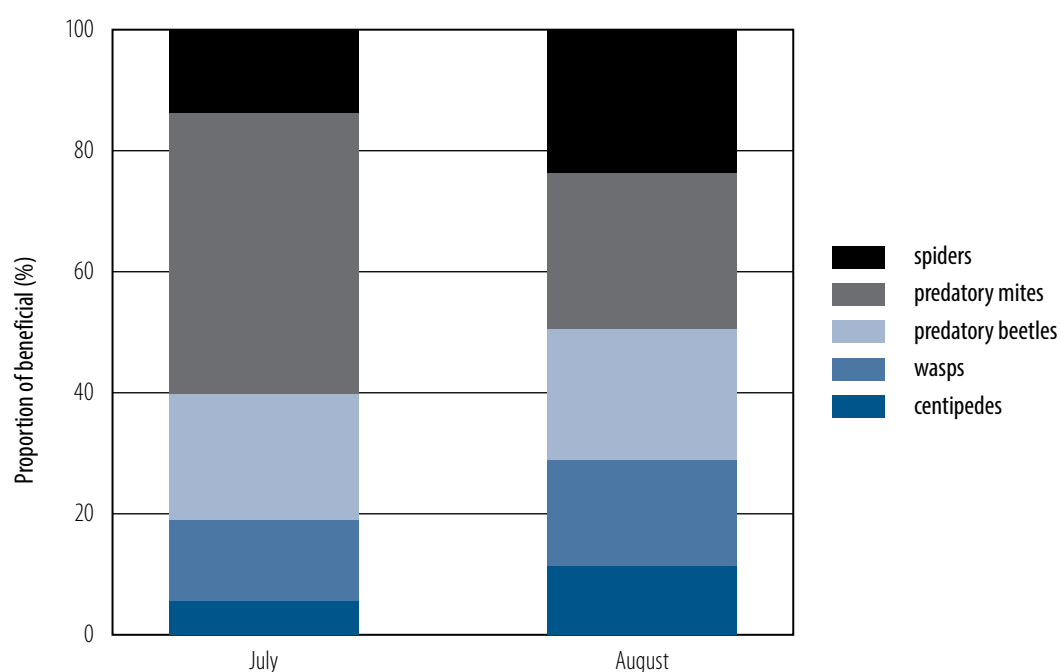


Figure 5. Proportion of beneficials trapped in canola paddock where the cage experiment was held during July and August 2018.

Summary

Parasitoid wasps are an effective tool for helping to control aphid populations. However, a number of factors will have a bearing on whether they are successful. The number of parasitoids and aphids is crucial. If a sufficient number of parasitoids is present when aphids start to colonise the crop, they could maintain sufficient numbers to overcome the aphids' high reproductive potential. Other factors might include climate and species. Parasitoids also need sufficient time to build up their numbers, so it is important to maintain habitat that supports their presence, plus that of other beneficial species, throughout the year.

Acknowledgements

This experiment was part of the 'New knowledge to improve the timing of pest management decisions in grain crops' project, CSE00059, 1 March 2015–30 June 2020. This project is a collaboration between CSIRO, cesar, SARDI and WA DPIRD. The project is a joint investment between NSW DPI and GRDC. Thanks to the NSW DPI farm staff for treating the seed and sowing the experiment paddock.