Crop protection

Assessing the effects of natural enemies on insect pests in canola

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Key findings

- Natural enemies (predators and parasitoids) found within the crop were diverse, but had variable distribution.
- The abundance of natural enemies increased with time, which was probably related to an increase in pest pressure as well as temperature.
- Growers might be able to use more targeted sprays to control pests.
- Seed treatments appeared to have no long-term effects on natural enemy abundance.

Background

Grain crops are home to a diversity of invertebrate pest species, but each year only a few species will reach high enough densities to cause significant damage and yield loss. The diversity of beneficial species, such as predators, parasitic wasps and flies, in certain contexts can suppress pest population growth thus stopping pest outbreaks. We are currently limited in our ability to predict when and where pest outbreaks will occur. This is partly due to a lack of fundamental ecological knowledge around where pest and beneficial species are found and the factors that facilitate pest outbreaks. This means that growers depend upon reactive chemical control with limited scope for alternatives such as cultural or biological control options.

The aims of these experiments were to determine:

- the potential effect of natural enemies on insect pests
- any long-term effects from insecticide seed treatments on natural enemies
- any differences in natural enemies and pest distribution.

Methodology

Site

All experiments and sampling were conducted in a 1 ha plot in the north-western corner of a canola (var. ATR Stingray(b)) paddock, sown on 4 May 2017, located at the Wagga Wagga Agricultural Institute. The experiment area was divided into two plots: half sown with fungicide-treated seed (Jockey®) and the rest, as well as the remainder of the paddock, sown with insecticide- (Gaucho®) and fungicide-treated seed. Apart from the seed treatment, no other insecticides were used on the canola crop.

Cage experiments

To assess the effect of natural enemies on pests, two types of cage experiments were conducted. In all experiments the target organism used was the green peach aphid (GPA).

In July, paired open and closed clip cages (Figure 1) were placed on canola plants either close to the edge (N = 5) or towards the centre (N = 10) of the untreated and treated plots. Each clip cage contained 20 GPA on a canola leaf and was left for 48 hours. Results were analysed as the percentage of live aphids in the open cage compared with those in the closed cage (control). A camera was set up at one of the open clip cages, recording photos at one minute intervals.

Figure 1. Paired open and closed clip cages with green peach aphid on a canola plant, July 2017.

In September, six replicates of five exclusion cages were erected around single canola plants distributed within the central section of the treated seed plot (Figure 2). The extra cage was to ensure there was a full set of four cages with good aphid colonies, but unfortunately this meant there were not enough cages to do comparison experiments within the untreated seed plot. Any invertebrates found on or near the plant were removed during the set up. The canola was at the flowering/podding stage, but was relatively sparse due to the dry conditions. Each plant was first inoculated with 50 GPA on the top leaves and left enclosed for one week to ensure the aphids had colonised the plants. At day 0 of the experiment, aphid numbers were counted and excess aphids removed to ensure a start of approximately 50 GPA. Buds, flowers and lower leaves were removed to allow for an easier and more accurate aphid count, and the following treatments were applied:

- For reared predators (CR), five green lacewing larvae at the 2nd instar stage were added and the cage closed.
- For local predators (CP), the surrounding area was sampled using a sweep net to identify local predatory species. Although predators appeared scarce, adult brown lacewing were the most common. Therefore, two of these, plus two commercially-reared spotted ladybeetles (*Harmonia octomaculata*) were added and the cage closed.
- For the open control (OC), the net on the cage was removed to determine the effect of natural local predators and the environment.
- For the closed control (CC), the cage was left closed to determine aphid growth without predation.

Live aphids were counted and recorded, along with any predators or aphid mummies, on days 0, 2, 4, 7 and 15, starting on 26 September 2017. As this was part of a project to look at the regional diversity of natural enemies across southern Australia, these cage experiments were also conducted in WA, SA and Victoria. Consequently, all protocols had to be the same in each state.

Figure 2. Set of exclusion cages in a canola paddock, after applying 50 green peach aphids in September 2017.

Paddock sampling

To determine the abundance and diversity of natural enemies and pests, the paddock was sampled during July, September and October using pitfall traps. Nine traps (45 mm diameter, 120 mL volume, containing 50 mL propylene glycol) were placed towards the centre of each of the untreated and treated seed plots and five were placed along the edges. These were left open for one week before collection.

Analysis

Data were 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±SE.

Results

Seed treatment

No significant differences were found between treated and untreated seed plots. This was true for the clip cage experiment as well as abundance and diversity within all three pitfall trap samples including June, which occurred only seven weeks after sowing. Consequently, data from these two plots were pooled for further analyses.

Cage experiments

Within the clip cages, the total numbers of aphids found were significantly less in the open cages compared with the closed cages ($P = 0.001$, F = 11.74, DF = 1). While it cannot be confirmed that all the aphids had been eaten, a photo of a predatory mite on an open cage provides some evidence that there might have been some predation. While the percentage of live aphids found within the open clip cages was greater in those located at the centre of the paddock (20.5±7.5%) than those at the edge (13.3±6.9%), the difference was not significant ($P = 0.55$, F = 0.36, DF = 1).

In the exclusion cage experiment, the mean number of aphids displayed a similar pattern in most of the cages, though there was a large degree of variation among the cages. This resulted in no significant effect from the treatments ($P = 0.15$, F = 1.83, DF = 3; Figure 3). However, there was a significant effect of time ($P<0.001$, F = 11.14, DF = 4). Aphid numbers were suppressed for the seven days in all treatments apart from OC, but on day 15 numbers had significantly increased ($P<0.05$; Tukey). For the OC cages, numbers generally steadily increased over the entire 15 days. It was noticeable during the experiment that the timing coincided with a large influx of cabbage aphids in the paddock. Several parasitised aphid mummies were found in the OC, but as these can take 2–4 weeks to develop, the controlling influence of parasitoid wasps could not be measured. This could be investigated in later experiments.

Of the other state experiments, only WA had significant suppression in both OC and CR cages, while results in Victoria and SA were very similar to NSW. This probably indicates that stressed plants, due to lack of moisture and warmer temperatures in south-eastern Australia, were major factors for this lack of significant results.

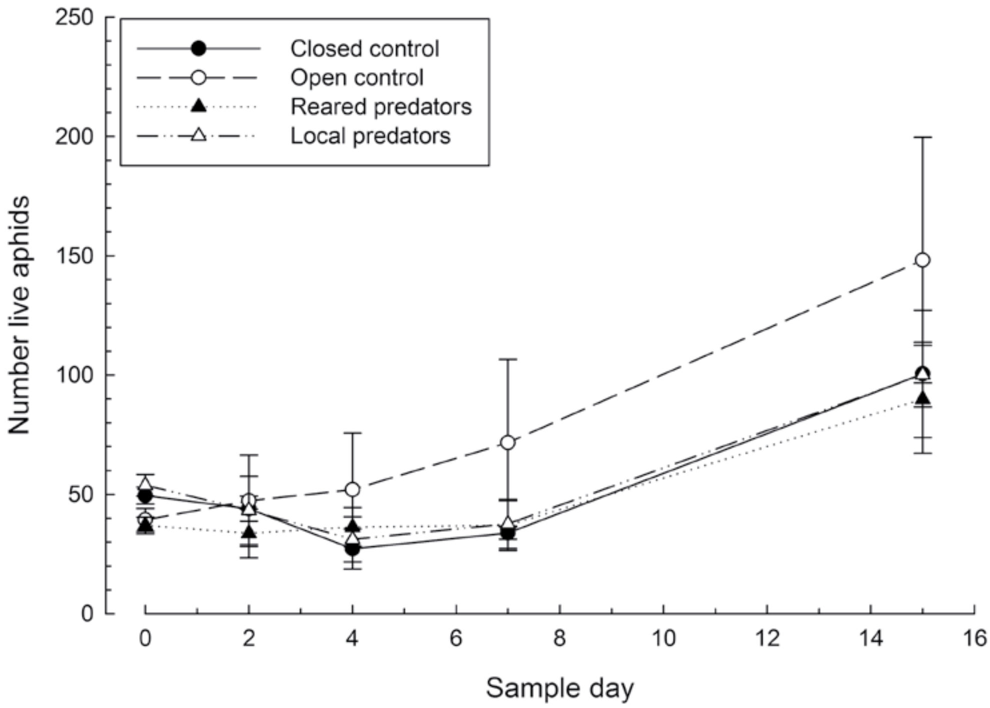

Figure 3. Changes in the mean (±SE) number of live aphids on canola plants over time during a large exclusion cage experiment.

Paddock sampling

As would be expected with rising temperatures, the abundance of both natural enemies and pests significantly increased with time (natural enemies: $P<0.001$, F = 40.99, DF = 2; pests: $P<0.001$, F = 47.96, DF = 2; Figure 4). Pests comprised between 33.60–90.88% of the invertebrates sampled during the different periods, while natural enemies ranged from 1.68–28.00%. The composition of invertebrates also changed. For pests, lucerne flea was predominant in July, while aphids were the primary pest in September and October. This resulted in a corresponding change in natural enemies. In July low numbers of ground-dwelling invertebrates such as spiders, predatory mites and beetles, plus a few wasps were found. By September, the numbers of spiders and mites, which probably contributed to suppressing the lucerne flea population, had increased, while brown lacewings and hoverfly larvae, whose diet is primarily aphids, were also present. In October, brown lacewings comprised approximately half of the natural enemies trapped.

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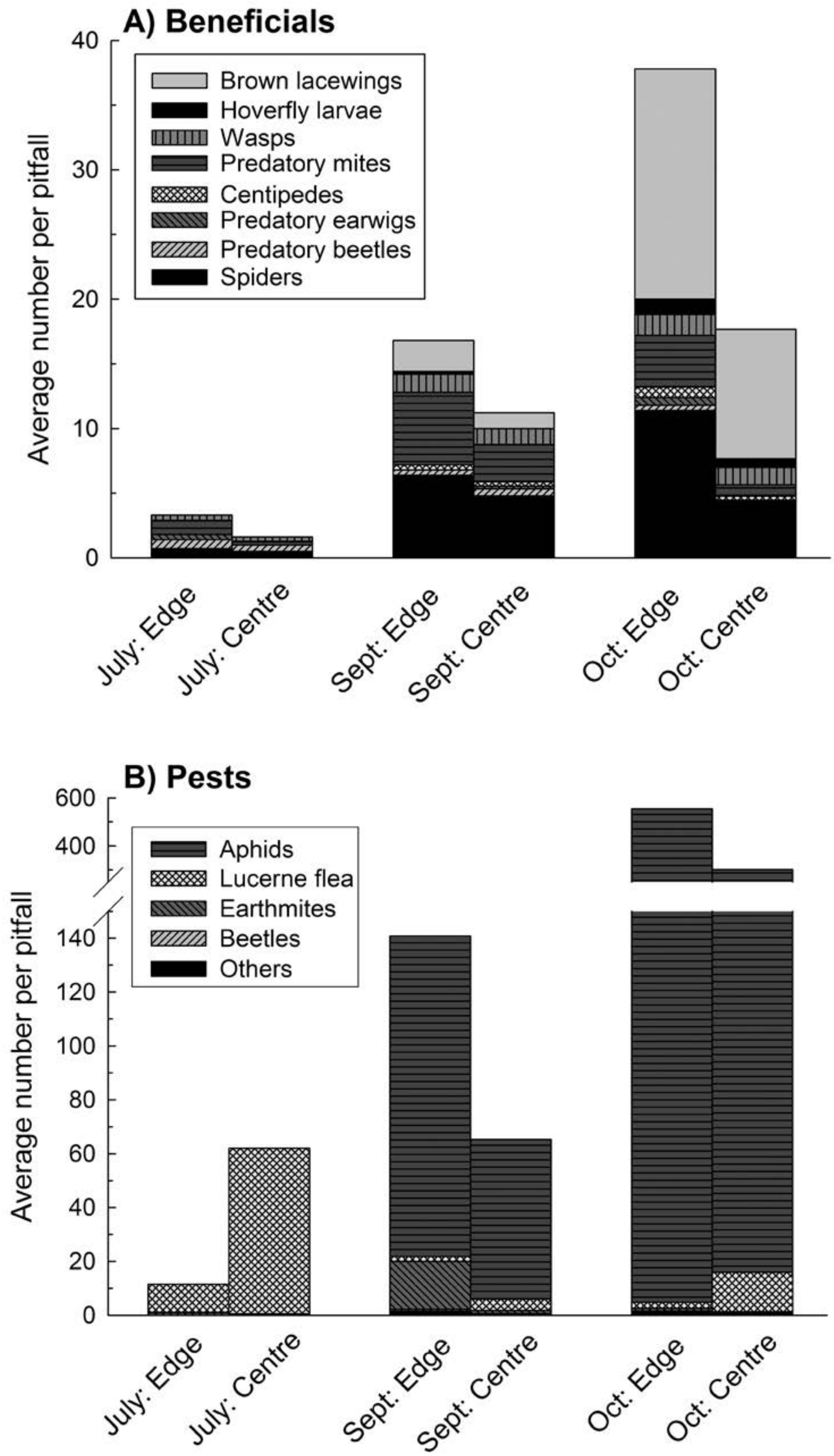

Figure 4. Comparison of diversity and abundances of natural enemies and pest invertebrates captured in pitfalls located either at the edge or centre of a canola paddock throughout 2017.

Distribution in the paddock was also influenced by location (Figure 4). Significantly more natural enemies were found along the edge, compared with the centre of the paddock in both July (P = 0.002, F = 12.38, DF = 1) and October (P = 0.011, F = 9.17, DF = 1). While a similar pattern was also found in September, this was not significant (P = 0.059, F = 4.34, DF = 1). Pests also had significantly higher abundance along the edge during September (P<0.001, F = 30.51, DF = 1) and October (P = 0.044, F = 5.04, DF = 1), corresponding with aphid flights arriving in the paddock from other fields. In July, however, pests were primarily found in the centre of the paddock (P<0.001, F = 16.76, DF = 1), probably due to lucerne flea hatchings from the previous season.

Summary

The abundance and composition of natural enemies responded to the abundance and composition of pests present, and both cage experiments indicated signs of predation and parasitism. However, these natural enemies appeared unable to control large infestations, as seen with the large influx of aphids late in the season. Unfortunately, as yield was not measured in this experiment, it is not known whether these aphids caused any economic damage in this moisture-stressed crop.

The effect of location preference for pests can influence pest-management decisions. For flying dispersal species such as aphids, a border spray might be sufficient to control them. Combined with a selective rather than a broad spectrum spray, this could increase the numbers of natural enemies present in the field throughout the season and possibly the next one as well.

Seed treatments appear to have no lasting effects on natural enemies and can be seen as a 'softer' option in pest control during crop establishment. However, continued prophylactic use can lead to other issues, such as resistance or effects on soil fauna not studied here.

Acknowledgements

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