Pest resilient landscapes in horticulture: A Lockyer Valley perspective

Introduction

South-east Queensland, like other horticultural areas in Australia, hosts a range of farming systems including conventional, organic, protected cropping and hydroponics.

On a global scale, across these systems, pests destroy more than 40 per cent of the potential global food production despite the annual use of approximately three million tonnes of pesticides[1].

The Australian Horticulture Sustainability Framework (2021) and the Australian Agriculture Sustainability Framework (2022) highlight the importance of best practice land management for soil health, reducing erosion, increasing biodiversity, preserving natural waterways and incorporating functional natural landscapes, while acknowledging that land under agricultural management delivers ecosystem services.

Following discussions with Hort Innovation's Olive Hood on pest resilient landscapes, VegNET VegNET South-East Queensland Regional Development Officer Darren Brown investigated if it was possible, in a horticultural context, to meet the goals of the sustainability frameworks while reducing pesticide use and maintaining productive horticultural farms in the Lockyer Valley.

In particular, Darren examined if the findings from a recent vegetable levy-funded project, *Field and landscape management to support beneficial arthropods for IPM on vegetable farms* (VG16062), were relevant to Lockyer Valley growers. This project, which ran from 2017 to 2020, helped vegetable growers to develop practical approaches for pest control, building on previous research from Australia and around the world that shows pest populations can be influenced by field and landscape vegetation on farms.

Key messages

- Maintaining acceptable control of pests through sustainable pest management practices is a key focus area for VegNET South-East Queensland.
- Following industry discussions on pest resilient landscapes and the publication of industry sustainability frameworks, Regional Development Officer Darren Brown investigated how the Lockyer Valley is balancing the competing demands of productive farms and environmental sustainability.
- The recent findings of a vegetable levy funded research project, *Field and landscape management to support beneficial arthropods for IPM on vegetable farms* (VG16062) was also discussed.
- VegNET VegNET South-East Queensland will continue to raise awareness of the VG16062 findings and the implications for regional farming systems, and keep growers informed of insights around sustainable pest management practices. The project will also follow-up with growers looking to increase the resilience of their landscapes and connect them with natural resource management or Landcare groups to increase native habitats on their farms.

1 Jeanneret, P. B. (2016). Landscape Features to improve pest control in Agriculture. Solutions, 48-57

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Insights from grower discussions

Darren visited Rob Bauer (Bauers Organic Farm) and Reck Farms in the Lockyer Valley, and held discussions with agronomists Antony McConville and Andrew Richards.

Bauers Organic Farm consists of 282 hectares (113 hectares are cropped). There are many smaller paddocks across the property which are mostly surrounded by riparian fringes or other natural/non-crop habitats (see image 1 below).

Rob considers all organisms in the landscape including bats and birds such as magpies, ducks and scrub turkeys.

The farm ecosystem has a variety of plants which includes many natives (Acacias, Eucalypts, Casuarina and Melaleucas), which will self-regenerate in the area if left alone. There are several weed species as well, including Chinese Elms, Leucaena, Castor oil plant, cats claw creeper and a range of grass species including green panic and couch grass.

Nesting sites and over-wintering areas are important for birds, bats and insects. Leaving as much natural landscape mixed with the cropping enterprise reduces the impact of pest insect species on the horticultural crops. Unfortunately, weeds are possibly worse in this system of wide-ranging plant species in the agricultural landscape.

Reck Farms operates 16 diverse properties over four regions (Mulgowie, Upper Tenthill, Lower Lockyer and Brisbane Valley), farming approximately 1000 acres. There is generally less pressure on the farms which have higher amounts of native vegetation around the cropping areas. However, this is not always observable.

Insights from industry discussions

Lockyer Valley agronomist Anthony McConville, who was involved in VG16062, said that generally there is less insect pest pressure in fields with large amounts of surrounding vegetation. However, it appears that other factors play a large part in the success of remnant vegetation and its effectiveness in suppressing pest insects.

Image 1: Aerial view of Bauers Organic Farm showing cropping and non-cropping areas.

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"Flowering strips are a good idea and appear to have an impact on pests, but it is difficult for growers to see this as a positive and not a loss of productive cropping space," Anthony said.

"Crops growing nearby can have an impact in overcoming the best principles of integrated pest management (IPM) and vegetation as a management tool. The degree to which surrounding landscapes and IPM can be used to control pests is determined by the crops grown and the amount of damage which can be tolerated."

It takes time for beneficials to build up to levels where they can control the pest species. It is difficult to find reasons for unknown hot spots of insect activity (possibly linked to non-vegetable crops nearby).

"Insects will move from a non-vegetable crop into vegetables particularly if the non-vegetable crop gets harvested. Organic or conventional farmers all face the same issues," Anthony added.

Andrew Richards, another agronomist based in the Lockyer Valley, said that remnant vegetation can sometimes assists with pest control, however, other factors reduce the effect of vegetation.

"Pest hot spots do not seem to be reduced by remnant vegetation. IPM is a great principle, but it does not always work, and chemicals are often required to suppress pests to acceptable levels. This is very much dependent on the crop species and the acceptable levels of damage."

AgBiTech Australia's Zara Janke added that there are wider implications on managing pests.

"Do not look for specific beneficials, look at the system. It is not necessary to know which beneficial species are in the crop, just that they are there and are parasitising pest species eggs. Any vegetation or flowering plants which support beneficials will improve their impact on pest species."

Improving grower productivity, profitability, preparedness and competitiveness

While this activity initially aimed to determine if increasing vegetation had a positive effect on insect pests in vegetable crops, it quickly became apparent that this was only part of the issue and solution.

There are benefits to increasing useful vegetation in and around vegetable crops, and this is backed by existing research. How vegetation is incorporated on a farm is determined by the individual grower and the limits of their production system.

Endeavouring to meet the goals of the Horticulture Sustainability Framework and the Australian Agriculture Sustainability Framework will be a major challenge. Further research is required to develop approaches to incorporate habitat conservation with agricultural production. Part of such integration will pivot around better farm planning.

Investments such as those through carbon markets that result in long-term biodiverse carbon storage on farms could be critical in this respect, including stewardship schemes where farmers are paid for demonstrably improved conservation outcomes on their land[2].

VegNET South-East Queensland connected growers with VG16062 findings and outputs, as well as key researchers such as Dr Loren Fardell who is currently researching the impact of microbats on insects. There is significant opportunity to continue sharing the learnings from the project further.

Next steps

Going forward, VegNET South-East Queensland will continue working with growers, agronomists and researchers to boost their knowledge of pest resilient landscapes and how they can be used to reduce the reliance on synthetic pesticides. This links in well with existing research on managing fall armyworm and using an IPM and area wide management approach to manage diamondback moth.

Image 2: Bauers Organic Farm riparian area. **Credit:** Darren Brown.

2 Lindenmayer, D. (2022). Birds on Farms: a review of factors influencing bird occurrence in the temperate woodlands of South-Eastern Australia. EMU - Austral Ornithology, 238-254.

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Key findings from existing research on pest resilient landscapes

Field and landscape management of crop pests, by biological control or direct effects of vegetation on pests, offer great opportunities to vegetable growers.

Biological vs. synthetic insecticides

Research has found that pests were no more numerous in fields where only biological insecticide types – such as Bacillus thuringiensis (Bt) or Nuclear Polyhedrosis Virus (NPV) – were used when compared with fields using synthetic insecticides. The number of beneficial insects was significantly higher in fields sprayed only with biological insecticides compared to those where a mixture of insecticides was used[1].

Flora and fauna

Wild fauna occurs in every agroecosystem and their interactions with crops can influence yields positively or negatively. Research on the impact of fauna activity on agricultural production mostly focuses on the costs (e.g. crop damage) or benefits (e.g. pollination), with few studies addressing cost-benefit trade-offs in the same context. This has resulted in an incomplete understanding of the implications of fauna activity in agroecosystems[2].

Pest resilience is not as simple as increasing the non-crop habitat. Other biotic and abiotic mechanisms play a role, including:

- Selecting pest-resistant crop varieties
- Intercropping
- Using cover crops
- Climate adapted push-pull techniques
- Mulching
- Minimum tillage and other soil management practices[3].

One explanation for this difference may be that the greater diversity of organisms involved in pest control (such as birds, bats, spiders, beetles, flies, etc.) may underlie their more diverse landscape responses[4].

Organic vs. conventional

There is no difference in biological control between organic and conventional fields when the farming system was the sole predictor (Figure 1). However, the number of distinct habitat patches in the landscape had a positive effect on biological control only in more complex landscapes[5].

Birds are important ecosystem service providers across a range of ecosystem types. They can travel long distances, have high metabolic demands and can utilise a range of habitats.

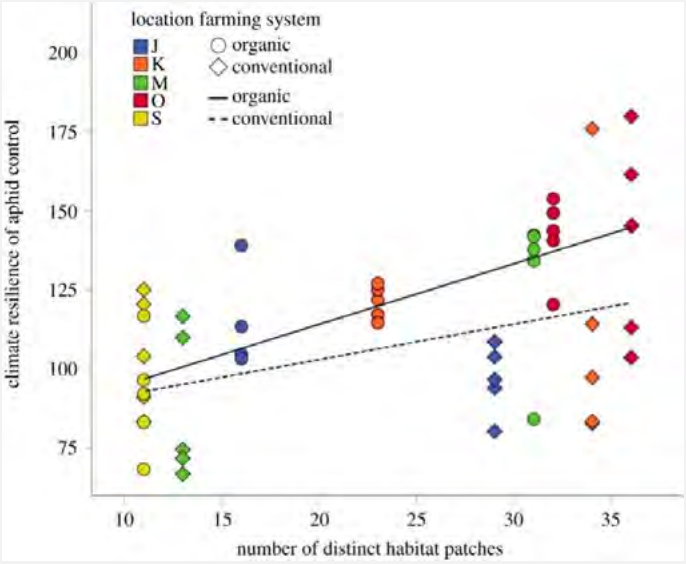

Figure 1: Biological control, farming system, habitat patches effect on aphid control, where JKMOS are randomly assigned fields. **Source:** B.B Feit[6]

1 Gurr, G. (2021). Field and landscape management to support beneficial arthropods for IPM on vegetable farms. Sydney: Horticulture Innovation Australia.

2 Peisley R.K., S. M. (2015). A systematic review of the benefits and costs of bird and insect activity in Agroecosystems. Springer Science reviews, 113-125.

3 Heeb, L. J. (2019). Climate smart pest management: Building resilience of farms and landscapes to changing pest threats. Journal of pest science, 952-969.

4 Karp, D. e. (2018). Crop pests and predators exhibit inconsistent responses to surrounding landscape composition. Proceedings of the National Academy of Sciences (pp. 7863-7870). PNAS.

5 Feit, B. B. (2021). Landscape complexity promotes resilience of biological pest control to climate change. Proceedings of the Royal Society B. Royal Society

6 Feit, B. B. (2021). Landscape complexity promotes resilience of biological pest control to climate change. Proceedings of the Royal Society B. Royal Society.

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Birds are commonly found in agroecosystems and their foraging activities provide significant benefit to primary producers from biological control of pests, however, birds are most active within 20m from natural vegetation[7].

In Australia, 66 percent of insectivorous bats roost in tree hollows, and bat colonies do not travel great distances to exploit crop insects. Thus, bats foraging over crops in Australian agroecosystems are predominately tree-dependent species roosting in nearby non-crop woody habitat and may provide a pest control service. Around 53-63 tonnes of insect pests are removed from Australian cotton crops each year by the average non-reproductive bat[8].

It is apparent that there are many factors contributing to pest control in the horticultural landscape (Figure 2).

Figure 2: Pest management depends on both local management and surrounding landscape context. Source: M. Johnson[9] .

7 Peisley R.K., S. M. (2015). A systematic review of the benefits and costs of bird and insect activity in Agroecosystems. Springer Science reviews, 113-125

8 Heidi Kolkert, R. S. (2021). Insectivorous bats provide significant economic value to the Australian cotton industry. Ecosystem Services

9 Johnson, M. (2020). Diversified agricultural Landscapes for pest control. Resilience Landscapes, SLU global Seminar. Uppsala: Centre for Biological Control.

Image: Bauers Organic Farm and nearby riparian native vegetation. **Credit:** Darren Brown.

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Other research

In addition to the research from Hort Innovation project VG16062: *Field and landscape management to support beneficial arthropods for IPM on vegetable farms*, other studies include:

- 206 insect-only studies, where 18 percent related to vegetables and 70 bird studies, where 2.9 percent related to vegetables[10]
- 1 micro-bat study in cotton (University of Queensland is currently undertaking a study in the Lockyer Valley on how well bats can control insect pests)[11].

Additional references

- Gagic, V. P. (2018). Ecosystem service of biological pest control in Australia: the role of non-crop habitats within landscapes. Austral Entomology, 194-206.
- Peisley, R. K. (2017). The benefits and costs of bird activity in Agroecosystems. Bathurst: Charles Sturt university.

10 Peisley R.K., S. M. (2015). A systematic review of the benefits and costs of bird and insect activity in Agroecosystems. Springer Science reviews, 113-125

11 Heidi Kolkert, R. S. (2021). Insectivorous bats provide significant economic value to the Australian cotton industry. Ecosystem Services.

Further information

Contact VegNET South-East Queensland Regional Development Officer Darren Brown at ido@lockyervalleygrowers.com.au or 0456 956 340.

Field and landscape management to support beneficial arthropods for IPM on vegetable farms (VG16062) was funded by Hort Innovation using the vegetable research and development levy and contributions from the Australian Government.

More information and resources from the project can be found here: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/

Image: Typical creek line in the Lockyer Valley. **Credit:** Darren Brown.