Case study:
IPM and biodiversity in lettuce, Spring 2023

October 2024 / version 1

Summary:

This case study shares the crop protection approach taken in successfully harvesting a marketable spring lettuce crop using integrated pest management and biodiversity as key strategies.

Introduction

This report details the Spring 2023 planting of the lettuce crop, utilising Integrated Pest Management (IPM) and biodiversity as key strategies.

In agriculture, the complexity of pest management is influenced by a myriad of factors, including climate, agricultural practices, and evolving pest resistances.

Our primary objective is to effectively manage pest populations by natural means, through enhancing on-farm biodiversity to reduce the reliance on chemical sprays.

By integrating these methods within existing agricultural practices, this approach aims to demonstrate a sustainable model of pest control that minimises chemical inputs while maintaining crop health and productivity as part of a core resistance management strategy.

This project is looking to continuosly refine these strategies over future crop cycles, and look into outcomes that might necessitate further research or investigation.

Crop overview

This section provides an overview of the lettuce crop's growth and the environmental challenges it faced during the spring 2023 season.

The crop experienced generally favourable conditions, although a notably wet period towards the end presented some disease challenges. This season was characterised by high aphid pressure, making it a critical time for testing IPM strategies and pest resistance management under stress.

Despite these pressures, the IPM system proved effective, operating with success. However, the occurrence of aphid infestations despite the implementation of advanced management techniques, raises important questions.

Our thriving lettuce crop, flanked by annual plantings, and strategically placed insectaries within the crop.

Lettuce thriving under careful cultivation and effective pest management practices.

Weekly IPM workshops with growers and industry members were conducted, demonstrating the practical application of IPM in the field alongside theoretical classroom sessions.

Additionally, the biodiversity plantings played a significant role in influencing the crop insect dynamics, contributing positively to overall crop health and productivity. The crop was successfully harvested, meeting expectations in terms of quality and yield.

Crop overview

The lettuce variety 'Espada' (High Resistance: Bl:1-29, 32, 34, Nr:0) was transplanted on September 14, 2023, followed by two additional plantings at two-week intervals. For this case study, we focus on the first two lettuce plantings in detail. Harvesting commenced on November 17, 2023.

Monitoring details

Crop monitoring was initially scheduled on a 7-day cycle, adjusted to more frequent intervals when scouting thresholds were triggered. During each session, 10 plants were systematically scouted in a diagonal pattern across the cultivation block, following basic industry guidelines. Spray thresholds were set according to these guidelines and were further refined by field experience to enhance our decision-making processes.

Pest overview

The purpose of this September planting slot was to assess how biodiversity plantings could influence pest dynamics, particularly under high pest pressure.

From the onset at the seedling stage, the crop experienced significant aphid activity of mainly currant lettuce aphid, with some other species including green peach aphid.

Despite the currant lettuce aphid resistant variety and the application of a drench for aphid control at transplanting, aphid numbers continued to multiply rapidly. This led to two outbreaks; the first outbreak reached a threshold that typically necessitates a spray application. However, the initial drench delayed the need for further chemical interventions, allowing us to manage the outbreak effectively without additional sprays.

The second outbreak was also successfully controlled, through the timely intervention of predatory insects. Additionally, the crop faced low caterpillar pressure, including a native species not typically observed in lettuce crops, likely attracted by the permanent plantings. Caterpillar species did not reach problematic levels.

Slugs posed another significant challenge, exacerbated by the wet conditions. Despite using slug bait, controlling their population proved difficult.

Natural enemies overview

During this growing season, the crop benefitted from a diverse array of beneficial insects, crucial for natural pest control.

The dedicated lettuce planting crew in action, essential to the successful cultivation of our crops.

The second outbreak was also successfully controlled, through the timely intervention of predatory insects.

Adult hoverfly, a beneficial species.

Predominantly, Tasmanian brown lacewings (Micromus tasmaniae) were observed, along with several small hoverflies (Melanostoma fasciatum), which were systematically counted during monitoring sessions. Additionally, Pacific damsel bugs (Nabis kinbergii) were frequently sighted, although these observations were outside the formal monitoring counts.

An interesting discovery was the presence of aphid midge (*Aphidoletes sp.*) larvae on a lettuce plant, situated within an aphid colony. Aphid midge larvae predate on many aphid species. This occurrence is notable as aphid midge larvae are not typically associated with lettuce crops in the Pukekohe region.

Overall, the levels of predatory insects were considerably high for a spring lettuce crop in this area, with instances of several lacewings per plant being recorded.

Disease update

Remarkably, the crop exhibited minimal disease presence, despite significant rainfall during the latter part of the growing season. That level of rainfall typically promotes disease development and was indeed causing issues in surrounding crops in the area.

Thresholds

During this crop cycle, we utilsed threshold guidelines from the Information Guide for IPM in Outdoor Lettuce (August 2007), focusing particularly on the aphid-to-predator and caterpillar thresholds. The primary threshold we monitored was the aphid one, where we calculate the ratio of aphids to predators (excluding spiders) as follows:

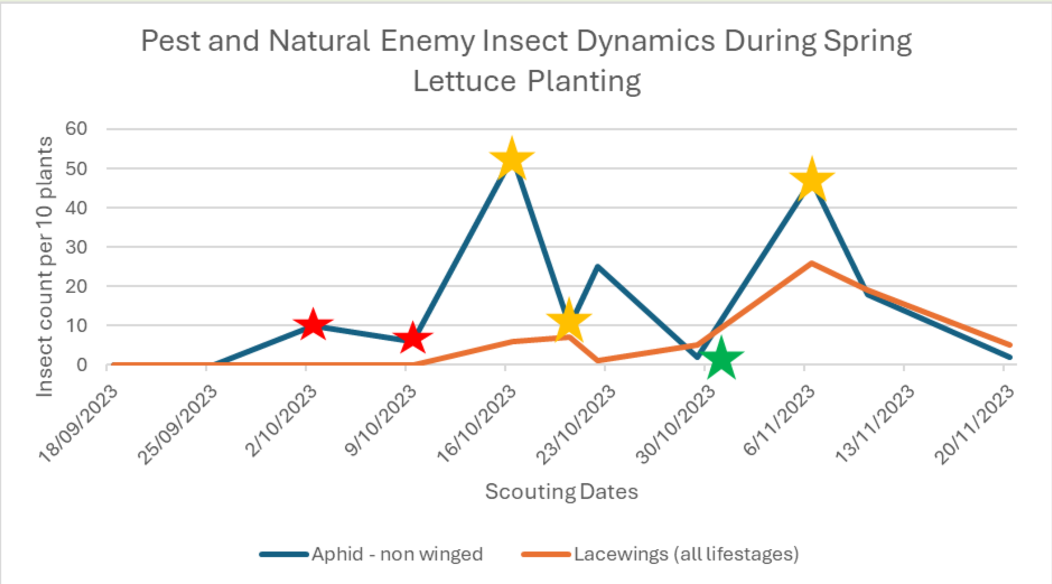
Aphid/Predator Ratio = Total number of aphids / Total number of predators
Based on this calculated ratio, the following actions were prescribed:

- Less than 10: No action required; schedule the next scouting in 7 days.
- Close to 10: No immediate action; increase scouting frequency to every 3-4 days.
- Greater than 10: Apply a selective insecticide and scout again in 7 days.

In our more biodiverse system, we occasionally reached the spray threshold. However, considering the other controls that were still effective at the time, we opted not to spray immediately but to continue monitoring closely, ready to act if necessary. Overall, these adapted thresholds have demonstrated their effectiveness in our system, enabling us to manage pest populations effectively without relying heavily on chemical interventions.

Monitoring results

Throughout the growing season, we closely monitored pest and beneficial insect populations to assess the effectiveness of our IPM strategies and biodiversity enhancements. The graph below provides a visual representation of the main pests and beneficial insects observed during the two primary planting periods. Key moments when spray thresholds were reached are marked with red stars, while yellow stars denote instances where we approached threshold levels, prompting increased scouting frequency. The green star indicates when the cover crop was mulched, to provide increased predatory insect support for the crop.



Additionally, the accompanying table details the diversity of other species encountered in the crop. This includes both pests and beneficial insects not routinely monitored but observed sporadically, which offers insight into the broader ecological impact of our biodiversity efforts.

The table categorizes these sightings into those systematically recorded during monitoring and those observed incidentally, providing a comprehensive view of our crop's pest and beneficial insect landscape.

Diversity of insect species observed in the lettuce crop:

Pest		Beneficial	
Monitoring	Currant lettuce aphid, other aphids	Monitoring	Hoverfly – adults
	Soybean looper caterpillar		Hoverfly – juvenile
	Native caterpillar		Hoverfly – eggs
	Thrips		Ladybird - adult
	Slugs		Lacewing – adults
			Lacewing – juveniles
			Lacewing – eggs
			Lacewing - pupae
			Parasitised aphid mummy
			Spiders
		Observed	Aphid midge - juvenile
			Pacific damsel bug

Biodiversity planting impacts

The diversity of plantings within our farm ecosystem played a significant role in pest management this season.

For this crop, the on-farm biodiversity included an annual floral strip flanking both sides which was sown on September 18, 2023, with a mix of alyssum, buckwheat, calendula, cornflower and marigolds. The first flowers (buckwheat) opened on October 20, 2023.

The permanent native planting along the front of the block, which were now half-grown, had its spring-targeted plants flowering. Groundcovers flowering were *Disphyma austral*, *Lobelia angulate*, *Metrosideros carminea* 'RedCarpet', *Muehlenbekia axillaris*, *Pratia puberula*, *Pratia puberula alba*, *Pimelea* 'Blue Peter', *Pimelea prostrata* 'SilverGhost'.

Shrubs flowering were *Carex lambertiana*, *Carex virgata*, *Olearia chesmannii*, *Pomaderris kumeraho*. The six moveable insectaries, which had been recently planted, were placed within the crop on November 9, 2023.

The insectaries had the following flowering natives present: *Leptinella dioica*, *Leptinella* 'Seal Island', *Leptinella rotundata*, *Manuka* (flat, Joy Nursery), *Leptospurmum nanum* 'Kiwi', *Leptospermum scoparium* 'Kea', *Muehlenbeckia axillaris*, *Parahebe catarractae* 'Snowcap', *Pimelea prostrata* 'Anatoki', *Pimelea prostrata* (Joy Nursery), *Pimelea prostrata* (Robinson's Nursery), *Pimelea prostrata* 'Silver Ghost'.

The biodiverse planting on the farm has provided food and shelter for a wide range of insects.

The diversity of plantings within our farm ecosystem played a significant role in pest management.

Native groundcover *Disphyma austral*.

Additionally, a well-developed mixed annual cover crop containing buckwheat, berseem clover, linseed, phacelia and vetch was established from an early May sowing in a block ~100 metres from the crop.

These biodiversity measures provided habitats for natural enemies like the Tasmanian brown lacewing and the small hover fly, significantly contributing to pest control. Although we observed the typical types of pests such as lettuce aphid and soybean looper caterpillars, a native caterpillar emerged as a unusual pest. However, it did not constitute any significant issue for the crop.

This native caterpillar, likely attracted by the permanent plantings, underscores the need for ongoing monitoring to better understand which plants are attracting these pests and natural enemies.

Notably, the mulching of the cover crop in adjacent blocks coincided with a substantial influx of lacewings into the lettuce crop. This timely arrival of predators led to a high prevalence of adult lacewings among the lettuce plants, providing effective control without the need for chemical sprays. This success illustrates the critical impact of enhancing habitat diversity for natural enemies during the winter, preparing a robust natural defence for spring when the crop is most vulnerable.

Additionally, we observed an increase in aphid midge presence, which likely benefitted from the diverse plantings and contributed to reducing our reliance on insecticides.

To quantify the impact of our biodiversity efforts, a summary of total insect counts and the diversity of species observed within the lettuce crop:

Pests: 199 individuals across 5 species

Natural enemies: 85 individuals across 7 species

This data highlights the ecological balance we are striving to achieve through biodiversity, enhancing both pest control and crop health.

Harvest

The crop was successfully harvested and met the expectations of the grower, who remarked that it "looks good" and expressed satisfaction with the results given the growing conditions.

Additionally, the crop was well-received at the market, garnering no negative feedback, which underscores the effectiveness of our pest management practices.

Reducing insecticides

We effectively managed to reduce insecticide use on our biodiverse property by employing IPM strategies of resistant varieties and drenching, complemented by our biodiversity plantings.

This approach led to a significant reduction, using eight fewer insecticidal active ingredients across five field spray applications.

Native caterpillar spotted among the lettuce, highlighting the diverse insect life influenced by our farm's ecosystem

Cover crops provided habitat for natural enemies alongside native plants in bloom during the September lettuce.

Adhering to our resistance management strategy was seamlessly maintained without the need for additional spray applications.

The table below outlines the schedule of fungicide and insecticide applications made during the crop cycle, comparing our biodiverse crop with a similar conventional crop nearby. This comparison illustrates our reduced reliance on chemical treatments due to our integrated pest management and biodiversity strategies.

Leptinella dioica in flower.

Our Crop Treatment			Nearby Crop Treatment		
Date	Fungicide	Insecticide	Date	Fungicide	Insecticide
		Durivo drench @ transplant			
13/10/2023	Intuity +Integralis +Incursus Field		19/9/2023	Intuity +Mancozeb	Transform
1/11/2023	Intuity +Kocide Opti +Mancozeb		28/9/2023	Intuity +Mancozeb	Pirimor
8/11/2023	Integralis +Kocide Opti +Incursus Field		3/10/2023	Mancozeb	Transform +Insecticide
			11/10/2023	Mancozeb	Pirimor +Insecticide
			26/10/2023	Mancozeb	Pirimor +Insecticide

This schedule provides a comprehensive overview of the treatments administered and highlights the contrast in chemical usage between the biodiverse and conventional farming approaches.

Conclusion

In conclusion, by significantly stretching spray thresholds and relying primarily on the initial transplant drench and currant lettuce aphid resistant variety, we effectively managed an infestation of mixed aphid species, including currant lettuce aphid, with the aid of farm-resident predatory insects.

However, the appearance of these aphids so early in the crop, despite our chosen resistant variety and drench application, raises important questions about potential resistance in the aphid population and the effectiveness of our drench application method.

Our biodiversity plantings, although still maturing, may have prompted the emergence of a new pest caterpillar, the appearance of the rarely seen aphid midge as a natural enemy, and enhanced mobility of other natural predators across the crop.

These developments underscore the dual impact of increased biodiversity: it introduces new challenges while bolstering pest control mechanisms.

An insectary of native plants in the lettuce crop was another component of the biodiverse planting at the farm.

This experience highlighted that the biodiversity provided more resilience to our cropping system during the pest outbreak, playing a crucial role in pest control when other methods did not perform as expected. Biodiversity plantings, while not a panacea, play a crucial role in complementing traditional chemical methods, contributing to a more robust and resilient IPM strategy.

The strategic use of the drench likely contributed to preserving a greater diversity of natural enemies than if frequent spraying had been employed. This approach underscores the benefits of integrating biodiversity with selective chemical interventions to build a more resilient agricultural ecosystem.

Biodiversity plantings, while not a panacea, play a crucial role in complementing traditional chemical methods, contributing to a more robust and resilient IPM strategy.

The risks and benefits of drenching, particularly in the context of developing resistance, highlight the need for careful application management and the incorporation of breaks in drench usage, as suggested in the lettuce aphid resistant management and prevention strategy, which is currently being updated.

Overall, this strategy reduced our reliance on chemical insecticides under high aphid pressure, not simply through a reduction in chemical usage, but more crucially through the strategic combination of a resistant variety, targeted drench application, and the enhancement of on-farm biodiversity. This integrated approach provided resilient control even under challenging conditions.

Moving forward, it is essential to ensure meticulous application and ongoing care of drenched plants to prevent the development of resistance. The continued monitoring of aphid populations and the effectiveness of our management strategies are critical.

As our biodiversity plantings mature, their potential to support natural enemies and enhance crop resilience will further unfold, allowing us to refine these integrated pest management strategies and push them further in future crops.

Acknowledgements:

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Other crop case studies

Case study: IPM and biodiversity in lettuce, Winter 2024 - here

This case study shares the crop protection approach taken in successfully harvesting a marketable winterlettuce crop using integrated pest management and biodiversity as key strategies.

Other related resources

Biodiverse planting on vegetables farms project - here

This project is designed to show manipulation of plant diversity on a farm can increase beneficial insect numbers and reduce the pests in a crop, meaning less use of insecticides is required.

Linked on this page are many grower resources relating to this biodiversity project, including 'how to' guides and monitoring sheet templates.