Invertebrate Function: Mixed Plant Species vs Monocultures

Project: Demonstration of Invertebrate Function in Response to Broadacre Management
Location: Moculta, SA
Farm size: 1800 ha
Farming system: Mixed farming
Soil type: Loam
Average annual rainfall: 400 - 500 mm

Aim

To demonstrate if increased paddock plant species promotes an increase in invertebrate species.

Introduction

Invertebrate activity and diversity were monitored at eight paddock sites at Moculta by Dr Michael Nash (What Bugs You) during winter/spring 2022. The sites ranged from highly diverse mixed species cover crops and pastures (5 sites), canola crop monocultures (2 sites) and an undisturbed grazed native pasture (1 site) (Table 1, Figure 1). Six of the eight sites were managed using regenerative principles on the property of Ian and Fiona Koch, while the canola sites were conventionally managed on the nearby property of Craig Hage. All sites were monitored using pitfall traps and yellow sticky traps for one week each month for four months between July-October.

Table 1: Description of the paddock sites and their associated plant species.

Site Number	Paddock type	Main plant species
1	Monoculture canola	Canola 1 sp.
2	Diverse mixed spp.	Approx. 18 spp. inc. phacelia, vetch, cereal rye, wheat, barley, crimson clover, tillage radish, ryegrass, linseed, beans, peas.
3	Diverse mixed spp.	Approx. 18 spp. (species as above)
4	Mixed spp. crop	Beans, peas, canola 5 spp.
5	Mixed hay crop	Vetch, ryegrass, clover, triticale 6 spp.
6	Native pasture	Grasses, clover > 20 spp.
7	Mixed spp. pasture	Cereals, ryegrass, clover, vetch 8 spp.
8	Monoculture canola	Canola 1 sp.

Increased invertebrate diversity in theory results in less pest threats through healthier plants and provision of ecosystems services. Those services of most interest being natural enemies providing pest control. In this demonstration, the farmers were particularly interested in red legged earth mite (RLEM) numbers as they are a serious threat to clover which in turn reduces pasture and livestock productivity.

Figure 1: Photos of selected paddock sites when sampling commenced in July 2022: Mixed species crop (left), native pasture (centre), canola monoculture (right).

Results – what invertebrates were observed?

The study indicated that increased invertebrate abundance and diversity was associated with increased plant diversity. The least number of invertebrate species were recorded at the two canola sites, 23-25 species, compared to 30-40 species at the most diverse mixed species crop sites and the native pasture (Table 2). Key species recorded at the canola sites included springtails, spiders, flies, and aphids. While the main species at the mixed species sites included springtails, spiders, predatory beetles, flies, parasitoid wasps, predatory mites, RLEM, lucerne fleas and aphids. The application of insecticides to the canola sites to control RLEM and aphids likely skewed these results, however, the RLEM numbers recorded at the other six sites where insecticides were not used were well below action threshold levels.

A key natural enemy, predatory carabid beetles, were recorded in pitfall traps in early spring at all sites, except the two canola sites. A surprise was slugs being active at the September sampling (Figure 2), along with snails that were commonly recorded throughout the four-month monitoring period. Spiny springtails, an indicator of good soil health, were recorded at most sites, except the canola sites. Their highest numbers were in the diverse mixed species and native pasture sites.

Table 2: Results from yellow sticky traps and pitfall traps assessing relative abundance (number) and number of species (species) recorded at each site during July-October 2022 at Moculta.

Paddock type	Total spp.	Pest		Natural enemies		Proportion (%)	
		Number	species	Number	species	Pest	Natural enemies
Monoculture canola	25	7	6	16	6	30	70
Diverse mixed spp.	38	455	8	61	10	90	10
Diverse mixed spp.	37	297	8	50	9	90	10
Mixed spp. crop	35	78	7	133	9	40	60
Mixed hay crop	35	183	8	60	12	80	20
Native pasture	40	511	7	58	10	90	10
Mixed spp. pasture	30	268	7	19	8	90	10
Monoculture canola	23	10	5	32	6	20	80

Discussion

The proportion of pests was greater at all mixed species sites compared to the canola monoculture sites where the proportion of natural enemies was higher, however at a much lower relative abundance (Table 2) (the exception was the Mixed species crop site (site 4), likely due to missing data because of traps being flooded). The results indicate managements tolerance of low pest abundance creates an environment where food is available for the natural enemies, thus creating a more stable system. That is, less pest outbreaks are expected due to a greater diversity and abundance of natural enemies in the mixed species systems.

The outcome from this project is specific to the 2022 season at the Moculta location due to a very wet spring and abundant plant growth late into the season. These results are concordant with European literature that more diverse farming systems can be more resistant to pest threats as pests' numbers are regulated by natural enemies, hence are considered more stable. Results are also consistent to an Australian study that indicate more diverse cropping systems (peas grown with canola), are less likely to be threatened by pests.

In contrast, a recent Ag Ex Alliance/CSIRO mixed species cover crop project spanning 20 sites over three seasons highlighted the complex and varied responses invertebrates demonstrate to crop diversity. However, what is clear is that management needs to understand the context in which diversity is being included into farming systems and growers' tolerance to sporadic pest threats. Risks are less where plant diversity is increased on farm and tolerance to pests is greater.

Figure 2: Black keeled slug recorded at the September sampling

Farmer Q&A

Livestock and mixed species cover cropping – pros and cons.

Ian Koch - sheep can access a diverse range of plants, therefore they can pick and choose what is right for their nutrition. A mixture of plants is more productive on less inputs, therefore there is less need for pesticides.

Craig Hage - there is a lack of herbicide options if spraying mixed species.

What led you to become involved with the invertebrate function project?

Ian - an interest in which beneficial invertebrates are on farm and being able to harness these natural enemies to limit pest threats.

Craig - monitoring of insect pest numbers and then spraying only when thresholds are reached.

What would be your 'go-to winter mix'?

Ian - buckwheat, chicory, plantain, phacelia, arrow leaf clover, balansa clover, sub-clover, peas, faba beans, vetch, barley, wheat, rye, oats, triticale, ryegrass, tillage radish, canola (would also like to add some more herbs if available).

Does your farm benefit from insect function?

Ian - yes it does because we don't kill insects all the time. The invertebrate diversity is key to insects working, we also note that the header is covered in spider webs after harvest.

What did you learn from the hands-on workshop run as part of this demonstration?

Ian - there is a lot more invertebrate diversity than what I thought in my paddocks. Attendees got to see and learn about the methods used to monitor invertebrate communities. We hear a lot about the nasties but not so much about the good insects – it's great to hear about the beneficials.

If you were to monitor invertebrates again, what would you do differently?

Ian - monitoring started too early when it was cold, and the invertebrates were not active, ideally would like to see monitoring extended over a longer period.

From a grower's perspective, does mixed cover cropping have a place in lower north farming systems to decrease pest threats?

Ian - A more diverse farming system is more resilient to pest threats; therefore, we do not have to rely on insecticides to manage insects that are considered damaging, this includes RLEM.

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