

Does the cutting of lucerne (*Medicago sativa*) encourage the movement of arthropod pests and predators into the adjacent crop?

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Abstract Lucerne (*Medicago sativa*) has been suggested as an ideal refuge habitat as part of an integrated pest management (IPM) program because it harbours high numbers of beneficial arthropods. Whether or not cutting of lucerne encourages the movement of these beneficials into adjacent target crops is unknown. Vacuum samples were used to determine the effects of cutting lucerne on arthropod abundance (pests and predators) within lucerne and adjacent soybean (*Glycine max*) crops. Vacuum-sample collections of arthropods were conducted before and after lucerne cutting on seven occasions in four fields over two seasons. In the lucerne, 10 m by 1 m strips parallel to the crop interface were sampled at 5, 10, 15, 20 and 30 m from the interface. In the soybean, 10 m of row were sampled at the same distances from the crop interface. The abundance of predators in lucerne was reduced immediately after cutting at all distances from the interface. Predator abundance in soybean did not show any change. The cutting of lucerne significantly reduced pest numbers within the lucerne but had little effect on pest abundance in the adjacent soybean. The temporal pattern in pest and predator abundance was very different for each field sampled. Generally, arthropods decreased in abundance after cutting and gradually increased as the lucerne grew back. In soybeans, arthropod numbers fluctuated regardless of the cutting of the lucerne. Cutting of lucerne alone does not guarantee movement of predators into the adjacent target crop. The presence of lucerne fields within a cropping area may have some impact on regional predator populations, and so still be useful for IPM programs, but this has yet to be tested critically.

Key words conservation biocontrol, habitat manipulation, movement, predators, refuge crops, vacuum sampling.

INTRODUCTION

Refuge habitats or nursery crops can represent vegetation within an agroecosystem that provides areas for beneficial arthropods to increase in abundance. They may include remnant bushland patches, riparian vegetation, abandoned or fallow fields, field edges, roadside verges, domestic parks or gardens, and planted crops. By definition, refuge habitats are more attractive to beneficial arthropods than conventional crops because they provide the appropriate physical or biological resources in areas where they have been depleted (Wratten & van Emden 1995). These resources may include overwintering sites, food (in the form of pollen and/or nectar), alternative prey for predators and hosts for parasitoids, as well as refuge from insecticide sprays. The practice of providing refuge habitats in the form of 'companion plants' (e.g. flowers) in garden systems has been implemented for many years (Wratten *et al.* 1998). In some broadacre cropping systems, refuge habitats are now being used as part of integrated pest management (IPM) programs (Walker *et al.* 1996; Mensah &

Khan 1997; Tuart 1999), despite poor understanding of the interaction between populations of beneficial arthropods in their refuge habitats and the crop system.

Refuge habitats in IPM programs rely on the premise that beneficial arthropods will move out of the refuge habitat into the target crop and stay there long enough to reduce pest numbers. How and why beneficial arthropods move from one crop to another are largely unknown. Although crops can be ranked in terms of the diversity and/or abundance of beneficial arthropods sampled, we do not know the underlying mechanisms that influence habitat attractiveness. Walker *et al.* (1996) tested lucerne, maize, mungbean, peanut, potato, sorghum, pigeon pea and sunflower as nursery crops for beneficial arthropods associated with cotton and found the greatest diversity in lucerne and sorghum. Mensah (1999) found a similar result, recording consistently higher numbers of predatory beetles and bugs in lucerne strips in comparison to cotton, sunflower, safflower, sorghum and tomato crops.

An ideal refuge habitat should harbour high numbers of effective beneficial arthropods, low numbers of pests, be easily manipulated to ensure movement of beneficials to the target crop, and supply a profit to the grower. Lucerne (or alfalfa), *Medicago sativa*, has long been thought to have these characteristics. This perennial forage crop is cut regularly (every 3–

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4 weeks in summer) just before flowering and allowed to dry in the field before being bailed and removed. One planting can last for 2–6 years. One of the major benefits of lucerne is its ability to fix nitrogen and so improve soil quality. It is considered a key crop for salinity control in many areas of Australia, and more recently lucerne cultivars have been developed for ethanol and plastic production, and for protecting groundwater quality (Comis 2002).

Bishop and Holtkamp (1982) first investigated the arthropod fauna of lucerne in Australia and Mensah (1999) and Walker *et al.* (1996) showed that lucerne crops generally support a diverse assemblage of arthropod species. Recently cotton growers have been encouraged to use lucerne as a refuge crop for beneficial arthropods (Mensah & Harris 1995). This recommendation stems from work by Mensah (1997, 1999, 2002a,b) using within-field strips of lucerne combined with food sprays (Envirofeast, Bayer CropSciences, Australia) to increase beneficial numbers in the cotton crop. Hossain *et al.* (2000a) found that strip-cutting of lucerne fields conserved beneficial arthropods by providing uncut strips of lucerne as refuges. They suggested that subsequent cutting of refuges should encourage movement of beneficial arthropods into the re-growing strips, and so contribute to pest control. However, few studies have measured the movement of beneficial arthropods from lucerne into adjacent target crops. Lockrey *et al.* (1994) also found that distance from lucerne had an effect on the spatial distribution of some arthropods, but this trend was not consistent and could not be attributed to the cutting of lucerne *per se*. Mensah (1999) recorded an increase in arthropod abundance in cotton at up to 300 m away from a lucerne strip, but the effect of cutting on arthropod abundance in the cotton was not tested.

Hossain *et al.* (2002) directly measured the movement of predators after lucerne cutting using barrier pitfall traps and malaise traps. They demonstrated that habitat manipulation via lucerne cutting could increase the density and movement of some pest and predator species into adjacent uncut lucerne strips. Sentinel cards baited with *Helicoverpa* spp. eggs showed that predation within the uncut plots decreased with distance from the cut plots (also see Hossain *et al.* 2001). In this study we investigate the importance of lucerne cutting in terms of predator abundance and movement. Unlike previous studies, the target crop was soybean, *Glycine max*, rather than uncut lucerne. Vacuum samples were used to determine the effect of lucerne cutting on arthropod abundance (pests and predators) within the lucerne and adjacent soybean. The abundance data were used to indirectly assess whether lucerne cutting encourages movement of predators into the soybean.

MATERIALS AND METHODS

Field sampling

Arthropods were sampled in soybean fields adjacent to lucerne fields at the Gatton campus (27°34'S, 152°20'E) of the University of Queensland in the Lockyer Valley, Queensland, during the summers of 2000–01 and 2001–02. Many crops are

grown in the Lockyer Valley, including irrigated and non-irrigated grain crops, forage crops and horticultural crops. During summer temperature can range from a maximum of 35°C to a minimum of 15°C. Lower than average rainfall was recorded across the two seasons in which we sampled. In the first season, two fields (Mendel 3.2 ha and Horti 4.4 ha) of soybean (cv. Cawana) were planted in rows (75 cm row spacing) during the last week of December 2000. The adjacent lucerne (Mendel, cv. Sceptere, and Horti cv. Sequel/L69) was planted 2 years previously. In the second season, two fields (Gilbert A 5.5 ha and Gilbert C 8.8 ha) of soybean (cv. Warrigal) were planted in rows (75 cm row spacing) in the first week of December 2001. The adjacent lucerne (cv. Hallmark/Sequel HR) was planted early in the same year. The soybean was inter-row cultivated to reduce weeds and irrigated when necessary, but no insecticides were applied. The lucerne was cut and bailed approximately every 4 weeks. At each site, the lucerne was directly adjacent to the soybean, except at Horti where the lucerne and the soybean crops were separated by a grassy road (5 m wide).

Arthropods were collected by vacuum sampling over seven lucerne cuts, one in Mendel and two each in Horti, Gilbert A and Gilbert C. Samples were taken 1–2 d prior to cutting (before sample) and 1 d after cutting (after sample) in the lucerne and adjacent soybean. The vacuum sampler was a converted PB2105 leaf blower (Echo, United Kingdom) and arthropods were collected in a bag (0.5 mm mesh material, 20 cm diameter opening, 40 cm length) attached to a pipe (diameter 12 cm) inserted over the exhaust fan. Collection bags were removed from the nozzle while the vacuum was still running, sealed and kept chilled until they were returned to the laboratory for sorting. Arthropods were killed by placing the collection bags in a freezer overnight. In the lucerne, 10 m by 1 m strips parallel to the crop interface were sampled at 5, 10, 15, 20 and 30 m from the interface. The nozzle of the vacuum sampler was moved slowly through the foliage in a swinging motion, covering a 1 m swath. Each 10 m² area was vacuumed twice (up and back). In the soybean, 10 m of row was sampled at the same distances from the crop interface, by slowly moving the vacuum nozzle through the foliage and up and down the plant stem. Each side of the plants in the 10 m of row was sampled (up and back). A new transect position (at least 20 m from the previous transect) along the interface was used on each sampling date.

A day after sampling the contents of each collection bag was emptied onto a white tray and the adult and juvenile arthropods sorted into major predator and pest groups (Table 1). Small arthropods (e.g. microhymenoptera and some immature stages) were not recorded. Soybean fields had row spacings of 75 cm so the numbers were converted from numbers per 10 m row to numbers per 10 m².

Data analysis

Each cut was considered a sampling unit for the purpose of statistical analysis ($n = 7$). Three of the four fields studied were subject to two cuts during the sampling period. Thus the

Table 1 Major arthropod groups used for sorting vacuum sample catches from lucerne and soybean fields. Only those arthropods that were analysed are included in the table. Identifications and common names are based on Wood *et al.* (2000)

	Taxon	Common name	Crop
Pest group			
Lepidoptera	<i>Helicoverpa</i> spp.	Heliothis	SB, L
	<i>Spodoptera litura</i> (Fabricius)	Cluster caterpillar	SB, L
	<i>Aproaerema simplexella</i> (Walker)	Soybean moth	SB, L
	<i>Lamprosema abstitalis</i> (Walker)	Legume webspinner	SB, L
	<i>Merophyas divulsana</i> (Walker)	Lucerne leafroller	L
	<i>Zizina labradus</i> (Godart)	Blue-grass butterfly	SB, L
	<i>Thysanoplusia orichalcea</i> (Fabricius)	Soybean looper	SB, L
	Lepidoptera	Other loopers	SB, L
	Lepidoptera	Other pest Lepidoptera	SB, L
Coleoptera	<i>Monolepta australis</i> (Jacoby)	Redshouldered leaf beetle	SB, L
	<i>Zygrita diva</i> Thomson, <i>Corrhenes stigmatica</i> (Pascoe)	Lucerne crownborers	SB, L
	Coleoptera	Weevils	SB, L
Other Hemiptera	<i>Nezara viridula</i> (Linnaeus)	Green vegetable bug	SB, L
	<i>Piezodorus hybneri</i> (Gmelin)	Banded shield bug	SB, L
	<i>Riptortus serripes</i> (Fabricius), <i>Melanacanthus scutellaris</i> (Dallas)	Brown bean bugs	SB, L
	Hemiptera	Other pest bugs	SB, L
Hemiptera – Jassids	Cicadellidae	Leafhoppers, Jassids	SB, L
Hemiptera – Mirids	Miridae	Pest mirids	SB, L
Predator group			
Formicidae	Hymenoptera – Formicidae	Ants	SB, L
Coccinellidae	Coccinellidae	Various ladybeetles	SB, L
Hemiptera	<i>Oechalia schellebergii</i> (Guérin-Ménéville)	Spiny shield bug	SB, L
	<i>Cermatulus nasalis</i> (Westwood)	Glossy shield bug	SB
	<i>Taylorilygus pallidulus</i> (Blanchard)	Broken-backed bug	SB, L
	<i>Tytthus chinensis</i> (Stål)	Predatory crop mirid	SB, L
	<i>Campylomma liebkechti</i> (Girault)	Apple dimpling bug	SB, L
	<i>Geocoris lubra</i> Kirkaldy	Big eyed bug	SB, L
	<i>Nabis kinbergii</i> Reuter	Damsel bug	SB, L
	Hemiptera	Other predatory bugs	SB, L
Neuroptera	Neuroptera	Lacewings	SB, L
Araneae	Araneae	Spiders	SB, L

L, lucerne; SB, soybean.

sample units are not strictly independent, as they came from the same fields. However, after graphing the data, differences were clearly not significant and it is unlikely that this non-independence would have affected the conclusions drawn. Repeated-measures ANOVA was used to compare the population mean of each arthropod group (Table 1) caught before and after cutting, at different cuts, and at different distances from the interface. The interaction between before and after cutting and distance from the interface was tested. All analyses were performed using S-Plus (Mathsoft 1999). Aphidae (aphids) and Aleyrodidae (whiteflies) were excluded from the analysis of pest groups because they were highly abundant in a few cases but not present in the remaining cuts. In the predator groups the 'Other Coleoptera', staphylinid beetles and *Dicranolaius bellulus* (Guérin-Ménéville) (red and blue beetles) and syrphids (hover fly adults and immatures) were not analysed because very few individuals were collected. Arthropod collections were further grouped into predators in soybean, pests in soybean, predators in lucerne and pests in lucerne, and analysed as above (Table 1).

The observed number of arthropods in the soybean field after nearby lucerne cutting was compared with expected values assuming the arthropods missing from the lucerne fol-

lowed one of three movement scenarios: all of the arthropods missing from the lucerne after cutting moved into the target soybean field and spread evenly throughout that field; 50% of the arthropods missing from the lucerne after cutting moved into the target soybean field and spread evenly throughout that field; 25% of the arthropods missing from the lucerne after cutting moved into the target soybean field and spread evenly throughout that field.

RESULTS

The sample data were combined for all seven cuts to produce means of pest and predator abundance for the sampling date before and directly after cutting (Fig. 1). The abundance of predators in lucerne was reduced immediately after cutting at all distances from the interface (before: mean $17.5 \pm$ standard error 1.5, after: 4.2 ± 0.5 ; Table 2). Predators in soybean did not show any significant change in abundance before or after cutting of the adjacent lucerne (before: 14.2 ± 1.1 , after: 14.7 ± 1.5 ; Table 2). None of the predator groups showed a major increase in abundance in the soybean field after cutting (Table 2). The difference in predatory Hemiptera abundance

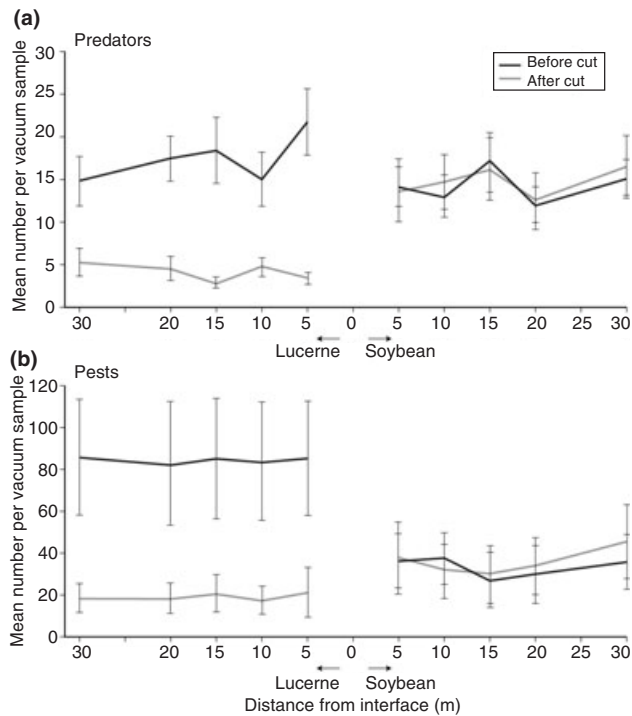


Fig. 1. Vacuum samples of (a) predators and (b) pests from soybean and adjacent lucerne fields. One vacuum sample was taken immediately before the lucerne was cut and the second 1 d after cutting. The data are collected from seven cuts in four fields over two seasons and expressed as mean numbers of arthropods collected per 10 m². The bars represent standard error.

in soybean before and after cutting was almost significant (before: 3.4 ± 0.7 , after: 4.4 ± 0.8 ; Table 2). However, there was no significant effect of distance from the interface. This result was predominately due to the numbers of *Nabis kinbergii* Reuter collected during two cuts (Gilbert A cut 1 and Gilbert C cut 1, Fig. 2). Over all cuts there was a significant difference in *N. kinbergii* abundance after lucerne cutting in both the lucerne (before: 1.7 ± 0.3 , after: 0.5 ± 0.1 , $P < 0.01$; Table 2) and soybean (before: 0.3 ± 0.1 , after: 1.1 ± 0.4 , $P = 0.02$; Table 2). However, there was generally few *N. kinbergii* in the lucerne and the soybean. For the majority of arthropod groups analysed there was a significant difference between cuts (exception being predatory Neuroptera in soybean $P = 0.20$ and lucerne $P = 0.16$) and no significant difference with distance from the soybean/lucerne interface (Table 2).

The cutting of lucerne significantly reduced pest numbers within lucerne (before: 84.5 ± 11.9 , after: 18.9 ± 3.6 ; Table 2), but had no significant effect on pest abundance in the adjacent soybean (before: 32.9 ± 5.5 , after: 35.3 ± 6.5 ; Table 2). Of the pest groups, only Hemiptera – Jassids showed a significant increase in the soybean field after the adjacent lucerne was cut (before: 15.7 ± 3.0 , after: 20.8 ± 4.2 ; Table 2). However, this increase in abundance was at 15–30 m from the interface, not directly adjacent to the lucerne field as might be expected due to movement from the adjacent field.

The temporal pattern in pest and predator abundance was very different for each field sampled. In Mendel, the lucerne

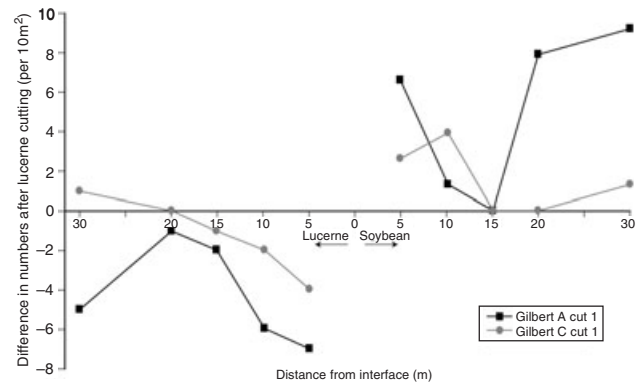


Fig. 2. Difference in numbers of *Nabis kinbergii* Reuter collected after lucerne cutting from soybean and adjacent lucerne field. One vacuum sample was taken immediately before the lucerne was cut and the second, 1 d after cutting at various distances from the crop interface. The data from only two of the seven cuts are shown.

predators decreased in abundance after cutting and gradually increased as the lucerne grew back. A similar trend was observed for the lucerne pests. Predators in soybean fluctuated regardless of the cutting of the lucerne. In Horti, the pattern of pest and predator abundance in the soybean mirrored what was occurring in the lucerne. In the second season, the numbers of pests in Gilbert A and C were considerably higher than the previous season. The predators and pests in the soybean fluctuated independently of the cutting of the adjacent lucerne in both fields. The cutting of the lucerne did reduce pest and predator numbers within the lucerne in both fields.

The observed difference in arthropod numbers in soybean after cutting rarely matched any of the three movement scenarios investigated (Table 3). After the first cut in Gilbert A, the second expected scenario (50% of the lucerne arthropods spread evenly over the adjacent soybean field) almost matched the observed difference in pest numbers in soybean (observed difference = 1.1, expected from scenario 2 = 1.2, within 10% of observed). In Gilbert C (cut 1), the expected values from scenario 2 were within 20% of the observed numbers in soybean (observed difference = 2.4, expected from scenario 2 = 2.7). Mendel (cut 2) exhibited the greatest increase in predators (4.3 per m²) in the soybean after the adjacent lucerne was cut. Gilbert C (cut 2) showed the greatest increase in pests (16.5 per m²) in the soybean after the adjacent lucerne was cut. This increase coincided with a large decrease in the numbers of pests (166.2 per m²) and predators (20.4 per m²) within the lucerne field after cutting. Fields Horti (cut 1 and 2), Gilbert A (cut 2 pests) were not analysed, because the arthropods decreased within the soybean after the adjacent lucerne had been cut.

DISCUSSION

If there was movement of arthropods (pests or predators) from lucerne to the adjacent soybean field in response to cutting we would expect to see more arthropods in the soybean directly after cutting, and maybe some relation to distance from the

Table 2 Results (*P*-values) of repeated-measures ANOVA used to compare the population mean of each arthropod group caught in soybean and an adjacent lucerne field before and after cutting (Before/after) of lucerne and at different distances (Distance) from the interface. The interaction between before and after samples and distance was also tested (Interaction). *P*-values shown in bold are significant at the 0.05 level

	Crop	Distance	Before/After	Interaction
Pest group				
Lepidoptera	Soybean	0.37	0.47	0.64
Lepidoptera	Lucerne	0.79	<0.01	1.00
Coleoptera	Soybean	0.14	0.14	0.99
Coleoptera	Lucerne	0.45	0.02	0.81
Other Hemiptera	Soybean	0.13	0.43	0.95
Other Hemiptera	Lucerne	0.29	<0.01	0.52
Hemiptera – Jassids	Soybean	0.25	<0.01	0.53
Hemiptera – Jassids	Lucerne	0.85	<0.01	1.00
Hemiptera – Mirids	Soybean	0.09	0.56	0.53
Hemiptera – Mirids	Lucerne	0.65	<0.01	0.85
Total pests	Soybean	0.23	0.29	0.34
Total pests	Lucerne	0.94	<0.01	1.00
Predator group				
Formicidae	Soybean	0.51	0.21	0.88
Formicidae	Lucerne	0.37	<0.01	0.48
Coccinellidae	Soybean	0.62	0.38	0.98
Coccinellidae	Lucerne	0.17	<0.01	0.28
Hemiptera	Soybean	0.23	0.05	0.79
Hemiptera	Lucerne	0.15	<0.01	0.79
<i>Nabis kinbergii</i>	Soybean	0.52	0.02	0.86
<i>Nabis kinbergii</i>	Lucerne	0.01	<0.01	0.59
Araneae	Soybean	0.17	0.59	0.77
Araneae	Lucerne	0.23	<0.01	0.46
Neuroptera	Soybean	0.19	0.33	0.42
Neuroptera	Lucerne	0.62	0.11	0.68
Total predators	Soybean	0.40	0.69	0.96
Total predators	Lucerne	0.24	<0.01	0.24

Table 3 Comparison of observed changes in arthropod numbers in soybean after cutting of lucerne with three expected movement scenarios. All abundance measures are the means of five vacuum samples of 10 m² in the lucerne and 10 m of row in the soybean (converted to 10 m²) and the analysis assumes the vacuum sampler is equally efficient in both crop types

Field	Cut	Arthropod group	Observed difference [†] (No. per m ²)	Expected based on:		
				Scenario 1 (No. per m ²)	Scenario 2 (No. per m ²)	Scenario 3 (No. per m ²)
Gilbert A	1	Pests	1.12	2.34	1.17‡	0.58
Gilbert A	1	Predators	0.26	1.20	0.60	0.30§
Gilbert A	2	Pests	-0.83	NA	NA	NA
Gilbert A	2	Predators	0.14	1.84	0.92	0.46
Gilbert C	1	Pests	4.79	52.00	26.00	13.00
Gilbert C	1	Predators	2.40	5.40	2.70§	1.35
Gilbert C	2	Pests	16.49	83.10	41.55	20.78
Gilbert C	2	Predators	1.60	10.20	5.10	2.55
Mendel	2	Pests	3.19	11.40	5.70	2.85‡
Mendel	2	Predators	4.26	10.50	5.25	2.63

[†]Difference = after cut count – before cut count. [‡]Indicates expected values are within 10% of the observed value. [§]Indicates expected values are within 20% of the observed value.

Scenario 1. All lucerne arthropods spread evenly over adjacent soybean field.

Scenario 2. Fifty percent of lucerne arthropods spread evenly over adjacent soybean field.

Scenario 3. Twenty-five percent of lucerne arthropods spread evenly over adjacent soybean field.

interface. We did not see this (Fig. 1). The cutting of the lucerne did effectively reduce the numbers of pests and predators within the lucerne field, but a corresponding increase in abundance in the adjacent soybean in pests or predators did

not occur (Table 2). Only *N. kinbergii* showed the expected increase in soybean after the adjacent lucerne was cut (Fig. 2). This increase in abundance occurred at 5 and 10 m from the interface and there appeared to be some correspondence

between the numbers lost from the lucerne and those found in the soybean. However, this trend was only evident in two of the seven cuts.

In some cases, the average number of pests and predators did increase in soybean after cutting the adjacent lucerne (Table 3). However, this increase was often much smaller than what would be expected if all the arthropods missing from the lucerne were to move into the adjacent soybean and spread evenly throughout (scenario 1). Some of the arthropods missing from the lucerne may have moved into other surrounding fields and fields further away. The expected value, if 50% of the missing arthropods had moved into the adjacent soybean field, was closest to the observed value in three of the nine cases (Table 2). The expected value from scenario 3 (25% moved) was closest to the observed value in six of nine cases. This analysis relies on the assumption that the vacuum sampler is equally efficient in both crop types. Hossain *et al.* (1999) found that the efficiency of vacuum sampling differed between tall and short lucerne. No attempt was made to standardise the arthropod collection data between the two crop types and this may have biased the values obtained.

Not all of arthropods missing from the lucerne after cutting would have been able to move into adjacent fields. Some arthropods missing from the lucerne may have been killed during the cutting process. This seems unlikely for the flying arthropods that are able to disperse quickly when disturbed. In our study, we saw coccinellid adults flying away before the lucerne slasher cut an area of crop (S Pearce unpubl. data 2000–02). Further evidence that few arthropods are killed by the action of the slasher comes from Hossain *et al.* (2000b), who found that only 16% of *Coccinella transversalis* Fabricius, 7% of *Oeochalia schellebergii* (Guérin-Méneville), and no *Dicranolaius bellulus* (Guérin-Méneville) were killed by cutting. Howell and Pienkowski (1971) found that the abundance of linyphiid, thomisid and salticid spiders changed after lucerne cutting, and concluded this was not due to direct mortality, but to movement out of the field as well as the ability of spiders to hide in cracks in the soil. Our vacuum sampling protocol could detect only gross movements of plant-dwelling arthropods over a short time period (1 d). We could tell nothing about the direction in which animals moved, unlike Hossain *et al.* (2002) who detected directional movement of the ground-dwelling carabid adults, spiders and *D. bellulus* using barrier pitfall traps.

Studies investigating cut lucerne strips adjacent to uncut lucerne strips have shown some evidence of movement. In fields of hay lucerne adjacent to seed lucerne in Alberta, insect dispersal from the cut hay fields was detected for only a few species and it was only obvious directly adjacent to the cut hay (Schaber *et al.* 1990). Samu (2003) found that unmown strips of lucerne in Hungary contained a more diverse and abundant spider assemblage, but elevated abundance in unmown strips did not raise the spider numbers in mown strips (in comparison to controls). Studies, such as ours, that investigate movement from lucerne to an alternative target crop have shown even less consistent results. Stoltz and McNeal (1982) also found no difference in insect numbers at 10, 50

and 100 m into adjacent bean fields when lucerne was cut. Mensah (1999) found that predator numbers recorded in cotton at various distances away from a lucerne strip were not significantly different from each other. Some predators (predatory bugs and spiders) did show spatial patterns in relation to distance from lucerne, but these differences were not related to cutting the lucerne. Perhaps mark-recapture experiments (see Prasifka *et al.* 1999) or directional traps (Hossain *et al.* 2002) that include a food spray in combination with lucerne cutting may produce clearer evidence of arthropod movement.

Our results clearly show that cutting of lucerne is followed by an expected decrease in plant-dwelling pests and predators within the lucerne crop. No corresponding increase in abundance in pests or predators was observed in the adjacent soybean field. This suggests that cutting of lucerne alone does not consistently result in movement of predators into the adjacent target crop. Such a pattern needs to be clearly demonstrated if we are to have confidence in the use of lucerne cutting as a management strategy. The presence of lucerne fields within a cropping area may have some impact on regional predator populations and so still be useful for IPM programs, although this has yet to be tested.

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