THE IMPACT OF TWO INSECTICIDES ON HEMIPTERAN PESTS AND BENEFICIAL ARTHROPODS IN A WHITE CLOVER SEED CROP

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ABSTRACT

The effect of two insecticides, fluvalinate and dichlorvos on six species of insect pests and six beneficial arthropods was tested in a white clover seed crop in Canterbury. A single spray application was applied on 13 December; arthropods were monitored by suction sampling at 1, 3, 8, 15, 30 and 45 days after treatment. Numbers of blue-green lucerne aphids and Tasmanian lacewings were significantly reduced in the fluvalinate-treated plots compared to the control and dichlorvos-treated plots. Seed yield gains from the application of both fluvalinate and dichlorvos, while not statistically different, appeared to be financially profitable.

Keywords: Hemiptera, fluvalinate, dichlorvos, Neuroptera, Aphididae

INTRODUCTION

Since the successful introduction of the two parasitoids, *Bracon variegator* and *Neochrysocharis* sp., for clover casebearer moths, *Coleophora spissicornis* and *C. frischella*, the majority of white clover seed growers in Canterbury no longer apply insecticides (Pearson 1991). This reduction in insecticide use has led to an increased incidence of insect injury to white clover flower heads. Pearson (1991) considered that Australian crop mirid (ACM, *Sidnia kinbergi*) was the major cause of damage. Subsequent work by Schroeder (1995) has indicated that potato mirid (PM, *Calocoris norvegicus*) may be of greater importance. Other common hemipteran pests of legume seed crops in New Zealand are the brown shield bug (BSB, *Dictyotus caenosus*), the green vegetable bug (*Nezara viridula*) and the wheat bug (*Nysius huttoni*) (Wightman and MacFarlane 1981). Although the occurrence of potato mirid and other hemipteran pests in white clover seed crops coincides with flower development, little is known about their impact on seed yield components.

Although the control of these pests can be achieved by insecticides (Wightman and Whitford 1982) few insecticides are currently registered for use in white clover seed crops. Five insecticides (trichlorphon, bromophos, pirimicarb, demeton-S-methyl and endosulphan) were screened by Wightman and Whitford (1982), but only pirimicarb and endosulphan remain commercially available. Pirimicarb had no significant effect on mirids (Wightman and Whitford 1982). The range of insecticides available for use in flowering legume crops is limited because of the need to conserve bee pollinators, which are afforded legal protection under the Apiaries Act 1969, Section 35. Without these pollinators, there would be little seed set.

Dichlorvos is recommended for use in controlling clover casebearer and fluvalinate is recommended for the control of clover casebearer moth and aphids in white clover seed crops (O'Connor 1994). This experiment investigated the impact of dichlorvos and fluvalinate, applied at the recommended time for clover casebearer moth control (Pearson 1982), on the numbers of pest and beneficial arthropods of a white clover seed crop and the financial gains/losses incurred by their application.

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MATERIALS AND METHOD

The experiment was conducted on a non-irrigated 8 ha, first-harvest white clover (cv. Grasslands Huia) seed crop located at Weedons (6 km west of Lincoln, Canterbury). The two insecticide treatments were fluvalinate (36 g/ha) and dichlorvos (180 g/ha) applied in 200 litres water and 50 ml of 100% non-ionic surfactant. For the untreated control 200 litres water with 50 ml surfactant were applied per hectare. Treatments were applied to 18 x 188 m plots that were replicated eight times in a randomised complete block design. Each block had a border of 12 m and was sprayed with fluvalinate (as for the treatment plots). The plots were sprayed on the evening of December 13, 1993, when conditions were still and mild (16–17°C).

Three positions per treatment plot were sampled the day before treatment and 3, 8, 15, 30, and 45 days after treatment (DAT) using a 'Vortis' suction sampler described by Arnold (1994). The sampling positions were selected at 47 m intervals down the centre of each plot. One sample consisting of 10 suction, was taken at each of the three sampling positions, covering an area of 0.603 m² per plot. The rationale for the number of samples taken is described by Schroeder (1995). Samples were then stored in a freezer for later counting and identification of insects.

The numbers of ACM, PM, BSB, meadow spittlebug (*Philaenus spumarius*), blue-green lucerne aphid (*Acyrtosiphon kondoi*), and wheat bug were recorded along with the following beneficial arthropods: eleven spotted ladybird (*Coccinella undecimpunctata*), Pacific damsel bug (*Nabis kinbergii*), Tasmanian lacewing (*Micromus tasmaniae*), the large and small hoverflies (*Melangyna novaezelandiae* and *Melanostoma fasciatum*), harvestman (*Phalangium opilio*), and spiders (mainly Lyniphiidae, *Lephyphantes tenuis*). Data for each species were analysed, per sample day, for significant differences between treatments using analysis of variance.

The crop was sprayed with diquat at 600 g/ha in 350 ml water/ha on February 8 to desiccate the crop. Three days later, 3 x 0.45 m (1.35 m²) strips were harvested at each of the three sampling positions per treatment plot using a rotary mower. Harvested samples were oven dried before being threshed in order to obtain seed yields for each plot.

RESULTS

All the targeted species were collected during the sampling period, but only species with overall pooled mean densities of >1/m² are presented in Table 1. Of the pest species present, aphids were collected in the greatest numbers while Lyniphiid spiders made up the majority of predators collected.

Of the insect pests, BGLA numbers generally increased up to 30 DAT, then decreased markedly. Dichlorvos had no effect on BGLA numbers, but fluvalinate reduced numbers up to 15 DAT, then gave rise to markedly increased numbers at 45 DAT. Adult spittlebugs were present up to 45 DAT, with a slight decrease in numbers at 45 DAT. Both insecticides appeared to have some effect on numbers, though fluvalinate appeared to have a larger effect than dichlorvos, especially at 3, 15 and 45 DAT. BSB nymphs were present only at 30 and 45 DAT. Neither insecticide treatment had any effect on their numbers.

Of the beneficial arthropods sampled, eleven spotted ladybird adult numbers decreased over the sampling period. Numbers were significantly lower in the dichlorvos-treated plots at 3 DAT and in the fluvalinate-treated plots at 15 DAT. Overall adult Tasmanian lacewing numbers were constant over the sampling period, but decreased at 45 DAT. The number of adult lacewings was significantly lower up till 30 DAT in the fluvalinate-treated plots, while numbers were similar in the dichlorvos and untreated control plots. Tasmanian lacewing larvae and Lyniphiid spider numbers peaked towards 30–45 DAT. There were significantly lower numbers of lacewing larvae collected from the fluvalinate-treated plots at 30 DAT, with significantly higher numbers of Lyniphiid spiders collected from the dichlorvos-treated plots at 3 and 8 DAT and significantly lower numbers collected from the fluvalinate-treated plots at 15 DAT.

TABLE 1: Square root transformed (and back-transformed) mean density (number/m²) of pest and beneficial arthropods collected before and after spray treatment application on December 13 1993.

	Days after treatment					
	0	3	8	15	30	45
Blue-green lucerne aphid						
fluvalinate	2.8 (7.8)	2.8 (7.6)	2.6 (6.9)	2.6 (6.8)	13.2 (173.2)	4.9 (23.7)
dichlorvos	2.7 (7.3)	3.9 (15.4)	4.9 (23.5)	6.9 (48.0)	13.3 (177.4)	0.9 (0.8)
untreated	3.3 (10.8)	3.8 (14.5)	4.5 (20.2)	6.2 (38.7)	13.1 (172.7)	2.1 (4.2)
LSD (5%)	1	1	1	1.7	2.2	2.4
flu v untrtd	ns	*	**	**	ns	*
dich v untrtd	ns	ns	ns	ns	ns	ns
Adult spittlebug						
fluvalinate	2.3 (5.1)	0.7 (0.5)	1.5 (2.1)	0.9 (0.8)	0.5 (0.3)	0.3 (0.1)
dichlorvos	1.7 (3.0)	1.5 (2.1)	1.4 (1.9)	1.6 (2.7)	1.3 (1.7)	1.3 (1.8)
untreated	2.2 (4.7)	2.3 (5.4)	2.0 (3.9)	1.9 (3.5)	1.0 (1.1)	1.4 (1.9)
LSD (5%)	0.9	1.2	1.0	0.6	1.0	0.9
flu v untrtd	ns	*	ns	**	ns	*
dich v untrtd	ns	ns	ns	ns	ns	ns
Adult eleven spotted ladybird						
fluvalinate	2.9 (8.5)	1.0 (1.0)	0.9 (0.9)	0.2 (0.0)	0.3 (0.1)	0.3 (0.1)
dichlorvos	3.0 (8.8)	0.9 (0.8)	1.2 (1.4)	0.4 (0.1)	0.6 (0.3)	0.0 (0.0)
untreated	2.6 (6.7)	2.3 (5.1)	1.2 (1.3)	1.1 (1.3)	0.2 (0.0)	0.0 (0.0)
LSD (5%)	0.8	1.3	1.2	0.8	0.8	-
flu v untrtd	ns	ns	ns	*	ns	-
dich v untrtd	ns	*	ns	ns	ns	-
Adult Tasmanian lacewing						
fluvalinate	4.2 (17.8)	2.4 (5.7)	2.3 (5.5)	1.7 (3.0)	3.0 (8.8)	2.0 (4.0)
dichlorvos	4.2 (17.9)	2.6 (6.6)	3.1 (9.7)	3.2 (10.4)	4.0 (16.2)	1.8 (3.1)
untreated	4.0 (15.6)	3.4 (11.8)	3.1 (9.4)	3.1 (9.8)	3.2 (10.5)	1.7 (3.0)
LSD (5%)	1.2	1.0	0.5	1.1	0.9	1.0
flu v untrtd	ns	*	**	*	ns	ns
dich v untrtd	ns	ns	ns	ns	ns	ns
Tasmanian lacewing larvae						
fluvalinate	0.2 (0.0)	0.2 (0.0)	0.3 (0.1)	0.4 (0.1)	0.7 (0.5)	2.2 (4.6)
dichlorvos	0.5 (0.3)	0.2 (0.0)	0.2 (0.0)	0.2 (0.0)	2.4 (5.6)	1.5 (2.1)
untreated	0.4 (0.2)	0.0 (0.0)	0.3 (0.0)	0.0 (0.0)	2.1 (4.5)	2.4 (6.0)
LSD (5%)	0.8	0.4	0.6	0.4	0.9	1.2
flu v untrtd	ns	ns	ns	ns	**	ns
dich v untrtd	ns	ns	ns	ns	ns	ns
Money spider						
fluvalinate	8.4 (71)	6.4 (41)	7.1 (50)	8.3 (68)	11.2 (124)	13.7 (188)
dichlorvos	7.8 (61)	7.3 (53)	7.8 (60)	9.5 (90)	12.7 (160)	14.5 (211)
untreated	8.2 (66)	6.6 (44)	6.5 (42)	9.5 (90)	12.3 (150)	14.3 (204)
LSD (5%)	1.2	0.6	1.0	1.1	2.1	1.3
flu v untrtd	ns	ns	ns	*	ns	ns
dich v untrtd	ns	*	*	ns	ns	ns

ns = not significant, * P= 0.05, and ** P= 0.01

There was no significant difference in seed yields between treatments (Table 2). Material costs for fluvalinate were \$40.75/ha and dichlorvos \$5.40/ha, with application costs for both at approximately \$15.00/ha. White clover seed prices were approximately \$4.00/kg for the season. The net returns on the mean yields are presented in Table 2.

TABLE 2: Mean seed yield (kg/ha) and net return (\$/ha) at \$4/kg seed.

Treatment/ Contrasts	Seed yield	Net return
fluvalinate	178	658
dichlorvos	168	650
untreated	140	560
LSD (5%)	52	208
flu v untrtd	ns	ns
dich v untrtd	ns	ns

DISCUSSION

The timing of application was too late to effectively reduce PM nymphs and subsequent adult numbers, too early to stop BGLA from reaching a maximum at 30 DAT in all treatments, and too early to have any impact on the number of BSB nymphs, which peaked at 8.8/m² 45 DAT. These three pests were found to be more likely to cause injury to flower heads during the season by Schroeder (1995). PM nymph numbers peaked in late October-early November in field verges (Schroeder 1995), which were not included in the sampling area of this experiment. A later application of insecticide prior to 30 DAT may have given a better control coverage and reduced the subsequent peak of BGLA at 30 DAT and BSB at 45 DAT. Spittlebug injury was found to be minimal in cage experiments and, consequently, considered not to be a major pest by Pearson (1991).

Fluvalinate had a prolonged residual effect on BGLA numbers which lasted for at least 15 DAT. Stein and Haverty (1990) reported a reduction of the aphid *Mindarus victoria* on white fur seedlings (*Abies concolor*) that lasted for 72 days after fluvalinate application. The fluvalinate-treated plots had higher numbers of BGLA than the other treatment plots at 45 DAT.

Adult lacewing numbers were reduced initially by both insecticides at 3 DAT. The lower number of adult lacewings collected from the fluvalinate-treated plots could be due to insecticide toxicity, or be a result of a reduced aphid food source, causing starvation or emigration to a host-rich area. The latter is more likely because lacewing are quite tolerant to pyrethroids (Townsend 1980). The reduction of adult lacewing in the fluvalinate-treated plots was reflected in the delayed occurrence of lacewing larvae in the plots, especially at 30 DAT.

Lynphiid spider numbers increased in the dichlorvos-treated plots. However, as little is known of their impact on pest numbers, further work is required to determine whether these spiders are worthwhile predators to conserve in white clover seed crops.

The financial gains from insecticide application compared to no insecticide, while not statistically different, were 15% for fluvalinate and 14% for dichlorvos. Larger financial gains may be achieved through more accurate timing of insecticide application to coincide with pest build-ups. Further study to identify the impact of the key pests and beneficial species within white clover seed crops is required for the development of economic thresholds. These should be incorporated within an integrated pest management programme to ensure optimal gains are achieved through different control tactics, including the use of insecticides.

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