THE EFFECTS OF DIFLUBENZURON ON LUCERNE FLEA

P.J. ADDISON, A.C. FIRTH and A. CLIFFE¹

Ruakura Agricultural Centre, Private Bag, Hamilton

¹*Nufarm Ltd, Private Bag, Auckland*

SUMMARY

The effects of diflubenzuron on lucerne flea (*Sminthurus viridis*) longevity, fecundity and egg viability were investigated in field and laboratory experiments. Diflubenzuron effected mortality in moulting nymphal stages of the insect, but had no apparent effect on the fecundity of adult lucerne flea, nor on the viability of their eggs. Bioassays of treated herbage indicated that the residual activity persisted for at least 2 weeks following field application of diflubenzuron at 12.5 g/ha.

Keywords: diflubenzuron, lucerne flea, pasture.

INTRODUCTION

Lucerne flea (*Sminthurus viridis* L.) occurs widely in New Zealand (Dumbleton 1939; Somerfield and Burnett 1976), but has only been recognised as a pest in pastures over the past two decades. Severe damage to the preferred host, white clover (*Trifolium repens* L.), has been recorded in dairy pastures in parts of Northland, South Auckland and Waikato (Wrenn *et al* 1983). The insect completes four to five generations per year and damaging infestations of nymphs and adults can occur from April to December.

Organophosphate insecticides applied to pastures in either spray or granule formulations give effective control of lucerne flea (Wrenn *et al* 1983; 1984). Wrenn and McGhie (1986) demonstrated that the insect growth regulator diflubenzuron was active against lucerne flea. Diflubenzuron is now registered for lucerne flea control in pastures in New Zealand.

This paper reports on experiments designed to determine the effects of diflubenzuron on lucerne flea longevity, fecundity and egg viability. The residual activity of diflubenzuron was also evaluated in bioassays.

METHODS

Experiment 1: Effects of field application on mortality and fecundity

On 26 September 1990 diflubenzuron (Dimilin 25W) was applied at 12.5 g/ha to a ryegrass (*Lolium perenne* L.)/white clover pasture at Ruawaro, near Huntly. The insecticide was applied using a hand held 2.4 m boom fitted with spraying systems flat fan nozzles (No. 730154) and operated at 210 kPa. The application volume was 220 litres/ha. The diflubenzuron treatment and an untreated control were replicated five times in a randomised block design with a plot size of 5x10 m.

Lucerne flea populations were assessed 7, 14 and 21 days after treatment by collection of insects from a 6 metre long swath per plot with a 300 mm diameter sweep net. The catches were killed in 70% alcohol and first instar (newly emerged) nymphs, other nymphs, and adults counted under a binocular microscope.

To determine the effects of diflubenzuron on the viability of deposited eggs 20, 7.5 cm diameter by 5 cm deep, cores were taken from each plot 2 days after treatment. The foliage was clipped from the cores and nymphal and adult lucerne flea on the soil surface removed with a vacuum cleaner. These cores were placed in a screenhouse in mesh covered plastic liverpails and nymph emergence from eggs recorded. The nymphs were collected using a motorised insect suction machine on days 4, 9 and 14 (days 6, 11 16 post-treatment), killed in 70% alcohol and counted under a binocular microscope.

To determine the effects on fecundity, adult lucerne flea were collected from treated and untreated plots with a sweep net 7 and 21 days after insecticide application.

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Twenty lucerne flea were confined for 5 days on each of five 10 cm diameter turf cores taken from an untreated area free of lucerne flea at Ruakura Agricultural Centre, Hamilton. The adult insects were then removed and the cores maintained in a screenhouse in mesh covered liverpails to allow egg development and hatch. All lucerne flea that emerged from eggs were collected after 20 days using a suction machine, killed in 70% alcohol and counted.

All insect counts were log transformed ($\log_e (x + 1)$) before analysis of variance.

Experiment 2: Bioassay evaluation of residual activity

Diffubenzuron was applied at 12.5 g/ha by the method described above to a ryegrass/white clover pasture free of lucerne flea at Ruakura Agricultural Centre. The treatments were applied on 2 November 1990 to five replicate plots, each 5x10 m, in a randomised block design. Five, 10 cm diameter by 5 cm deep, turf cores were taken from each plot 2 hours, 7 days and 14 days after treatment application. The cores were placed in mesh covered PVC tubes, 10 cm diameter x 15 cm high. Nymphal and adult lucerne flea were collected from an untreated area at Huntly and a known number (range 20-30) were confined to each PVC tube and placed in a screenhouse for 10 days. The surviving lucerne flea were collected from the tubes with a suction machine, killed in 70% alcohol and counted.

A regression analysis (logit) was carried out on the proportion of lucerne flea surviving in each PVC tube.

RESULTS AND DISCUSSION

Diffubenzuron significantly reduced the number of lucerne flea in the treated pasture plots (Table 1). The mode of action of diffubenzuron is interference with cuticle deposition and a subsequent disruption of moulting (Mulder and Gijswijt 1973; Grosscurt 1978). Wrenn and McGhie (1986) found in laboratory experiments that diffubenzuron was active against lucerne flea nymphs while adults were relatively unaffected. Thus, the reduction in adult numbers in the treated plots is likely to have occurred as a result of the diffubenzuron preventing nymphs from reaching adulthood.

TABLE 1: Numbers of lucerne flea in three age categories 7, 14 and 21 days after application of diffubenzuron to pasture.

Treatment	DAT:	$\log_e (x + 1)$ of lucerne flea numbers/6 m sweep								
		Emergent Nymphs			Other Nymphs			Adults		
		7	14	21	7	14	21	7	14	21
untreated		5.71 (300)	4.44 (84)	4.94 (139)	6.69 (803)	5.57 (261)	6.35 (571)	4.58 (97)	3.33 (27)	4.49 (88)
diffubenzuron		5.66 (287)	3.59* (35)	4.18 (65)	4.74** (113)	2.90*** (17)	4.72** (111)	3.80* (44)	1.47*** (4)	2.90** (18)
LSD (5%)		0.74	0.78	1.28	0.94	0.40	0.70	0.48	0.59	0.59

DAT = Days after treatment application.

*, **, *** means statistically different from the untreated values at $P < 0.05$, $P < 0.01$, and $P < 0.001$ respectively.

() actual number of lucerne flea.

Lucerne flea eggs present in the soil when diffubenzuron was applied to the pasture remained viable and their rate of development was unaffected (Table 2). Adult lucerne flea collected from the diffubenzuron treated pasture produced a similar number of viable eggs to those insects from untreated pasture (Table 3). The reductions in fecundity and egg viability noted for some insect species treated with diffubenzuron (Grosscurt 1977; Henzell *et al* 1979) were not apparent in lucerne flea.

TABLE 2: The effect of diflubenzuron on the viability of lucerne flea eggs in soil cores taken from untreated and treated pasture areas.

Treatment	DAT:	$\log_e (x + 1)$ of emergent lucerne flea nymphs/20 soil cores		
		6	11	16
untreated		5.49	5.36	4.92
diflubenzuron		5.67	5.74	5.14
LSD 5%		0.54	0.67	0.36

DAT = Days after treatment application.

TABLE 3: Fecundity of lucerne flea collected from diflubenzuron treated and untreated pasture, as determined by the number of emergent nymphs per 20 adults.

Treatment	DAT:	$\log_e (x + 1)$ of emergent nymphs/20 adults	
		7	21
untreated		6.02	2.36
diflubenzuron		5.34	2.18
LSD (5%)		0.86	0.92

DAT = Days after treatment application

In the bioassay of treated pasture turves, diflubenzuron exhibited significant residual activity against lucerne flea (Table 4). The residual activity of diflubenzuron was longer than that observed for organophosphate and carbamate insecticides in similarly conducted bioassays by Wrenn *et al* (1983). Their work indicated that in bioassays with carbamate and organophosphate insecticides insect mortality declined to below 50% by day 10 while in the present work diflubenzuron effected more than 50% mortality for 14 days. This long residuality is consistent with the field results reported here (Table 1) and those of Wrenn and McGhie (1986) in which the maximum level of lucerne flea control was achieved some weeks after application of diflubenzuron.

TABLE 4: Proportion of lucerne flea surviving in bioassays 0, 7 and 14 days after application of diflubenzuron to pasture.

Treatment	DAT:	Proportion of lucerne flea surviving					
		0		7		14	
		Proportion	SE	Proportion	SE	Proportion	E
untreated		0.37	0.02	0.55	0.02	0.43	0.02
diflubenzuron		0.03***	0.01	0.18***	0.01	0.18***	0.01

DAT = Days after treatment application.

*** Significantly different from untreated at $P < 0.001$.

Lucerne flea populations occur mostly as aestivating eggs over the hotter and drier summer months. Aestivation is broken in the autumn in response to declining temperatures and increasing soil moistures (Pottinger *et al* 1985). Egg hatch is spread over several weeks. When applied in autumn, after nymphs begin emerging and before the appearance of reproductive adults, diflubenzuron may prevent lucerne flea numbers reaching damaging levels for a longer period than do conventional insecticides. Diflubenzuron applications during other periods of the year may have little advantage over conventional insecticides for control of lucerne flea. In the latter conditions the residuality of diflubenzuron may be offset by its slower mode of action and lack of activity against lucerne flea adults.

CONCLUSIONS

Diflubenzuron provides control of lucerne flea by adversely affecting the development of nymphal stages. The fecundity of adult insects and egg viability do not appear to be affected. Diflubenzuron displayed 2 weeks residual activity against lucerne flea.

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