INFLUENCE OF TRAP COLOUR, DESIGN AND HEIGHT ON CATCH OF FLYING CLOVER ROOT WEEVIL ADULTS

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ABSTRACT

Adult clover root weevil (*Sitona lepidus*, CRW) catches on sticky traps of different colours, design and height were evaluated in two field experiments carried out on the outskirts of Hamilton in the summer of 1999–2000. In Experiment 1, yellow cylinder traps placed at a height of 1200 mm caught the most CRW. In Experiment 2, both white and yellow cylinder traps placed at a height of 1200 mm were equally attractive to CRW adults. In both experiments, fewer CRW adults were caught on cylinder traps of all colours set 400 mm above the ground. Cylinder traps painted red, green and blue and set 1200 mm above the ground caught similar numbers of insects to traps of all colours set at 400 mm. In Experiment 2, flat traps with a sticky surface that was parallel to the ground caught very few weevils irrespective of their colour and height.
Keywords: *Sitona lepidus*, flight, dispersal, cylinder sticky trap, flat sticky trap, colour, height.

INTRODUCTION

Clover root weevil (*Sitona lepidus* Gyllenhal (Coleoptera: Curculionidae)) (CRW) was first discovered in dairy pastures in Waikato in 1996 (Barratt et al. 1996). Subsequent investigations revealed it had spread over an area of 200,000 ha with two epicentres of infestation, one north of Auckland and the other in the Waikato/coastal Bay of Plenty area, and was unable to be eradicated (Barker et al. 1996). Since 1996, CRW has spread at an average rate of ca 35 km/year and now occurs throughout the North Island (Hardwick et al. 2004; Eerens et al. 2005). Clover root weevil has also been detected in the South Island, but as of February 2007 it appeared to be limited to small, discrete populations in Richmond and the Rai Valley in the Nelson region, and immediately northwest of Christchurch (Phillips et al. 2007).

Whilst it is likely some CRW dispersal into previously uninfested regions has been human assisted, the vast majority has probably been through adult flight. Dispersal flights are made by CRW adults during late spring–summer (Stein & Rezwani 1973; S. Hardwick & P.J. Addison, unpubl. data). Interest in the flight behaviour of CRW has increased following the introduction of the Irish strain of *Microctonus aethiopoides* (Hymenoptera: Brachonidae) to New Zealand (Gerard et al. 2007) since the ability of the parasitoid to rapidly disperse will largely depend on the extent to which eggs and larvae of the parasitoid can be dispersed via flights of infected CRW adults.

Sticky flight traps placed in pastures may be useful for measuring rates of parasitism in flying weevils, and may also be helpful in predicting if newly established pastures are at risk of being rapidly re-invaded by CRW to assist in making sound pest management decisions. Previously, dispersal flights by Argentine stem weevil (*Listronotus bonariensis* (Kuschel) (Coleoptera: Curculionidae)) and lucerne weevil (*Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae)) in New Zealand have been monitored using bright yellow cylindrical sticky traps (e.g. Pottinger 1966; Goldson et al. 1984; Barker et al. 1989).

However, the catch rate of some weevil species, such as West Indian sweet potato weevil (*Euscepes postfasciatus* (Fairmaire) (Coleoptera: Curculionidae)) (Nakamoto & Kuba 2004) and pecan weevil (*Curculio caryae* (Horn) (Coleoptera: Curculionidae)) (Tedders et al. 1996), was significantly greater using traps that were not yellow. In other studies, trap colour did not influence weevil catch rates (e.g. Hunt & Raffa 1991; Kalleshwaraswamy et al. 2006). The height and orientation of trapping surfaces can also influence capture rates (e.g. Riley & Schuster 1994; Smart et al. 1997).

This study investigated the influence of sticky trap colour, height and trapping surface orientation on capture rates of CRW adults to optimise the design of sticky traps for monitoring of CRW flights.

MATERIALS AND METHODS

Two experiments were conducted in the summer of 1999/2000. The timing of the experiments coincided with the period in which clover root weevil adults were known to undertake dispersal flights (S. Hardwick & P.J. Addison, unpubl. data). In both experiments, CRW flight activity was monitored at AgResearch Ruakura on the outskirts of Hamilton. The study areas and the surrounding environs were ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) paddocks. The aspect was flat and there were no nearby hedges, trees or other structures that might have influenced CRW flight behaviour.

Experiment 1

Experiment 1 was conducted from 26 November 1999 to 5 January 2000. The flight traps consisted of a pair of 300 × 110 mm diameter cylinders mounted on a stake, one above the other, 400 and 1200 mm above the ground. Both cylinders on each trap were painted the same colour and were covered with a transparent plastic sheet coated with adhesive (Fly control adhesive, Garrick Trading Co Ltd). There were five trap colours, blue, green, red, white or yellow, and ten replicates of each trap were used, giving 50 traps in total. Traps were laid out in a grid of five rows of 10, with each row containing two replicates of each colour. Within each row the position of each trap was assigned completely at random. Traps were placed 10 m apart within rows, with 15 m between rows.

Experiment 2

Experiment 2 was conducted from 20 January–21 February 2000. The two designs of flight trap tested were cylinder traps (described above) and flat traps. Flat traps consisted of a pair of 210 × 300 mm, coloured corflute sheets mounted so that the trapping surface was parallel to the ground, and either 250 mm or 1200 mm above it. The lower trapping surface was attached to the bottom of an upturned wire milk crate, while the upper trapping surface was mounted on a stake and held in place using clips and a wire loop. The upper surface of each trapping surface was coated in Stickem®. The colour treatments used were the same as in Experiment 1. Five replicates of each trap design and colour (10 treatments) were used giving 50 traps in total. Traps were laid out in a grid of five rows of ten, with each row containing a flat and a cylinder trap of each colour. Within rows, cylinder traps were alternated with flat traps, but the five colours were assigned in a completely random manner. Traps were laid out 15 m apart with 15 m between rows.

In both experiments, traps were inspected daily and any CRW adults present were counted and removed. The sticky trapping surfaces were replaced at approximately weekly intervals. Catch data were square root transformed and statistically analysed using a split plot ANOVA with colours being main plot treatments, heights being subplot treatments and with five blocks (rows).

RESULTS

Experiment 1

Both colour and height significantly influenced the catch of CRW adults (Table 1). Significantly more weevils were caught on yellow traps placed at 1200 mm than on traps of any other colour or any traps at 400 mm (P<0.05) during the 42 day trapping period. During the trial, it was also noted that traps set at 400 mm tended to more rapidly accumulate dust than those at 1200 mm.

Experiment 2

Clover root weevil catch data for the cylinder traps in Experiment 2 were similar to those observed in Experiment 1 (Table 2). Yellow and white coloured traps caught more weevils than red, green or blue traps (P<0.001) (Table 2). The greatest numbers of weevils were caught in yellow or white cylinder traps and set at 1200 mm (P<0.05), whilst the least were found in red, green and blue traps set at 400 mm. Yellow and white traps at 400 mm were of intermediate effectiveness.

Results from Experiment 2 suggested that flat traps caught fewer CRW adults than cylinder traps (Table 2). However, due to the alternating layout of cylinder and flat traps a direct statistical comparison of the data was not possible. A similar number of weevils (P>0.05) was caught using flat traps irrespective of their colour or the height that they were set at (Table 2). As was observed in Experiment 1, traps of both designs set at 400 mm in height accumulated dust and debris more rapidly than those set at 1200 mm.

TABLE 1: Mean number of clover root weevil adults caught per trap over the period of 26 November 1999–5 January 2000 on different coloured cylindrical sticky traps at heights of 400 mm or 1200 mm in Experiment 1. Values presented are square root transformed data with back transformed means in parentheses.

	Trap colour					Height
Trap height	white	red	yellow	green	blue	mean
400 mm	2.9 (8.4)	1.7 (3.0)	2.7 (7.6)	1.9 (3.7)	1.8 (3.2)	2.2 (4.9)
1200 mm	3.4 (11.5)	2.2 (4.9)	4.2 (18.3)	2.5 (6.4)	2.0 (4.0)	2.9 (8.3)
Colour mean	3.1 (9.9)	1.9 (3.9)	3.5 (12.4)	2.2 (5.0)	1.9 (3.6)	
LSD (P<0.05)	Colour means		0.4			
	Height means		0.3			
	Height × colour means		0.6	heights within colours		
	Height × colour means		0.6	all other comparisons		

DISCUSSION

Yellow or white cylinder traps mounted 1200 mm above the ground are the most suitable for monitoring CRW flights. The yellow cylinder traps previously used to study Argentine stem weevil and lucerne weevil flights (e.g. Pottinger 1966; Goldson et al. 1984; Barker et al. 1989) should thus also be suitable for monitoring CRW flights. Prokopy & Owens (1983) suggested that attraction to yellow is characteristic of all herbivorous insects. Experiment 1 clearly demonstrated that yellow traps were superior to traps of other colours. However, in Experiment 2 white traps were as effective at trapping CRW adults as yellow traps. Cabbage seed weevil (*Ceutorhynchus assimilis* (Paykull)(Coleoptera: Curculionidae)) has been reported as being attracted to traps that are yellow and white (Goos et al. 1976; Laska et al. 1986), yellow and green (Buechi (1990) as cited in Smart et al. 1997) or yellow only (Smart et al. 1997). Attraction to a particular colour may also be influenced by the surroundings (Kirk 1984). While the study site remained superficially similar in appearance between the two experiments, it is probable that its vegetative composition changed slightly, perhaps due to seasonal effects and changes in soil nutrient status.

TABLE 2: Mean number of clover root weevil adults caught per trap over the period of 20 January–21 February 2000 on different coloured cylindrical and flat sticky traps at heights of 400 mm or 1200 mm in Experiment 2. Values presented are square root transformed data with back transformed means in parentheses.

	Trap colour					Height
Trap height	white	red	yellow	green	blue	mean
Cylinder traps						
400 mm	3.1 (9.6)	1.4 (1.9)	3.9 (15.2)	1.5 (2.2)	0.5 (0.2)	2.1 (4.4)
1200 mm	4.9 24.0)	2.3 (5.3)	5.4 (29.6)	2.5 (6.2)	1.7 (2.9)	3.4 (8.3)
Colour mean	4.0 (16.0)	1.9 (3.7)	4.7 (22.1)	2.0 (4.0)	1.1 (1.2)	
LSD (P<0.05)	Colour mean		0.4			
	Height mean		0.5			
	Height × colour mean		1.0	heights within colours		
	Height × colour mean		0.8	all other comparisons		
Flat traps						
400 mm	1.8 (3.2)	1.4 (1.9)	1.9 (3.7)	1.5 (2.2)	1.7 (2.9)	1.6 (2.5)
1200 mm	1.6 (2.5)	1.5 (2.2)	1.6 (2.5)	1.3 (3.2)	1.7 (2.9)	1.5 (2.2)
Colour mean	1.7 (2.9)	1.5 (2.2)	1.7 (2.9)	1.4 (1.9)	1.7 (2.9)	
LSD (P<0.05)	Colour mean		0.6			
	Height mean		0.7			
	Height × colour		1.6	heights within colours		
	Height × colour		1.2	all other comparisons		

In both Experiments 1 and 2, cylinder traps set at 1200 mm caught more weevils than those set at 400 mm. This may be due to factors such as fouling of the trapping surface with dust and wind blown debris, as well as to CRW flight behaviour. Fouling may have influenced the ability of the lower trapping surface to catch CRW by reducing trap stickiness and/or reflectance. Similar observations were recorded by Riley & Schuster (1994) who observed that sticky traps placed near the soil surface rapidly became covered in wind-blown debris, which reduced their ability to capture pepper weevil (*Anthonomus eugenii* Cano (Coleoptera: Curculionidae)). A secondary effect of dust accumulation on a trapping surface is that it will alter its reflectance, thereby potentially altering any visual cues that adult CRW may be responding to. When CRW fly, they climb to heights greater than 1 m before moving horizontally. After flight, CRW rapidly drops back into the pasture canopy. Sustained flight immediately above the pasture is rarely if ever observed (S. Hardwick & P.J. Gerard, unpubl. data). This flight pattern may make traps mounted at 1200 mm more likely to intercept CRW. Therefore, fouling and flight behaviour may have both caused the lower CRW catch recorded on cylinder traps mounted at 400 mm above the ground. In conclusion, yellow or white cylinder traps of a design similar to that used in previous studies of weevil flight activity in New Zealand pastures are suitable for monitoring CRW flights.

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