MATING DISRUPTION OF CURRANT CLEARWING, *SYNANTHEDON TIPULIFORMIS*

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SUMMARY

A synthesised pheromone blend released from polyethylene dispensers, resulted in mating disruption of both feral and tethered virgin female currant clearwing moths during field trials conducted in Canterbury from 1987 to 1990. None of the tethered virgin females mated in treated blackcurrant plantings (n = 152), whereas from 33-71% mating occurred in untreated blocks (n = 90). Trap catches of male moths in 1989-90 and 1990-91 were reduced markedly by placement of pheromone dispensers in blackcurrant field plantings. Assessment of the mating success of feral female moths also confirmed mating disruption in the presence of pheromone dispensers.

Keywords: blackcurrants, currant clearwing, *Synanthedon tipuliformis*, pheromone, mating disruption

INTRODUCTION

The currant clearwing, *Synanthedon tipuliformis* (Lepidoptera: Sesiidae) is a serious introduced pest of the plant genus *Ribes*, which includes: blackcurrants, *Ribes nigrum*, red and white currants, *R. sativum* and gooseberries, *R. grossularia*. Blackcurrants are mainly grown commercially in the South Island.

Currant clearwing is a diurnally active, univoltine, lepidopterous species of Eurasian origin, which became established in this country when the early European settlers introduced currants and gooseberries as home garden plants. Larvae of this pest feed and develop on the food reserves contained within the pith of *Ribes* spp. canes. Infestations in blackcurrant plants cause indirect crop losses in various ways including: destruction of flower buds; depletion of food reserves; inhibition of spring bud break; cane-tip dieback and cane breakage during windy periods, and mechanical harvesting of the crop. Fruit yield losses in blackcurrants resulting from currant clearwing infestation in plants in Tasmania were reported by Hardy (1981) to be 25% and 33% for 4 and 5 year old plantings respectively. In Europe various levels of crop losses (up to 60.2%) have been reported (Pala *et al* 1986).

Currant clearwing lays its eggs on the canes. Larval development and pupation are completed within extensive feeding tunnels in the cane pith. Once in the cane the larvae are very difficult to control.

Until recently, blackcurrant growers in New Zealand have relied on insecticides for the control of currant clearwing. Pre-harvest recommendations (MAF Annual Spray Guide 1989) include an application of parathion at least 14 days prior to harvest, timed to coincide with the hatch of larvae prior to their entry into the cane pith. Baker (1980) recommended the application of azinphos-methyl immediately after harvest, followed by applications 2 and 4 weeks later. These treatments were stated to reduce clearwing infestations by 80%. In mixed commercial plantings of blackcurrants this recommendation is often not possible due to the different cultivar ripening times and the possibility of mite outbreaks.

Recently, consumer opposition to pesticide use has increased and tests for residues have become more sensitive for export produce. Mating disruption through the use of pheromones offers an alternative control strategy to pesticides. It has been successfully implemented for some pests (Campion *et al* 1989) and is possible for the lightbrown apple moth (Suckling and Shaw 1990).

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The pheromone blend for currant clearwing was isolated by Voerman *et al* (1984) as a binary mixture of (*E*, *Z*)-2, 13 octadecadien-1-ol acetate (*E*, *Z*2, 13-18:0Ac) and (*E*, *Z*)-3, 13 octadecadien-1-ol acetate (*E*, *Z*3, 13-18:0Ac). In trials conducted in Canterbury in 1985-87, this synthetic pheromone in the ratio of 100:3, incorporated within rubber septa, provided high levels of attraction of males to traps (Thomas and Burnip 1989; Szocs *et al* 1990), with a mean of 193.6 moths caught per trap/week during a 3 week period at Irwell, Canterbury. This paper reports the results of further field trials using this pheromone to disrupt mating of currant clearwing.

MATERIALS AND METHODS

In 1987 this pheromone blend was used for the first time in polyethylene hollow tube dispensers placed in field plantings of blackcurrants for mating disruption trials against the currant clearwing. The dispensers containing the binary mixture of *E*, *Z*2, 13-18:0Ac (50.0 mg) and *E*, *Z*3, 13-18:0Ac (1.7 mg) were supplied by the Shin-Etsu Chemical Co. Ltd., Tokyo. Mating disruption trials were conducted on level properties at Lincoln, Irwell and Lakeside in Canterbury, from 1987-1991. Each year the dispensers were tied on canes at spaced intervals along rows to provide placement rates ranging from 250-1000/ha with evenly distributed pheromone release point sources. The rate of pheromone release (mg/ha) although measured has yet to be confirmed.

The effectiveness of the pheromone dispensers was assessed by determining mating success of tethered virgin and feral females, and by trapping male moths and dissecting canes (not reported here). Virgin female moths were obtained by rearing larvae removed by manual splitting of cane samples collected during the previous winter. Larvae were held in polycarbonate tubes with artificial diet (Singh 1983) at $20 \pm 2^\circ\text{C}$, until pupation occurred. Pupae were sexed and held separately in Petri dishes at temperatures suitable for variable emergence. Female moths were tethered, while anaesthetised with CO_2 , by tying a length of cotton around the base of one pair of wings and stapling the tether to a mating platform.

Mating stations comprised modified 'Zoecon ICP' type, (Trece Corp. Salinas, CA.) waxed cardboard platforms (traps) without sticky bases. The stations were hung on metal posts about 1.5 m above ground and placed centrally in treated or untreated plots/blocks of blackcurrants planted according to normal commercial production standards. Moths were replaced daily or every 2-3 days depending on moth availability and weather conditions. Virgin female moths were set out at mating stations between 0830 and 1000 hours and were collected approximately 24 h later. Feral females were collected individually into tubes by hand from treated or untreated plots on a regular basis during peak periods of moth activity. Moths were dissected to determine if mating had occurred.

Male moth activity was monitored by hanging pheromone baited 'Zoecon ICP' type or International Pheromone Systems (IPS) bucket traps in pheromone-treated or untreated blocks of blackcurrants.

1987-88 Lincoln

The Lincoln research planting comprises about 1 ha of blackcurrants enclosed by a mix of poplar and *Pinus radiata* shelter. One half of the block comprising the cv 'Magnus' was divided in half, so that 10 rows received dispensers at the rate of 1000/ha, while the 10 rows most distant (therefore least likely to have been influenced significantly by the synthetic pheromone) provided an untreated control area. A buffer zone (8 rows) separated mating stations located either in the untreated or treated areas. An adjoining plot (0.5 ha) of mixed blackcurrant cultivars also remained untreated. From 27.11.87 to 7.1.88 four mating stations in both the treated and untreated plots were operated with tethered virgin females.

1988-89 Lincoln and Irwell

Dispensers at 1000/ha were placed within the entire Lincoln block. Four modified 'Zoecon ICP' type traps with sticky bases were set up within the entire block, one trap positioned approximately centrally within each quarter. These were baited with synthetic pheromone, 100:3 (100 μg) per pherocap. Pherocaps were changed six weekly and trap bases weekly, or when moth scales were considered to affect trap efficacy. The number of male moths trapped was recorded weekly.

On the Irwell property two adjoining 6 year old cv 'Millist' blackcurrant blocks each of 1.8 ha and bounded separately by poplar shelters were used, one being treated with dispensers at 1000/ha while the other remained untreated.

A larval rearing problem prevented the use of many tethered females. However, collections of feral moths were made from the Lincoln and Irwell treated blocks and the untreated block at Irwell.

1989-90 Lincoln, Irwell and Lakeside

Dispensers (250/ha) were placed throughout the Lincoln block on 23.10.89 and the entire planting of about 18 ha at Irwell at various rates (250-1000/ha) from 9-13.11.89. The treated and untreated blocks used in 1988-89 received 500/ha. Dispenser rates were estimated on the basis of planting age and estimates of larval infestations in canes, because mating disruption is a density dependent control tactic.

Moth monitoring previously conducted in 1988/89 at Irwell and on the Lakeside property (to be reported elsewhere) showed that pherocaps baited with 800 µg (binary blend) captured the highest number (mean catch/trap of 852 in a season) of male moths (Thomas and Burnip unpublished) so four 'Zoecon ICP' type traps baited with this pherocap loading (replacing the 100 µg loading) were put out in the Lincoln and on three Irwell blocks to ascertain the success of male orientation disruption.

Virgin female moths were tethered at mating stations at Lincoln during November/December 1989, and in an untreated block at Lakeside during December 1989/January 1990. Collections of feral female moths were made on fine days within the Lincoln planting.

1990-91 Lincoln, Irwell and Lakeside

Dispensers were again placed throughout the plantings at Lincoln (250/ha) and Irwell (variable rates) during October/November 1990. At Lakeside, dispensers were placed into only 6 ha of a total of 9 ha on 13.11.90. On each of the remaining three blocks four IPS traps baited with currant clearwing pheromone, 800 µg/cap, were set up (8.11.90) and monitored twice weekly. Following a rapid rise in male moth activity (catches increased from about 15-22 to 40-130) during December 1990, these blocks were treated with pheromone dispensers on 13.12.90.

RESULTS AND DISCUSSION

The properties on which these trials were conducted are isolated from each other (>1000 m) and from home garden plantings of blackcurrants except at Lincoln (<500 m)

TABLE 1: Mating of tethered virgin female currant clearwing moths in pheromone-treated and untreated plots.

Location	Period	Dispenser rate/ha	Treated		Untreated	
			No. of females*	Mated %	No. of females*	Mated %
Lincoln	23.11.87-7.1.88	1000	68	0	69	33.3
Lincoln	22.11.88-5.12.88	500	34	0	—	—
Lincoln	30.11.89-27.12.89	250	50	0	—	—
Lakeside	27.12.89-9.1.90	0	—	—	21	71.43

*Numbers remaining intact at mating stations after 24 hours of exposure for mating.

As an initial measure of the success or failure of the mating disruption trials, the mating success of tethered virgin females at mating stations in treated and untreated plots can be considered (Table 1). Few problems were encountered with females tethered within mating stations, although a few disappeared (<5%) or were partially eaten by predators, probably earwigs and spiders. No mating of tethered females in mating stations occurred in treated plots during 1987/88, 1988/89 or 1989/90 at Lincoln (n = 152). In the untreated plots 33% of females mated at Lincoln in 1987/88 and 71% of females mated at Lakeside in 1989/90. While the plantings are not directly comparable, it can be concluded that the high concentration of clearwing pheromone

released into the treated blocks, after dispensers were put in place, almost completely suppressed mating activity. Weather conditions also play a role in mating behaviour and may provide the reason for the variation in mating levels of virgin females in the untreated plots (daily range 0-100%). Differences also existed between sites, which may be explained by differences in the background population levels of moths.

Mating disruption of currant clearwing moths in pheromone treated plots was further confirmed from the dissection of feral females collected in either treated or untreated areas (Table 2). Too few feral females were collected at Lincoln in 1987/88 for valid comparison between treated and untreated areas. Mating of feral female moths in the pheromone-treated planting at Lincoln was considerably higher than for Irwell in 1988/89 but not as high as the untreated area at Irwell. The possible explanation for this only became evident at the termination of moth collections on 1.1.90. Within the total area bounded by shelter, a block of cv 'Heritage' raspberries (250 m²) remained untreated. These were in flower and high numbers of clearwing moths were frequenting the area and feeding on the flowers. This occurred again during December 1990 and not until dispensers were placed on the raspberries, did moth numbers decline in the vicinity. It is noteworthy that mating was occurring (from observations of moths *in copula*) on the raspberries prior to placement of the pheromone dispensers in that area. Also, males outnumbered females by about 3:1 so mating was probably inevitable given the visual cues used by this insect during courtship. While this situation can be addressed in future, it outlines the need for growers using disruption technology for clearwing control to provide pheromone coverage in all plantings within shelter boundaries including the shelter trees themselves.

TABLE 2: Mating success of feral female clearwing moths collected from pheromone-treated or untreated blackcurrant plantings.

Location	Period	Treatment Rate/ha	No. moths	% mated
Irwell	1988/89	0	36	69.4
Lincoln	1989/90	250	45	20.0*
Lincoln	1988/89	500	37	10.8*
Irwell	1988/89	1000	67	3.0

*Estimated mating of females captured in treated plots may include immigrants already mated (see text).

The results of monitoring male moth catches in pheromone-baited (800 µg/cap) traps within dispenser-treated blocks at Lincoln and Irwell during 1989 are presented in Table 3. Only 33 male moths were trapped in treated blocks for the entire season. At Lincoln where 250 dispensers/ha were in place and block 8 at Irwell with 1000 dispensers/ha, no male moths were trapped. This indicates the high level of

TABLE 3: Total catches of male clearwing moths from pheromone (800 µg) baited traps sited within pheromone dispenser-treated areas, 24.11.89-28.3.90.

Site	Trap	No. dispensers/ha	No. seasons treated	Total mean catch/trap
Lincoln	Zoecon	250	3	0
Irwell Blk 4	Zoecon	250	1	2.25
Irwell Blk 1	Zoecon	500	2	6.0
Irwell Blk 8	Zoecon	1000	1	0
Lakeside	Zoecon	0	0	138
Lakeside	IPS	0	0	737

effectiveness of the currant clearwing pheromone dispensers in disrupting the behaviour of male moths and their orientation to pheromone baited traps in the presence of high emission levels of synthetic pheromone. High numbers of males were trapped in some untreated blocks (Table 3).

During 1990/91, following dispenser treatments on monitored blocks at Lakeside, trap catches of moths were suppressed (Fig. 1) in a similar way to that reported for the lightbrown apple moth (Suckling and Shaw 1990). Few moths (0-2/week) were caught in any trap during the rest of the season, compared to the numbers trapped (total mean catch/Zoecon trap of 148) in a previous year.

Fig. 1: Suppression of male currant clearwing moth catch in traps on three independent blocks of blackcurrants at Lakeside following placement of pheromone dispensers in the field.

The various methods outlined in these trials demonstrate that mating disruption of the currant clearwing is possible through the treatment of commercial blackcurrant plantings with polyethylene dispensers containing currant clearwing pheromone. This result adds another species to the sesiids already disrupted by pheromone in Japan and elsewhere (K. Ogawa pers. comm.; Yonce 1981). The indirect effect that dispenser use has on control of larval infestations in canes is under investigation and will be reported later. Mating disruption is an alternative control strategy that offers an attractive novel technology to blackcurrant growers in future and in fact has been adopted by some already in New Zealand, with a total treated area of about 35% of the crop (250 ha) in 1990/91.

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REFERENCES

- Baker, R.T., 1980. Control of the currant clearwing (*Synanthedon tipuliformis* (Clerck) — Lepidoptera: Sesiidae). *Proc. 33rd N.Z. Weed and Pest Control Conf.*: 129-132.
- Campion, D.G., Critchley, B.R. and McVeigh, L.J., 1989. Mating disruption. In: *Insect Pheromones in Plant Protection*. Jutsum, A.R. & Gordon, R.F.S. (eds) John Wiley & Sons Ltd. London. 369p.
- Hardy, R.J., 1981. Field observations of the effect of currant borer moth *Synanthedon tipuliformis* (Clerck) (Lepidoptera: Aegeriidae) on the yield of black currants produced in Tasmania. *Sci. Hort.* 15: 165-173.
- Pala, E., Labanowska, B.H., Niezychowska, M. and Sokolowski, R., 1986. Evaluation of some insecticides for the control of the currant clearwing moth (*Synanthedon tipuliformis* Cl.). *Fruit Sci. Rep.* 13: 45-54.
- Singh, P., 1983. A general purpose laboratory diet mixture for rearing insects. *Insect Sci. Applic.* 4: 357-62.
- Suckling, D.M. and Shaw, P.W., 1990. Preliminary trials of mating disruption of lightbrown apple moth in Nelson. *Proc. 43rd N.Z. Weed and Pest Control Conf.*: 311-316.
- Szocs, G., Miller, L.A., Thomas, W., Vickers, R.A., Rothschild, G.H.L., Schwarz, M. and Toth, M., 1990. Compounds modifying male responsiveness to main female sex pheromone component of the currant borer, *Synanthedon tipuliformis* Clerk (Lepidoptera: Sesiidae) under field conditions. *J. Chem. Ecol.* 16: 1289-1305.
- Thomas, W.P. and Burnip, G.M., 1989. The use of pheromones for monitoring the currant clearwing, *Synanthedon tipuliformis* (Lepidoptera: Sesiidae) Pp 100-104. In: Bellas, T.E. (ed). *Proceedings of a Joint CSIRO-DSIR Workshop — Application of Pheromones to Pest Control*. Canberra July 11-14, 1988. Div. of Ent. CSIRO.
- Voerman, S., Persons, C.J. and Priesner, E., 1984. Sex attractant for currant clearwing moth *Synanthedon tipuliformis* (Clerck) (Lepidoptera: Sesiidae). *J. Chem. Ecol.* 10: 1371-1376.
- Yonce, C.E., 1981. Mating disruption of the lesser peachtree borer, *Synanthedon pictipes* (Grote and Robinson), and the peachtree borer, *S. exitosa* (Say), with a hollow fiber formulation. *Misc. Public. Ent. Soc. Amer.* 12: 21-29.