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FIELD EVALUATION OF AGGREGATION PHEROMONES FOR MASS-TRAPPING OF CANE WEEVIL BORER

by

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1.0 INTRODUCTION

Sugarcane weevil borer, *Rhabdoscelus obscurus* (Boisduval) (Coleoptera: Curculionidae: Rhynchophorinae), is native to Papua New Guinea, but was accidentally introduced to Queensland, Hawaii and Fiji with imported sugarcane material in the late 1800s (Veitch 1917). The larval stage is a serious pest of commercial sugarcane in those countries, and is also a minor pest of palms in Queensland (Halfpapp and Storey 1991).

Males of several species of Rhynchophorinae are known to produce pheromones which attract both males and females (Giblin-Davis *et al.* 1996). Chang and Curtis (1972) first showed that males of *R. obscurus* release a pheromone after feeding on fermenting sugarcane. Fermenting sugarcane is also attractive to *R. obscurus* (Bell 1937). The aggregation pheromones of several species of Rhynchophorinae have been chemically identified and synthesised. Oehlschlager *et al.* (1995) has tested synthetic rhynchophorol as a method of removal trapping of the palm weevil, *Rhynchophorus palmarum* (L.), in oil palm plantations in Costa Rica.

2.0 IDENTIFICATION OF *R. obscurus* PHEROMONES

Adult *R. obscurus* were collected from sugarcane fields in north Queensland and sent to Simon Fraser University in October 1996. Volatile emissions were identified in aerations from confined males using gas chromatography, and the active constituents determined by electroantennographic detection of responses by male or female weevil antennae (eg see Giblin-Davis *et al.* 1996). Three compounds were identified from male *R. obscurus*; 2-methyl-4-octanol, 2-methyl-4-heptanol and 6-methyl-2-hepten-4-ol.

Previous analyses of aerations from *R. obscurus* collected in Hawaii showed that males from there only produced and responded to 2-methyl-4-octanol (R Gries, unpublished). 2-methyl-4-heptanol is a major component of the aggregation pheromone of *Paramasius distortus* (Gemminger & Harold) and a minor component of that of *Metamasius hemipterus* L. 6-methyl-2-hepten-4-ol is rhynchophorol (Rhyncholure), the major pheromone produced by and attractive to *Rhynchophorus palmarum* (Giblin-Davis *et al.* 1996).

3.0 FIELD EVALUATION OF PHEROMONES

3.1 Methods

The trap used to catch *R. obscurus* comprised a 25 cm diameter cylindical pot of black plastic with a volume of approximately 10 L. Each trap contained approximately 1 L of water with a few drops of detergent to catch weevils which entered. The water was replaced each week when weevils were removed for counting and sexing. Lures were suspended from a wire grid (2.5 cm mesh) placed over the open top. Where sugarcane was used as a lure, 500 g of fresh chopped cane was placed in an open-weave bag and hung in the centre of the trap. Weevils clinging to the bag of cane were included in the counts for those traps. Three synthetic pheromones were supplied by ChemTica

Internacional in separate plastic lures designed to release approximately 3 mg/day. The lures were (1) 2-methyl-4-octanol ("octanol"), (2) 2-methyl-4-heptanol ("heptanol"), and (3) 6-methyl-2-hepten-4-ol ("rhynchophorol"). The lures were kept frozen until used in field experiments. The pheromone lures were also suspended from the grid. When more than one lure was used per trap, the sugarcane and slow-release pheromones were hung so that they did not touch each other or the side of the trap. Sugarcane and lures were replaced with fresh material after each 2-week experiment.

Three experiments were conducted sequentially in the same sugarcane field at Spanos Road, Silkwood, north Queensland. The canefield was approximately 3 ha and was surrounded by other cane. The cane cultivar was Q138 and was a third-ratoon crop (four years old). Q138 is highly susceptible to infestation by *R. obscurus* in north Queensland (Robertson and Webster 1995). Traps were placed in a randomised complete block design, with 10 replicates of each treatment. They were placed in the inter-row space, with two rows of cane between traps within replicates, and 10 m along the row between replicates, and were at least 3 m (two rows of cane) from the edge of the field.

The treatments compared in each of the three experiments are given in Tables 1 - 4. Experiment 1 compared cane bait on its own, three synthetic lures per trap, a combination of cane plus the three lures, and no cane or lures. Experiment 2 compared cane alone, cane plus three lures per trap, and cane plus each of the three lures separately. Experiment 3 compared cane alone, and cane plus three lures per trap, with cane plus combinations of two synthetic lures per trap. Experiment 1 ran from 1 to 15 May 1997, Experiment 2 from 16 to 30 May, and Experiment 3 from 4 to 18 June 1997. Weevils were sexed from all traps on 8 May 1997 (Expt 1) and 18 June 1997 (Expt 3), and from subsamples from each treatment on 23 May 1997 (Expt 2). Daily rainfall was recorded at Feluga, 10 km from the study site.

Trap catches were analysed by ANOVA on untransformed counts with means separated using the least significant difference test (Statistix^{R} ver. 4.1). Deviation of sex ratio from 1:1 was analysed by chi-squared test.

3.2 Results

In Experiment 1, greatest numbers of *R. obscurus* adults were caught in traps baited with sugarcane plus the three lures, in both weeks (Table 1). Traps with sugarcane alone caught significantly fewer weevils. Few weevils were caught with the combination of three synthetic lures but no sugarcane, and in traps with neither lures nor sugarcane (Table 1).

In the first week of Experiment 1, the sex ratio of weevils differed between traps baited only with cane (1.15 males: female) and traps baited with both cane and three lures (0.85 males: female) ($\chi^2 = 4.53$; $P < 0.05$) (Table 2).

In Experiment 2, there was no significant difference between any treatment in numbers of weevils caught in week 1. In the second week of Experiment 2, the combination of three pheromones per trap plus cane caught significantly more weevils than the other four treatments ($P < 0.0005$) (Table 3).

The sex ratio of weevils caught in week 1 of Experiment 2 differed significantly between treatments. As in Experiment 1, cane alone caught significantly more males (1.46 males: female), while cane plus all three lures caught a higher proportion of females (0.7 males: female) ($\chi^2 = 21.35$; $P < 0.001$). More males than females were caught for each of the three pheromones used alone with cane, although the sex ratio was not significantly different from 1:1 for rhynchophorol and octanol (Table 2).

In both weeks of Experiment 3, traps which included rhynchophorol caught greater numbers of weevils compared to traps with cane plus heptanol and octanol (week 1, $P = 0.1$; week 2, $P < 0.03$) (Table 4).

Catches of weevils in week 2 of Experiment 3 were dominated by females in all treatments (Table 2). Only in cane plus heptanol and rhynchophorol treatment was the sex ratio not statistically different from 1:1.

Daily rainfall totals over the trapping periods are given in Table 5.

3.3 Discussion

Pheromone lures alone are not attractive to either sex of *R. obscurus*, as shown in Experiment 1, Treatment 3 (Table 1). However, combined with chopped sugarcane baits, pheromones significantly increased the weekly trap catches compared to sugarcane alone. When combined with cane, no single pheromone was shown to catch more weevils than the three pheromones acting together, and in week 2 of Experiment 2, the three lure combination attracted significantly more than any single lure (Table 3). In the third experiment, cane plus two pheromones was as good as cane plus three pheromones, provided rhynchophorol was included as one of the pair (Table 4). This suggests that rhynchophorol is the major component involved in the aggregation behaviour of *R. obscurus* in Queensland.

The sex ratio differed between treatments with cane bait alone compared to cane plus three synthetic lures in the first two experiments. More females were caught when the lures were included. In Experiment 3, catches in all treatments except cane plus heptanol and rhynchophorol were dominated by female weevils. These experiments were conducted at the same site over a 6-week period, and numbers of weevils declined between experiments. This decline may have been due in part to removal of adult weevils. The female-dominated sex ratio in Experiment 3 may have been due in some way to the lower overall catches late in the period, or to other seasonal effects.

Differences between treatments in the first week of both Experiment 2 and Experiment 3 failed to reach statistical significance in ANOVA. The use of fresh cane in week 1 of each experiment may have influenced the attraction of weevils, which orient to fermenting cane. Cane baits may have been more attractive in week 2 than in week 1 of all three experiments, which could influence interpretation of these data. The sex ratio differences between cane alone and cane plus three synthetic lures were consistent in Experiments 1 and 2, where weevils were sexed in week 1 of both experiments. A higher proportion of females may be attracted as cane decays. This needs to be determined in further experiments.

The preliminary work reported here indicates that further field studies with synthetic pheromones are warranted to test the feasibility of removal-trapping of *R. obscurus* to control borer damage in Queensland sugarcane.

4.0 ACKNOWLEDGMENTS

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Table 1: Mean number of *Rhabdoscelus obscurus* adults caught per trap per week (standard error of mean in brackets) in relation to trap treatment in Experiment 1, Silkwood. Means followed by the same letter within columns do not differ significantly (P>0.05). The three lures were “heptanol”, “octanol”, and “rhynchophorol”.

Treatment		**Week 1**	**Week 2**
1	no bait	0.2 (0.13) a	0.1 (0.1) a
2	cane only	144.3 (44.1) b	157.1 (24.2) b
3	3 lures only	2.8 (0.87) a	3.2 (1.0) a
4	cane + lures	246.3 (45.6) c	225.4 (31.1) c
	$LSD_{(0.05)}$	80.3	64.1

Wk 1, $F_{(3,39)} = 18.6$, $P<0.0001$; Wk 2, $F_{(3,39)} = 26.19$, $P<0.0001$

Table 2: Total number of male and female *Rhabdoscelus obscurus* caught per treatment in week 1 of Experiment 1, number of males and females in a subsample of each treatment in week 1 of Experiment 2, and total number of males and females in each treatment in week 2 of Experiment 3. Deviation of sex ratio from 1:1 analysed by χ^2.

Experiment	Treatment		Males	Females	Sex Ratio
1	1	no bait	1	1	not tested
	2	cane only	211	183	1:1
	3	3 lures* only	3	25	not tested
	4	cane + 3 lures	184	216	1:1
2	1	cane only	162	111	P<0.03
	2	cane + 3 lures	159	228	P<0.02
	3	cane + hep	213	148	P<0.02
	4	cane + rhyn	224	202	1:1
	5	cane + oct	203	162	1:1
3	1	cane only	54	102	P<0.01
	2	cane + 3 lures	80	198	P<0.001
	3	cane + hep + rhyn	96	124	1:1
	4	cane + rhyn + oct	98	233	P<0.001
	5	cane + hep + oct	38	96	P<0.001

* Three lures, hep (= “heptanol”), rhyn (= “rhynchophorol”), and oct (= “octanol”).

Table 3: Mean number of *Rhabdoscelus obscurus* adults caught per trap per week (standard error of mean in brackets) in relation to trap treatment in Experiment 2, Silkwood. Means followed by the same letter within columns do not differ significantly ($P>0.05$). hep = "heptanol"; rhyn = "rhynchophorol"; oct = "octanol".

Treatment		Week 1	Week 2
1	cane only	72.4 (16.0) a	85.5 (11.8) a
2	cane + 3 lures	87.1 (9.5) a	143.3 (29.1) b
3	cane + hep	85.1 (13.9) a	83.6 (16.5) a
4	cane + rhyn	95.9 (14.3) a	89.8 (16.3) a
5	cane + oct	60.3 (10.1) a	83.7 (13.7) a
	$LSD_{(0.05)}$	38.8	28.8

Wk 1, $F_{(4,49)} = 0.96$, $P>0.4$; wk 2, $F_{(4,49)} = 6.72$, $P<0.0005$

Table 4: Mean number of *Rhabdoscelus obscurus* adults caught per trap per week (standard error of mean in brackets) in relation to trap treatment in Experiment 3, Silkwood. Means followed by the same letter within columns do not differ significantly (P>0.05). hep = "heptanol"; rhyn = "rhynchophorol"; oct = "octanol".

Treatment		Week 1	Week 2
1	cane only	18.0 (4.5) a	15.6 (3.6) ab
2	cane + 3 lures	25.6 (5.0) ab	27.8 (6.7) bc
3	cane + hep + rhyn	21.2 (6.2) ab	22.0 (1.8)abc
4	cane + rhyn + oct	34.6 (7.5) b	33.1 (6.9) c
5	cane + hep + oct	14.6 (3.3) a	13.4 (2.5) a
	LSD $_{(0.05)}$	15.5	13.5

Wk 1, $F_{(4,49)} = 2.06$, P=0.1; wk 2, $F_{(4,49)} = 3.06$, P<0.03

Table 5: Daily rainfall (in mm) over the study period, as measured at Feluga, approximately 10 km from the study site at Silkwood. Rainfall measured at 7.00 am, recording the previous 24 hour total.

	Experiment 1		Experiment 2		Experiment 3	
Week 1	Date (May)	Rainfall	Date (May)	Rainfall	Date (June)	Rainfall
	2	16.0	17	8.0	5	11.0
	3	3.5	18	30.0	6	9.5
	4	0	19	0	7	3.5
	5	0	20	0	8	0
	6	0	21	0	9	0
	7	0	22	0	10	5.0
	8	2.0	23	0	11	5.0
Weekly Total		2.15		38.0		34.0

Week 2	Date (May)	Rainfall	Date (May)	Rainfall	Date (June)	Rainfall
	9	0	24	0	12	3.0
	10	6.0	25	0	13	2.0
	11	0	26	0	14	7.0
	12	0	27	8	15	24.0
	13	0	28	0	16	0
	14	1.0	29	0	17	0
	15	10.0	30	0	18	0
Weekly Total		17.0		0		36.0