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Insecticidal control of fruitspotting bug, *Amblypelta nitida* Stal (Hemiptera:Coreidae) and macadamia nutborer, *Cryptophlebia ombrodelta* (Lower) (Lepidoptera:Tortricidae)

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Summary

During 1982-83 sprays of 0.005% permethrin, applied at 2, 3 and 4 week intervals, 0.00125% deltamethrin applied at 3 week intervals and 0.05% endosulfan and/or 0.1% carbaryl applied at 2 week intervals were compared against *Amblypelta nitida* Stal and *Cryptophlebia ombrodelta* (Lower) on macadamia at Nambour. All treatments reduced damage by both insects ($P<0.01$). Deltamethrin was superior ($P<0.05$) to permethrin (2, 3 and 4 weeks) against *A. nitida* and was also superior ($P<0.01$) to endosulfan and/or carbaryl and permethrin (4 weeks) against *C. ombrodelta*. Deltamethrin resulted in less *A. nitida* damage ($P<0.05$) than permethrin (3 and 4 weeks) in mature nuts at harvest. Percentage recovery of no. 1 kernels for deltamethrin (38.41) was higher than endosulfan and/or carbaryl, permethrin (2 weeks) ($P<0.05$) and the untreated control ($P<0.01$).

Both permethrin (2 weeks) and deltamethrin resulted in increased ($P<0.05$) incidence of *Planococcus citri* (Risso).

INTRODUCTION

Fruitspotting bug (*Amblypelta nitida* Stal) and macadamia nutborer (*Cryptophlebia ombrodelta* (Lower)) often occur together on macadamia and seriously reduce yields and kernel quality (Brimblecombe 1948; Ironside 1981). *A. nitida* may cause damage anytime during nut development, but greatest losses result from attacks on the young soft-shelled nuts during the period October to December when most natural thinning also occurs. Most damage by *C. ombrodelta* usually takes place while the nuts are immature during the period November to February.

Sprays of 0.05% acephate, 0.05% endosulfan, 0.025% methidathion, 0.05% trichlorphon have been shown to control *A. nitida* (Ironside, unpub. data). Sprays effective against *C. ombrodelta* were reported by Ironside (1982) and it was shown that 0.005% permethrin gave longer protection than 0.05% methidathion, 0.075% acephate and 0.05% omethoate. The purpose of the work reported here was to compare the effectiveness of permethrin (applied at three different spray intervals) deltamethrin, and a combination treatment of endosulfan and/or carbaryl against *A. nitida* and *C. ombrodelta* (endosulfan was included to control *A. nitida* and carbaryl to control *C. ombrodelta*).

MATERIALS AND METHODS

The following insecticidal formulations were used along with 0.05 mL/L of wetting agent Chem-Wet 100:

carbaryl 800 g/kg wettable powder;
deltamethrin25 g/L emulsifiable concentrate;
endosulfan350 g/L emulsifiable concentrate;
permethrin500 g/L emulsifiable concentrate.

This experiment was conducted at Nambour during 1982-83 on 14 year old grafted macadamia trees (*Macadamia integrifolia*, cultivar HAES 508 (24 trees) and 246 (6 trees) (Kakea and Keauhou)). The layout used was a 6×5 randomised block design with single

tree plots. In order to reduce variance the trees were blocked according to variety, tree health and position in the experimental area. The insecticides were applied as high volume sprays using a hand held lance and the volume per tree ranged from 12 to 18 L and averaged 15 L.

Details of spray applications were as follows:

2 week interval%—11 applications from 7 October to 24 February;

3 week interval%—7 applications from 7 October to 10 February;

4 week interval%—6 applications from 7 October to 24 February.

Sprays for the endosulfan and/or carbaryl treatment were applied as follows:

endosulfan only on 7 and 22 October;

endosulfan plus carbaryl on 3 and 18 November and 27 January;

carbaryl only on 2, 16 and 30 December, 13 January, 10 and 24 February.

At the start of the trial on 6 October, 1982, the ground under each tree was cleared of all nuts. Then at weekly intervals until 30 March 1983, fallen nuts were counted and assessed for *A. nitida* and *C. ombrodelta* damage. During the period 13 October to 22 December heavy natural thinning occurred and subsamples of up to 100 freshly fallen nuts per tree were collected each week. After 22 December all of the fallen nuts under each tree were collected each week.

Maturity tests were carried out to determine when the crop was marketable and how long it should be protected from *C. ombrodelta* attack. Macadamia processors consider 90% or more of no. 1 kernels to be an acceptable level of maturity (R. Hand, CSR Ltd., pers. comm.). Each week from 9 February to 30 March dropped nuts were tested using a modification of the flotation method described by Liang and Myers (1975) and Ironside (1982). The nuts were dried to equilibrium moisture content (1.5%) at 47°C. *C. ombrodelta* husk damaged nuts and mature undamaged nuts from 508 and 246 were each tested separately. The numbers of nuts tested for each variety are shown in Table 1.

Table 1. Numbers of fallen nuts used in tests to determine kernel maturity

Pick-up dates (1983)	Mature undamaged nuts		*C. ombrodelta* husk-damaged nuts	
	508	246	508	246
9 Feb	—	—	150	—
16 Feb	—	—	204	32
23 Feb	—	—	238	53
2 Mar	—	—	277	49
9 Mar	69	—	200	38
16 Mar	116	113	200	38
23 Mar	338	213	301	15
30 Mar	300	197	197	14

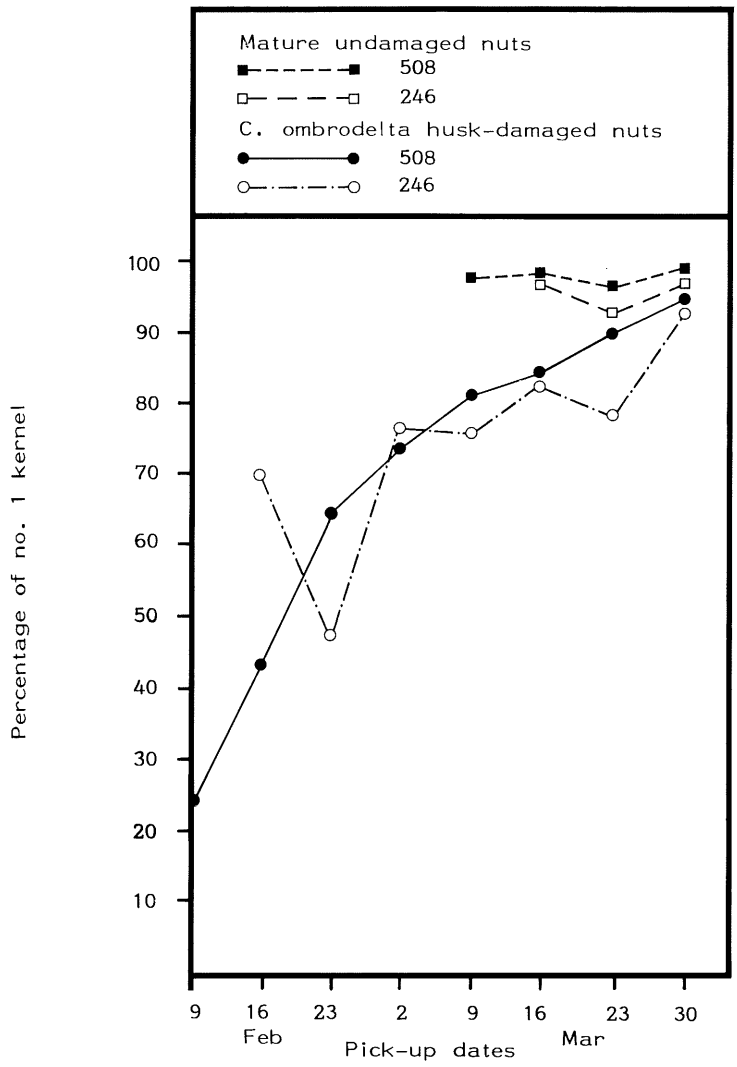
The total crop was harvested on 31 May to 1 June after the trees had been sprayed with ethepon to induce nut fall. After dehusking the weight of in shell undried nuts was recorded and a random sample of 100 nuts was taken from each plot to determine insect damage levels, kernel recovery and the percentage of no. 1 kernels.

On 22 March, four weeks after the last insecticide spray, the citrus mealy bug (*Planococcus citri* (Risso)) infestation on each of the trial trees was assessed by making a one minute search of the nuts and giving an infestation rating as follows:

Nil=1, Light=2, Moderate=4, severe=8.

RESULTS

Kernel maturity in fallen nuts as indicated by the percentage of no. 1 kernels is shown in Figure 1. The effects of treatments on insect damage, immature nut drop and yield is shown in Tables 2 to 6.



Control of *A. nitida*

All spray treatments reduced *A. nitida* damage ($P<0.01$) during thinning and in the mature nuts. Deltamethrin resulted in less damage ($P<0.05$) during thinning than permethrin (2, 3 and 4 weeks). In the mature nuts deltamethrin reduced damage ($P<0.05$) more than permethrin (3 and 4 weeks) (Table 2).

Table 2. Effect of insecticides on *A. nitida* damage during thinning (13 Oct to 22 Dec) and at harvest

Treatments and interval between sprays	Percentage of damaged nuts** during thinning		Percentage of damaged nuts at harvest
	Trans. mean	Equiv. mean	
Deltamethrin 0.00125% 3 weeks	0.016	0.025	0.20
Endosulfan 0.05%+/or carbaryl 0.1% 2 weeks	0.060	0.363	1.40
Permethrin 0.005% 2 weeks	0.073	0.538	1.60
Permethrin 0.005% 3 weeks	0.077	0.593	4.60
Permethrin 0.005% 4 weeks	0.087	0.763	5.00
Control: untreated	0.204	4.112	10.47
l.s.d. P=0.05	0.052		3.99
P=0.01	0.071		5.45

* Arc-sin transformation $\left(\sin^{-1} \sqrt{\frac{\%}{100}} \right)$

** *A. nitida* damage expressed as a percentage of the total crop.

Control of *C. ombrodelta*

All treatments reduced *C. ombrodelta* damage ($P<0.01$) to immature nuts. Deltamethrin resulted in a greater reduction in damage ($P<0.01$) than endosulfan and/or carbaryl and permethrin (4 weeks); endosulfan and/or carbaryl resulted in less damage ($P<0.05$) than permethrin (4 weeks).

Table 3. Effect of insecticides on *C. ombrodelta* damage to immature nuts from 22 December to 30 March

Treatments and interval between sprays	Percentage of damaged nuts**	
	Trans. mean	Equiv. means
Deltamethrin 0.00125% 3 weeks	0.021	0.042
Permethrin 0.005% 2 weeks	0.094	0.884
Permethrin 0.005% 3 weeks	0.094	0.889
Endosulfan 0.05% +/or carbaryl 0.1% 2 weeks	0.126	1.591
Permethrin 0.005% 4 weeks	0.225	4.985
Control: untreated	0.346	11.488
l.s.d. P=0.05	0.077	
P=0.01	0.105	

* Arc-sin transformation $\left(\sin^{-1} \sqrt{\frac{\%}{100}} \right)$

** *C. ombrodelta* damage expressed as percentage of total crop.

Recovery of no. 1 kernels and yield

Recovery of no. 1 kernels for deltamethrin was higher ($P<0.01$) than for the control and also higher ($P<0.05$) than for endosulfan and/or carbaryl and permethrin (2 weeks). Permethrin (3 and 4 weeks) also resulted in higher recovery ($P<0.05$) than the control (Table 4). However mean nut-in-shell yields for the treatments did not differ significantly ($P>0.05$).

Table 4. Percentage recovery of no. 1 kernels and the yield of dehusked nuts

Treatments and interval between sprays	Percentage recovery of no. 1 kernels	Yield *kg
Delamethrin 0.00125% 3 weeks	38.41	22.08
Permethrin 0.005% 3 weeks	36.98	17.94
Permethrin 0.005% 4 weeks	36.71	17.22
Endosulfan 0.05% +/or carbaryl 0.1% 2 weeks	35.83	16.92
Permethrin 0.005% 2 weeks	35.72	15.50
Control: untreated	34.26	12.84
l.s.d. P=0.05	2.09	Differences not significant
P=0.01	2.85	

* Since the F value for the treatments is not significant ($P>0.05$), differences between the means are not significant.

Undamaged immature nutdrop

The mean drop of undamaged immature nuts (22 December to 30 March), is shown in Table 5. Differences between the means were not significant ($P>0.05$).

Table 5. The drop of undamaged immature nuts from 22 December to 30 March

Treatments and interval between sprays	Percentage of undamaged immature nut drop	
	Trans. means*	Equiv. means**
Permethrin 0.005% 4 weeks	0.147	2.135
Endosulfan 0.05% +/or carbaryl 0.1% 2 weeks	0.155	2.373
Delamethrin 0.00125% 3 weeks	0.165	2.694
Permethrin 0.005% 3 weeks	0.181	3.256
Control: untreated	0.191	3.592
Permethrin 0.005% 2 weeks	0.221	4.825
s.e. of mean	0.027	

* Arc-sin transformation $\left(\sin^{-1} \sqrt{\frac{\%}{100}} \right)$

** Since F value for treatments is not significant ($P>0.05$), differences between means are not significant.

Incidence of *P. citri*

P. citri incidence on the permethrin (2 weeks) and the deltamethrin treatments was higher ($P<0.01$) than on the endosulfan and/or carbaryl treatment and also higher ($P<0.05$) than on the control.

Table 6. Incidence of *P. citri* on trial trees

Treatments and between sprays interval	Infestation rating
Permethrin 0.005% 2 weeks	5.6
Deltamethrin 0.00125% 3 weeks	4.4
Permethrin 0.005% 3 weeks	4.0
Permethrin 0.005% 4 weeks	3.2
Control: untreated	1.8
Endosulfan 0.05% +/or carbaryl 0.1% 2 weeks	1.2
l.s.d. P=0.05	2.30
P=0.01	3.14

DISCUSSION

The level of no. 1 kernels in husk damaged nuts increased from 24% on 9 February to 93-95% on 30 March (Figure 1). *C. ombrodelta* damaged nuts which dropped prior to 30 March were regarded as immature and unmarketable. On the 9 and 30 March no. 1 kernels in husk damaged nuts were 17 and 4% lower respectively than in mature undamaged nuts. The mean percentage of no. 1 kernels at the final harvest was 99.45±56. *C. ombrodelta* damage to the husks clearly becomes less important as the nuts mature.

The date when nuts reach maturity (>90% no. 1 kernels) varies with different varieties and also from season to season and locality to locality. In a trial in 1978-79 at Nambour using variety 246, a level of 94% no. 1 kernels in dropped husk damaged nuts was reached on 6 March, three weeks earlier than in the current trial (Ironside 1982).

Control of *A. nitida* with 0.00125% deltamethrin, 0.05% endosulfan and/or 0.1% carbaryl and 0.005% permethrin (2 weeks) was satisfactory. The level of *A. nitida* damage at harvest was unsatisfactory for 0.005% permethrin (3 and 4 weeks). Satisfactory control of *C. ombrodelta* was achieved with all treatments except 0.005% permethrin (4 weeks). When *C. ombrodelta* is active spray intervals for 0.005% permethrin should not exceed 3 weeks and for 0.05% endosulfan and/or 0.1% carbaryl should not exceed 2 weeks. Seven applications of deltamethrin (3 weeks) resulted in equal or better control than 11 applications of permethrin (2 weeks) or the combined treatments of endosulfan and/or carbaryl (2 weeks).

Deltamethrin and permethrin (3 and 4 weeks) increased the recovery of no. 1 kernels by 4.25, 2.75 and 2.45% respectively (Table 4). Based on a nut-in-shell price of $1.48 per kg, for nuts with 32% recovery of no. 1 kernels, an increase of 1% kernel recovery increases the nut-in-shell value by 5 to 6 cents per kg. It is not clear why the recovery of no. 1 kernels for deltamethrin should also be higher than that of endosulfan and/or carbaryl, and permethrin (2 weeks). Insect damage alone cannot account for these differences as permethrin (4 weeks), sustained more insect damage than both these treatments. The 11 spray applications may have resulted in a slight phytotoxic effect. The drop of undamaged immature nuts on permethrin (2 weeks) was 37 and 82% higher than the control and deltamethrin treatments respectively (Table 5). While these differences are not statistically significant they may indicate a trend. Carbaryl is a recognised thinning agent of apples but there has been no indication that it causes thinning of macadamia nuts.

P. citri incidence, four weeks after the final spray, was moderate to severe on the permethrin (2 week) and deltamethrin treatments, and negligible on the control and endosulfan and/or carbaryl treatments (Table 6). This confirms a previous suggestion (Ironside 1982) that synthetic pyrethroids result in a build up of pests not controlled by them due to the disruption of natural enemies. Endosulfan is relatively ineffective against *P. citri*, but carbaryl, while it is disruptive to natural enemies, is also effective against *P. citri*.

The incidence of macadamia pests varies considerably in different localities and in different seasons. Therefore applying sprays according to a predetermined schedule, as in this trial, can be unnecessarily expensive. It is therefore preferable to monitor pests and apply sprays only when required to prevent economic damage. Collection of data necessary to develop monitoring systems and to determine action levels at which insecticides should be applied is in progress.

Deltamethrin has proved to be highly effective against *A. nitida* and *C. ombrodelta* and could therefore be a useful insecticide for macadamia producers, particularly where *C. ombrodelta* is a pest. However, because deltamethrin is very disruptive to natural enemies, it is advisable to reserve it for use against *C. ombrodelta* and to restrict the number of applications to not more than three in any one year. Where *C. ombrodelta* is not a pest a less disruptive insecticide such as endosulfan is preferred for use against *A. nitida*.

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