EFFECTS OF EXPOSURE ON CHEMICAL CONTENT AND EFFICACY OF MALE ANNIHILATION BLOCKS USED IN THE ERADICATION OF *BACTROCERA PAPAYAE* IN NORTH QUEENSLAND

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Summary

A program to eradicate the introduced pest fruit fly species *Bactrocera papayae* Drew and Hancock (papaya fruit fly) from north Queensland commenced in October 1995. The primary eradication strategy employed was male annihilation using fibre-board ('Cane-ite') blocks (5x5x1.3 cm) impregnated with approximately 18 mL of a 3:1 mixture of male lure (methyl eugenol) and toxicant (maldison ULV). Studies were undertaken to determine the effects of short and long term exposure on the chemical content and efficacy (attraction and toxicity) of these blocks. As the numbers of *B. papayae* in the eradication area were very low, the efficacy of blocks was determined by their ability to attract and kill the endemic non-pest species *Bactrocera cacuminata* (Hering) which also responds to methyl eugenol. Results showed that the loss of methyl eugenol and of efficacy followed similar exponential curves over a 52 week exposure period. After eight weeks exposure the efficacy of blocks was reduced by 50% in comparison to a new block and the methyl eugenol content was reduced by 73%. The maldison content of blocks did not change significantly over a 28 week period, although some small loss of maldison occurred after prolonged exposure up to 52 weeks. Blocks up to 52 weeks old continued to attract and kill up to 5% of the number of flies caught by new blocks. The significance of these findings with respect to eradication treatments for papaya fruit fly is discussed.

INTRODUCTION

The control of fruit fly populations by using specific male attractants mixed with insecticide was first shown to be effective by Steiner and Lee (1955). The application of this male annihilation technique to fruit fly eradication programs has been particularly successful with species which respond to methyl eugenol (ME) because this lure is such a powerful attractant (Cunningham 1989). The lure/toxicant mixture is impregnated into some form of physical carrier which can be distributed either aerially or by ground application through the infested area. Various types of long lasting absorbent materials such as fibre-board blocks, cotton cords, cotton dental wicks and cigarette filter tips have been used as carriers (Bateman 1982). In more recent programs against oriental fruit fly, thickened gels have been used to carry the methyl eugenol/toxicant formulation (Cunningham *et al.* 1975).

Irrespective of the carrier involved, the success of a male annihilation program depends on thorough distribution of attractive sites and the need to achieve a balance between toxicity and attraction of the male annihilation formulation (Cunningham 1989). The effectiveness of a male annihilation program could be severely reduced if toxicity of lure carriers is lost before attraction. In most programs, treatments are re-applied at short term regular intervals (e.g. every 2–6 weeks depending on the type of carrier) to ensure that a high attract and kill pressure is maintained on the pest population. There is, however, relatively little published information which quantifies the chemical content and relative efficacy (i.e. attractant and toxic capacity) of physical carriers over short or longer term exposure.

In an extensive study of ME as an attractant in traps for *Bactrocera dorsalis* (Hendel), Steiner (1952) showed that it was non-repellent at high concentrations and that 1 mL per trap remained 'highly effective for a month or longer.' Steiner also claimed that a few drops of ME placed on porous larva rocks exposed to the weather attracted flies for 10–16 weeks. Other studies in Hawaii (Steiner and Lee 1955) showed that relatively large (10x10x¾inch) cane-fibre insulation boards ('Canec') treated monthly with 30 mL of ME/Pyrolan formulation and distributed at approximately 30 per square mile provided substantial control of oriental fruit fly populations. The blocks were durable enough to last through a 16 month period of heavy rainfall. No data were provided on the rate of loss of attractant or insecticide from the blocks.

In the eradication of oriental fruit fly from the Island of Rota in the Mariana Islands, cane fibre squares (2¼x2¼x$^3/_8$ inches) treated with a formulation containing 97% ME and 3% Naled were used (Steiner *et al.* 1965). Blocks were distributed aerially at a rate of 125 per sq. mile at approximately two week intervals. Each square carried an initial dose of 24 g of formulation and attraction and toxicity were reported to last for two months or more.

In 1982, the male annihilation method was successfully used to eradicate *B. dorsalis* from the Okinawa Islands, Japan (Koyama *et al.* 1984). A lure/toxicant formulation containing 67.5–80% ME, 3.5–5% Naled and 15–29% solvent was incorporated

into three kinds of absorbent materials, a cotton rope (0.6 cm diameter and 5.0 cm long, 0.83 g of formulation), rolled cotton (1.0 cm diameter, 3.9 cm long, 2 g of formulation) and a wood fibre-board square (4.5x4.5x0.9 cm, 10 g of formulation). In the early stages of the program, control was ineffective because the dose and persistency of the lure/toxicant in both types of cotton carriers were inadequate. When the dose was increased to >20 g of formulation/ hectare/month and the absorbent material changed to fibre-board squares, eradication was achieved. Fibre-board squares of the same size and carrying the same dose of lure/toxicant were also used at varying application rates to eradicate *B. dorsalis* from the Miyako and Yaeyama Islands in 1982–1985 (Nakamori *et al.* 1988).

Although cotton absorbent materials were found to be unsuitable in the previously mentioned eradication program, they have been used successfully in other programs (Bateman 1982). Queensland fruit fly was eradicated from Easter Island in 1972 using cotton cords (25–30 cm long) impregnated with cuelure and malathion (Bateman 1973). The oriental fruit fly was eradicated from several Torres Strait islands in 1993 in a program conducted by the Queensland Department of Primary Industries. Caulking cotton cordelitos, 30 cm long and holding approx. 6 g of formulation consisting of three parts ME to one part maldison ULV (Lloyd, unpublished data) were aerially distributed in this program. Samples of these cordelitos after three months weathering were tested against *B. dorsalis* in Hawaii by W. Mitchell and found to be still attractive and toxic (pers. comm., 1993).

In a program to eradicate Queensland fruit fly *Bactrocera tryoni* (Froggatt), from Western Australia in 1989, 'Cane-ite' blocks impregnated with 2 g of cuelure and 2 g of maldison were used (Sproul *et al.* 1992). The chemical content of these blocks did not change significantly during three months exposure, but after 6–12 months blocks contained 70% of the initial formulation. Efficacy tests carried out in Queensland with endemic populations of Queensland fruit fly showed that 24 month old blocks captured approximately 39% as many flies as new wicks treated with 3 mL of an 8:1 formulation of cuelure and maldison.

A major program to eradicate the introduced pest species papaya fruit fly, *Bactrocera papayae* Drew and Hancock from north Queensland commenced in October 1995. This program was based on widespread ground application of male annihilation treatments and protein bait spraying of breeding hot spots leading up to the implementation of a Sterile Insect Release Program planned to commence in 1998–1999. The male annihilation treatment employed was based on Cunningham's (1989) recommendation of a lure/ toxicant formulation of 3 parts ME to 1 part maldison ULV. The formulation was distributed by ground application of fibre-board ('Cane-ite') blocks at the rate of approximately 400 per km^2. During the first eighteen months of the program, new blocks were distributed every six weeks with old blocks being removed after 12 weeks. In mid-1997, blocking treatments were changed to an eight week cycle. Blocks in each cycle were colour-coded with a strip of paint applied to one edge of the block prior to chemical treatment. This allowed the approximate age of recovered blocks to be determined.

The following studies were undertaken to determine the absorptive properties of 'Cane-ite' blocks and to evaluate the effects of exposure on both chemical content and efficacy (i.e. attractant and toxic capacity) of blocks. As the population of papaya fruit fly in the Pest Quarantine Area was greatly reduced after several blocking cycles, the efficacy of blocks could not be tested directly against the target species. Instead, efficacy was determined by the number of endemic ME responding flies caught and killed by blocks. In north Queensland and in the Brisbane area where tests were carried out, the most common ME responding species is the wild tobacco fly *Bactrocera cacuminata* (Hering). This non-pest species has only one major host, *Solanum mauritianum* (wild tobacco) which is widespread in eastern Australia. Quantitative differences in responses of species to ME are not generally known. It was therefore assumed that these studies with *B. cacuminata* could provide useful information about the efficacy of male annihilation treatments aimed at eradicating *B. papayae*.

MATERIALS

Fibre-board blocks

Blocks (5x5x1.3 cm) were cut from sheets of fibre-board (CSR 'Cane-ite'^{TM}) which consists of soft wood fibre (approx. 97%), starch (approx. 2%) and paraffin wax (approx. 1%) according to the manufacturer's specifications. Blocks were saturated by overnight immersion in a mixture of 3 parts methyl eugenol to 1 part maldison ULV (1180 g/litre). An untreated block weighed 9 g ± 1 g and absorbed on average 18 g of formulation i.e. 13.5 g of ME and 4.5 g maldison ULV. Although every attempt was made to standardise block size and the dose per block during factory production, the weight of treated blocks varied by several grams. Furthermore, laboratory tests in which individually weighed blocks were dosed with known volumes of formulation indicated that the absorbent properties of the fibre-

board material varied considerably from block to block (Lloyd, unpublished data). All of the aged blocks used in these studies had weathered in exposed conditions in treated areas, but as these blocks were factory-prepared, the initial dose of formulation may have varied from block to block.

METHODS

Three separate experiments were undertaken to test the relative efficacy of old blocks (up to 52 weeks exposure) compared to newly treated, unexposed blocks. At the completion of each experiment, blocks were analysed to determine ME and maldison content.

Experiment 1—Blocks aged for up to 28 weeks

This experiment was undertaken early in the eradication program when data on the short term efficacy of blocks were required as a basis on which to plan eradication strategies. Factory treated blocks were weathered at DPI Kamerunga Research Station in Cairns for up to 28 weeks. At two week intervals, five blocks were randomly selected for chemical analysis of ME and maldison content. Using the same series of blocks, efficacy tests were undertaken with blocks after 2, 4, 6, 8, 10, 12 weeks exposure.

The efficacy trial was set up with pairs of weathered and new blocks at each of 15 sites. The test sites were in an area of the Pest Quarantine Zone well removed from high density blocking treatments and with a high endemic population of *B. cacuminata*. At each site, there were two replicate 'traps' for each treatment. A 'trap' consisted of a weathered block or a new block hung as a lure in a Steiner trap. Traps in each pair were separated by 10–15 m. The traps were cleared every three–four days over a two week period. Relative efficacy was expressed as the ratio of the total number of flies caught by a weathered block compared to the total number caught by a new block. Traps at each site were re-set with blocks on six occasions (i.e. after six exposure times) at two weekly intervals.

Experiment 2—Blocks aged for up to 52 weeks

Experiment 2 was undertaken approximately 12 months into the eradication program when blocks which had undergone long term exposure were available. The relative efficacy of aged blocks (up to 52 weeks) which had been distributed as part of routine eradication treatments was determined in paired comparison tests similar to Experiment 1. Blocks were retrieved from specific treated areas in north Queensland and sent to Brisbane for testing. The ages of the blocks (to ±1 week) were determined by their colour coding and by reference to information in the DPI Papaya Fruit Fly Database which recorded blocking dates for specific areas. Blocks which had been exposed for 9, 16, 23, 30, 34, 40, 46 and 52 weeks respectively, were tested.

Paired comparison efficacy tests were carried out in three locations in the outer Brisbane area (Mt Glorious, Redland Bay and Waterford) where endemic populations of the ME responding *B. cacuminata* were present. Four replicate pairs of traps were installed at each location, with pairs separated by 2–5 km. Each paired comparison consisted of an aged block in a Steiner trap placed approx. 200 m from a new block in a Steiner trap. The new blocks were accurately dosed in the laboratory with 18 mL of formulation (3 parts ME to 1 part maldison ULV). Traps were cleared after one week and the number and species of flies collected were determined. As in Experiment 1, blocks of one age only were tested against new blocks at any one time in any one location. Paired tests with blocks of different ages were run during consecutive weeks between February and April 1997. Relative efficacy was expressed as the ratio of flies caught by an aged block to flies caught by a new block at the same site. Chemical analysis of blocks to determine ME and maldison content was undertaken at the end of the efficacy tests.

Experiment 3

In the paired comparison tests described in Experiments 1 and 2 above, there was a possibility that the proximity of a high concentration of lure (as in a new block) might have drawn flies away from an aged block in the same vicinity, thus giving results which underestimated the attractancy of an aged block. Experiment 3 was designed to overcome this problem. The relative efficacy of old blocks (12, 23, 30 and 40 weeks exposure) compared to new blocks (laboratory dosed with 18 mL of formulation) was determined in a non-competitive situation at one location and over the same time period.

The experiment was conducted in an area surrounding the DPI laboratory complex at Indooroopilly, Brisbane where vegetation ranged from pockets of planted rainforest species to open eucalypt grassland. Wild tobacco growing on land adjacent to the site ensured a significant population of *B. cacuminata* throughout most of the warmer months of the year. Sixteen trap stations, four at each of four sites were chosen. Trap stations within a site were approximately 50–100 metres apart in roughly a square layout. Sites were approximately 500 m apart. A time slicing technique was employed in which aged blocks were tested for 48 h followed by new blocks on the same sites for 24 h. These old/new alternating tests were performed eight times over a period of 24 days. Four replicate blocks of each age were individually tagged prior to beginning the experiment. All blocks

were tested by suspending them over plastic buckets hung in suitable vegetation approx. 1.5 m above the ground. When old blocks were being tested, four blocks of a particular age (12, 23, 30 or 40 weeks) were tested at any one site i.e. all 16 stations were utilised. When the old blocks were retrieved (after 48 h), a single new block was installed at one station in each site for the next 24 h period, i.e. four stations only were utilised. This was done to ensure that the local fly population was not trapped out by an excess of new blocks before the experiment was completed. Flies in the buckets were collected, identified and counted and block age was randomly allocated to a site at each changeover time.

At the end of the 24 day experiment, 16 aged blocks had been tested for 8x48 h periods and four new blocks had been tested for 8x24 h periods. The total number of flies for each set of four blocks was calculated and the mean number of flies/block/24 h period was determined. Relative efficacy was expressed as ratio of the mean number of flies caught by an aged block to the mean number of flies caught by a new block in 24 h. At the completion of the experiment, all aged blocks were analysed to determine ME and maldison content.

Chemical analysis

Blocks from Experiment 1 (up to 28 weeks exposure) were analysed for ME and maldison content by M. Lacey, CSIRO Division of Entomology, Canberra. Analysis of blocks used in other experiments was carried out by A. Noble, Department of Natural Resources, Brisbane. The methods used involved solvent extraction of whole blocks followed by gas chromatographic analysis.

Statistical analysis

The CoPlot Scientific Graphics Software package was used to examine the relationships between mean ME content (g/block), mean maldison content (g/block), mean relative efficacy (%) and exposure time.

RESULTS

Chemical analysis of blocks, up to 28 weeks (Experiment 1)

Of the 70 experimentally weathered blocks analysed by CSIRO in this experiment, six were found to have aberrant low values of both ME and maldison which contrasted sharply with others in the series (Lacey, pers. comm.). As these low values correlated with significantly lower block weight, it was concluded that these blocks exemplified the known variability in uptake of formulation by factory prepared blocks as described earlier. These aberrant blocks were excluded from analysis of the data.

Results showed an exponential decline in the mean amount of ME present in each block from approximately 13 g in unexposed blocks to just over 2 g after 12 weeks exposure, and to approximately 0.5 g after 28 weeks exposure (fig. 1). The exponential model which best fitted the data was given by:

$$\text{Mean ME content} = 0.5308 + 12.1750e^{(-0.1782 \text{ Time exposed})},$$
$$R^2 = 0.998, P < 0.01.$$

In contrast, there was no significant decrease in maldison content with the toxicant level remaining at 4.5–5.0 g/block over 28 weeks exposure (fig. 2). A linear model was fitted to the data however the ANOVA indicated the regression was non-significant ($F_{1,12} = 1.20$, $P = 0.2942$, $R^2 = 0.091$). The variability

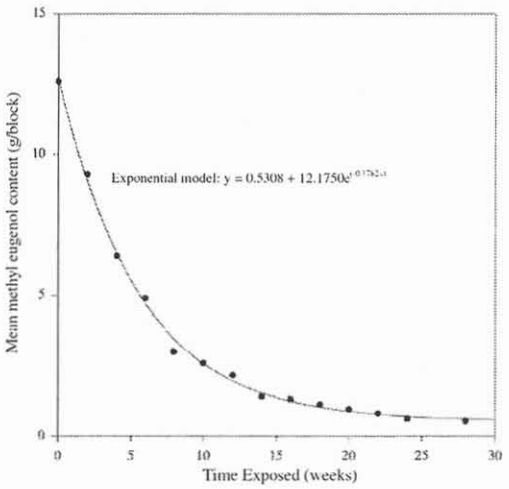

Figure 1. Change in methyl eugenol content of blocks with exposure time up to 28 weeks. Data from Experiment 1 (Ave SE mean: <=16wk=0.20, >16wk = 0.043).

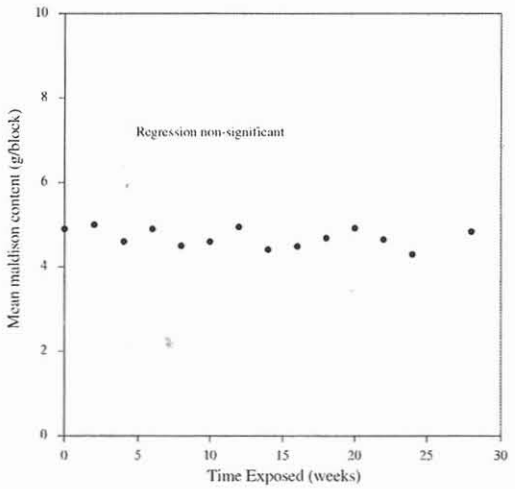

Figure 2. Change in maldison content of blocks with exposure time up to 28 weeks. Data from Experiment 1 (Ave SE mean = 0.16).

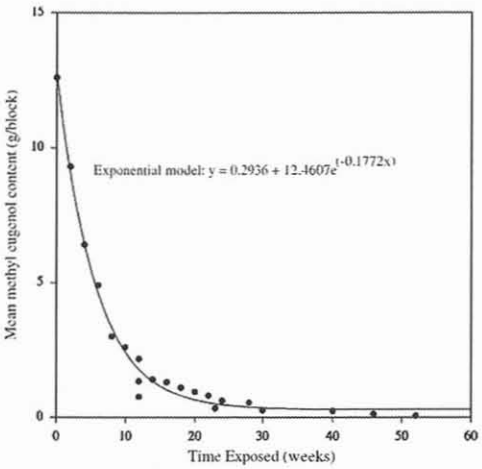

Figure 3. Change in methyl eugenol content of blocks with exposure time up to 52 weeks. Data from Experiments 1, 2 and 3 (Ave SE mean: <=16wk = 0.21, >16wk = 0.045).

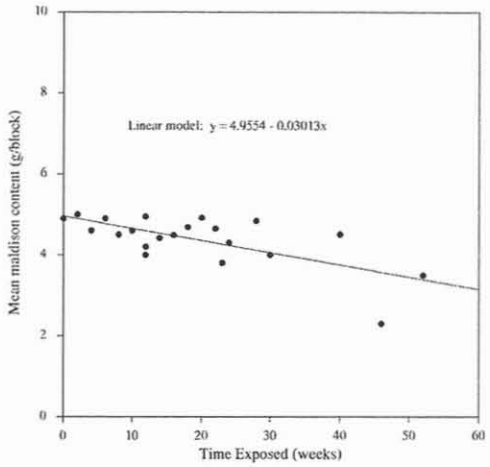

Figure 4. Change in maldison content of blocks with exposure time up to 52 weeks. Data from Experiments 1, 2 and 3 (Ave SE mean = 0.26).

in mean maldison content per block could in part be due to differences in the initial uptake of formulation as previously explained.

Chemical analysis of blocks up to 52 weeks (Experiments 2 and 3)

Analysis of weathered blocks retrieved from eradication areas showed changes in ME and maldison content which were in agreement with those in the experimentally weathered blocks in Experiment 1 up to 28 weeks. When ME content of older blocks (30, 40, 46 and 52 weeks exposure) was added to this combined data, there was little change in the exponential model (fig. 3).

$$\text{Mean ME content} = 0.2936 + 12.4607e^{(-0.1772\ \text{Time exposed})},$$
$$R^2 = 0.990,\ P < 0.01.$$

However, when results of maldison analyses for these older blocks were included, the regression analysis indicated that there was a significant correlation between mean maldison content and exposure time with maldison levels decreasing with increased exposure (fig. 4) ($F_{1,19} = 16.02$, $P<0.01$, $R^2 = 0.457$). Analysis of maldison content up to 28 weeks had shown no significant linear relationship. The maldison content of blocks after 40 and 46 weeks in particular was extremely variable possibly indicating differences in breakdown of the insecticide with different environmental conditions during very long term exposure.

Relative efficacy of aged blocks (Experiments 1, 2 and 3)

The mean relative efficacy for blocks of various ages as determined in Experiments 1, 2 and 3 are shown in table 1. Standard errors for results in Experiments 1 and 2 are shown but because of low fly numbers the results from Experiment 3 were grouped together over the duration of the test, so standard errors were not available. Experiments 1 and 2 involved paired comparison efficacy tests of blocks carried out at different times and under different conditions. Experiment 3 was designed to test older blocks of the same ages as some which had already been tested but under conditions where there was no possible competition from new blocks. In spite of these differing experimental designs, the results were remarkably consistent with blocks of the same age showing similar relative efficacy in different experiments.

Table 1. Relative Efficacy of Aged blocks

Block Age (weeks)	Mean Relative Efficacy[a] (%) ± 1 SE		
	Exp. 1	Exp. 2	Exp. 3[b]
2	87.2 ± 6.7		
4	82.4 ± 7.3		
6	57.8 ± 6.9		
8	56.9 ± 5.3		
9		47.5 ± 13.6	
10	46.7 ± 5.3		
12	39.2 ± 6.0		30.0
16		18.9 ± 7.2	
23		12.0 ± 3.9	11.9
30		9.9 ± 3.7	8.3
34		7.4 ± 2.0	
40		7.1 ± 1.9	7.2
46		5.0 ± 0.9	
52		3.8 ± 1.2	

(a) Relative Efficacy = ratio of number of flies caught by an aged block to number of flies caught by a new block under the same conditions.

(b) Fly catches were grouped together over the duration of the test to determine relative efficacy so no standard errors were available.

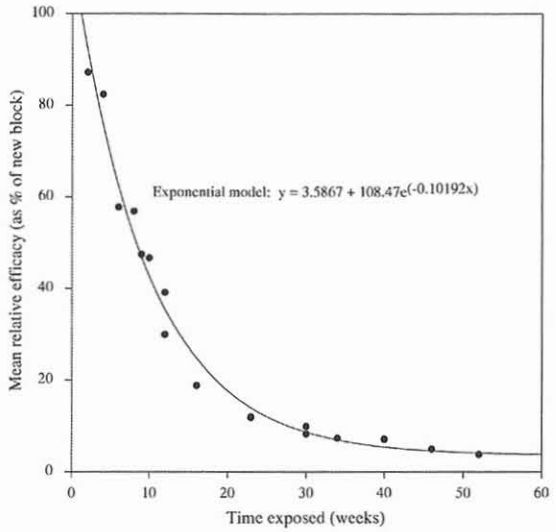

Figure 5. Change in efficacy of blocks with exposure time up to 52 weeks. Data from Experiments 1, 2 and 3.

Results of all three experiments were combined and an exponential curve fitted as shown in figure 5. The regression ANOVA indicated that the fit was highly significant.

$$\text{Mean Relative Efficacy} = 3.5867 + 108.47e^{(-0.1019\ \text{Time exposed})},$$
$$R^2 = 0.982, (P < 0.01)$$

Efficacy of blocks was reduced by approximately 35% after six weeks, 50% after eight weeks and by 65% after 12 weeks. After 20 weeks exposure, efficacy was reduced by approximately 80% but blocks continued to attract and kill small numbers of flies up to 52 weeks. In the two experiments carried out in the Brisbane area, more than 95% of the flies caught were *B. cacuminata*.

Additional information on 'Cane-ite' blocks

In the course of these studies, laboratory tests were undertaken to further investigate the properties and behaviour of 'Cane-ite' blocks. The results of these tests may have important implications in evaluating and/or improving eradication treatments and are therefore summarised below.

(a) The distribution of ME and maldison in blocks which had been exposed in the eradication area for 30 weeks was determined. The outer edge (17.5% by weight) of each block was shaved off and analysed separately from the central core. 11% of the total ME in the block and 18% of the total maldison were found to be in the outer edge (17.5%) of the block indicating that even after long term exposure, the outer surface of blocks remained both attractive and toxic.

(b) Untreated 'Cane-ite' blocks (mean wt=8.7 g) absorbed a mean of 3 g of water after 24 h constant exposure (floating) in water. After one week in water, blocks were still floating and had absorbed a mean of 8.1 g of water. When newly treated and aged blocks of 12, 16 and 40 weeks exposure were subjected to the same test, it was found that all blocks absorbed approximately the same weight of water (mean=2.3 g) after 24 h and a mean of approximately 4 g after one week, irrespective of prior weathering time. These results demonstrated that a treated block absorbed approximately half as much water as an untreated block irrespective of the amount of ME and maldison remaining in the block.

DISCUSSION

There is relatively little quantitative information published on the effects of exposure on efficacy and chemical content of lure/toxicant carriers used in male annihilation programs. Both male lures, methyl eugenol and cuelure, are known to be extremely long lasting under suitable conditions with cuelure probably lasting longer than ME (Bateman 1982). In a field trial in Hawaii, fibre-boards impregnated with cuelure and Naled were found to maintain their effectiveness undiminished over seven months (Cunningham and Steiner 1972). Cane fibre squares impregnated with ME and Naled were reported to remain attractive and toxic for more than two months in the Mariana Islands eradication program (Steiner *et al.* 1965). Few studies of physical carriers have involved chemical analysis of residual lure and toxicant and in most cases insecticides other than maldison have been used. An exception to this was the study of cuelure/maldison treated 'Cane-ite' blocks used in the eradication of Queensland fruit fly from Western Australia (Sproul *et al.* 1992) which showed no significant loss of lure or toxicant up to three months exposure.

The results of these current studies with similar 'Cane-ite' blocks impregnated with ME and maldison have shown no significant loss of toxicant up to 28 weeks but the male lure was rapidly lost from blocks over a ten week period. This loss of ME was, however, much slower than that reported from cigarette fillers treated with 0.5 mL lure (no insecticide) and suspended in air for 14 days (Shaver and Bull 1980). In the latter study, the loss of ME followed an exponential decline with the half-life of the lure being 3.5 days. The properties of fibre-board material and possibly the presence of insecticide significantly extend the life of the lure.

The efficacy tests described here were undertaken on the assumption that the target pest species *B. papayae* would respond to male annihilation blocks in much the same way as the non-target species *B. cacuminata* does. The success of blocking treatments to date in reducing the numbers of *B. papayae* to an extremely low level show the validity of this assumption (D.L. Hancock, pers. comm.).

The loss of efficacy of exposed blocks was closely correlated with the loss of the attractant ME as toxicity (measured by maldison content) remained relatively constant, at least up to 28 weeks. This result was not unexpected as methyl eugenol is much more volatile than maldison. The persistence of maldison in blocks may also be related to a number of other factors as suggested by M. Lacey (pers. comm.). These factors include the absence of light in the block which could protect maldison from photo-degradation; the approximately neutral environment (pH 6.5) which would not readily de-activate maldison by hydrolysis; and the wood fibre in blocks which may contain anti-oxidants which protect the pesticide from oxidative degradation. Analysis of the inner core and outer edges of 30 week old blocks showed that both ME and maldison were still available at the surface of the block to attract and kill. This was confirmed in the efficacy tests which showed that 30 week old blocks had an efficacy equivalent to approximately 9% of a new block.

As a manufactured building material, 'Cane-ite' has inherent water repellent properties exhibited by the fact that an untreated block absorbed only 3 g of water but approximately six times that weight of ME/Maldison formulation in 24 h. The fact that old and new treated blocks took up less water than untreated blocks demonstrated the even stronger hydrophobic nature of the block material once it had been treated with maldison and methyl eugenol.

The results of these studies have had a significant bearing on the implementation of eradication treatments for papaya fruit fly in the Pest Quarantine Area in north Queensland. The six week blocking cycle which was introduced in the early phase of the program ensured that new blocks were distributed when the relative efficacy of old blocks had fallen by 35%. Old blocks were withdrawn after 12 weeks at which stage relative efficacy had been reduced by 65%. From May 1997, papaya fruit fly numbers were greatly reduced throughout the entire Quarantine Area so an eight week blocking cycle with old blocks being withdrawn and new blocks applied in their place was introduced. This simplified the block retrieval process and reduced the time, labour and chemicals involved in the application of blocking treatments.

In mid–1997 the block retrieval rate in the Papaya Fruit Fly Eradication Program was 85–95% depending on the nature of the treatment area. The fact that these studies have shown that exposed blocks up to 52 weeks old were still attractive and toxic emphasises the need to achieve high block retrieval rates before establishing trapping grids to justify Area Freedom status and before the implementation of the Sterile Insect Release Program.

The environmental fate of toxicants used in male annihilation treatments has frequently been a major concern in eradication programs. The results of these studies show that in the current Papaya Fruit Fly Eradication Program there is no significant loss of insecticide into the environment during the normal exposure period for male annihilation blocks (6–12 weeks). The small percentage of blocks which are missed during retrieval operations may suffer some loss of maldison due to chemical breakdown after long term exposure (>30 weeks). This would not be expected to have any significant environmental impact. It is possible that the efficacy of blocks could be improved by incorporating in the formulation some component which reduces the rate of loss of ME. As maldison is not lost from blocks during the normal exposure period, it may also be possible to reduce the amount of insecticide per block without loss of efficacy.

These studies were undertaken as part of Research and Development in the QDPI Papaya Fruit Fly Eradication Program. The results were of value in implementing male annihilation treatments and may be relevant to other fruit fly eradication programs where information on physical carriers for male attractant/toxicant formulations is required.

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