Experiments on the Chemical Control of Some Insect Pests of Cocoa in Peninsular Malaysia with Particular Emphasis on *Helopeltis theobromae*

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Four series of insecticide screening trials are reported. The first three was of aim to select for alternative chemicals to gamma HCH against Helopeltis theobromae *in mature cocoa. All alternatives,* i.e. *decamethrin, permethrin, dioxacarb, propoxur and isoprocarb at 5, 25, 140, 75 and 156g a.i. per hectare respectively were found to be effective. However, different modes of application seem to lead to differentials in effectiveness of a chemical, it being seen that isoprocarb and dioxacarb would require to be medium to high volume sprayed, the synthetic pyrethroids fogged and propoxur by both methods. An analysis of cost showed isoprocarb and propoxur to be the more cost effective. The latter chemical, although slightly more expensive to use was more versatile in that it exhibited good bioeffectiveness when applied from high to ULV rates. It was however, clear that gamma HCH's performance in terms of cost and effectiveness could not be matched by any of the alternatives.*

The fourth trial investigates the effectiveness of 11 chemical treatments against Helopeltis, *mealybugs and aphid damage to shoots in immature field planted cocoa. All treatments were effective in controlling* Helopeltis, *good coverage by chemicals when spot spraying the relatively low shoots perhaps contributing to this. Systemic insecticides like dimethoate, monocrothophos and acephate provided best control of mealybugs with the synthetic pyrethroids decamethrin and permethrin being markedly less effective. As with* Helopeltis, *all treatments were effective against the aphids, perhaps explaining the general inconsequence of the insect in cocoa due to it being controlled together with spraying rounds against other insects in the crop.*

The cocoa plant is susceptible to a variety of insect pests throughout its lifecycle. Of these, the mosquito bug, *Helopeltis theobromae* is by far the most chronic (Azhar, 1984a), this being particularly true in plantings of the Peninsular. The pest attacks all stages of cocoa's development, shoots and pods being damaged. For the latter, losses could reach 85 per cent (Tan, 1974) and under certain situations, damage to shoots could be intense (Chung, 1986, pers. comm.).

Although natural enemies play an important role in controlling mirids, they cannot keep populations below economic levels (Anon, 1983) and as such chemical control remain an integral aspect of the pest's management. Since the verification of the usefulness of gamma HCH for control of the pest by Tan (1974), this insecticide had become the industry standard for the mirid's control in the country. As resistance by *Helopeltis* to the chemical had not yet been detected (Dzolkhifli Omar *et al.*, 1984) and together with a continued price differential in favour of its use, gamma HCH is expected to remain the chemical of choice for *Helopeltis* control for some time to come. However, present susceptibility levels cannot be guaranteed not to shift towards the less and coupled with legislative or industrial developments that could disable use of HCH, attempts to identify alternatives to use would be timely.

In immature field planted cocoa in addition to *Helopeltis*, mealybugs and to a lesser extent aphids are often problematic. The former encompass species like *Cataenococcus hispidus*, *Pseudococcus* sp., *Planococcus citri* and *Ferrisiana virgata* (Azhar, 1984b) and damage is primarily the distortion of shoots which when under repeated attack (either in combination or otherwise with *Helopeltis*) would cause significant set-back of planting points. The aphid *Toxoptera aurantii* is sometimes also detected on unhardened shoots and stalks of flowers and cherelles. Intense sap feeding by the insects are known to cause crinkling and distortion of shoots but these are often not permanent with damage being insignificant (Azhar, 1984b; Conway, 1971). However, the insect is frequently treated either directly or otherwise in sprays against mealybugs and records of the effects of insecticides used against the latter on the aphids could be useful.

With the foregoing, trials were conducted on the effectiveness of a series of insecticides against the pests. In the case of *Helopeltis* in mature cocoa, primary aim of the screening was for the identification of alternative insecticides to gamma HCH.

MATERIALS AND METHODS

In mature cocoa, 2 hectare permanent plots were set up in a 13-year old hybrid seedling planting on an estate near Teluk Intan, Perak. In the first series of trials, decamethrin (5g a.i./ha), permethrin (25g a.i./ha), dioxacarb (140g a.i./ha) and propoxur (75g a.i./ha) were compared with gamma HCH (125g a.i./ha) by knapsack spraying all trees in the block following the modified T2 method (Youdeowei, 1970). An untreated control was maintained. Pre- and post treatment censuses took the form of counting live mirids of all stages of its lifecycle on the central 100 trees, all pods that were readily visible being examined. Intervals of inspections were roughly fortnightly, recordings being extended up to 140 days from commencement of trial (DFCT) in order to gauge long term effectiveness or secondary effects of chemicals. For analysis of short-term effects of the chemicals, treatments were replicated 4 times in time with post treatment censuses being carried out at 16 and 34 DFCT. Time replicates were, as far as possible, initiated under similar cropping and weather conditions. All data collected were expressed in number *Helopeltis* per 100 trees with analysis of short term effects being the 2-way analysis of variance of percent mortality data (transformed by Arcsin $\sqrt{x}$) with subsequent comparison of mean per cent mortalities by Duncan's multiple range test. Such short term effects were substantiated by forementioned long term records (single replicate), *Helopeltis* numbers in all treatments being compared in terms of per cent protection calculated from weights of *Helopeltis* counts (Henderson and Tilton, 1955). Lastly, decision to treat in all occasions was reached when *Helopeltis* numbers per 100 trees exceeded 50.

A second series of trials were conducted with the same chemicals, rates and methodology as above except that treatments were administered by fog (methods of application and precautions as that for Pulsofg K10 machine as related by Taylor *et al.*, (1982)). This was of purpose to gauge performance of the alternatives when used with the ULV mode of application.

A separate trial with only short term

ducted with knapsack sprayed gamma HCH (125g a.i./ha), propoxur (75g a.i./ha) and isoprocarb (156g a.i./ha). Methodology was exactly that of the first series trials, this trial being of purpose to compare the merits of isoprocarb with the industry standard chemicals.

In immature cocoa, twice replicated 40 tree plots of a 2-year old clonal cocoa planting on an estate near Kajang, Selangor, was treated with gamma HCH (3.0 ml/litre water), dimethoate (1.5 ml/litre water), methamidophos (2.0 ml/litre water), monocrotophos (1.0 ml/litre water), endosulphan (3.0 ml/litre water), cypermethrin (1.0 ml/litre water), isoprocarb (1.5g/litre water), decamethrin (2.0 ml/litre water), acephate (2.0g/litre water), gamma HCH + acephate (2.0 ml HCH + 2.0g acephate/litre water), gamma HCH + dimethoate (2.0 ml HCH + 1.5 ml dimethoate/litre water) and control. Rates in this trial were expressed in terms of ml or g. formulation/litre water due to treatments being in the form of knapsack spot sprays on shoots that were affected by *Helopeltis*, mealybugs and aphids. Three rounds of spraying at roughly fortnightly intervals were carried out when pest levels were significant (more than 30% shoots damaged by each pest on a random survey of 10 shoots in each plot).

Census for *Helopeltis* damage took the form of counting total number of shoots and out of these number with fresh damage in the central 20 trees of each plot. Data were then pooled and expressed in terms of percent shoots with fresh *Helopeltis* damage for each census occasion.

Census for mealybugs were carried out by counting number of insects per randomly chosen shoot of the central 20 trees of each plot. Data were once again pooled and expressed into per cent protection by weights of mealybug counts.

Aphid counts were by the scoring of 1 randomly chosen shoot of the central 20 trees of each plot according to the scale:–

Score	*Number of aphids/shoot*
1	1–5
2	6–20
3	21–100
4	100

Total scores in each category were then pooled and compared with time.

For all recordings in immature cocoa, 3 censuses were carried out at about 2, 5 and 10 days after each spray and henceforth fortnightly, decreasing to monthly. Recording was maintained until 108 DFCT.

RESULTS

Short term results of the first series trails with knapsack sprayed alternatives to HCH are as in *Table 1*. It was seen that of the alternatives tested, only propoxur was statistically comparable to HCH in activity. This was substantiated by the long term recordings (*Figure 1*) where propoxur showed control trends similar to that of HCH. It was of interest to note that dioxacarb, although not showing significant short term control, proved to follow control trend of propoxur after 40 DFCT.

TABLE 1. RESULTS OF TRIALS WITH ALTERNATIVE INSECTICIDES AGAINST *HELOPELTIS THEOBROMAE* APPLIED BY KNAPSACK SPRAYER

16 Days after treatment			*34 Days after treatment*		
Chemical	*g a.i./ha*	*Mean % Mortality**	*Chemical*	*g a.i./ha*	*Mean % Mortality**
Control	–	7.53 ab	Control	–	25.27 ab
Decamethrin	5	49.56 ab	Decamethrin	5	57.57 ab
Permethrin	25	51.18 ab	Permethrin	25	57.61 ab
Dioxacarb	140	56.03 ab	Dioxacarb	140	60.02 ab
Propoxur	75	63.81	Propoxur	75	69.09
ϑ – HCH	125	65.94	ϑ – HCH	125	70.70

* Data transformed by Arcsin $\sqrt{x}$ prior to ANOVA. Means not followed by the same letter are significantly different ($P < 0.05$) by Duncan's multiple range test.

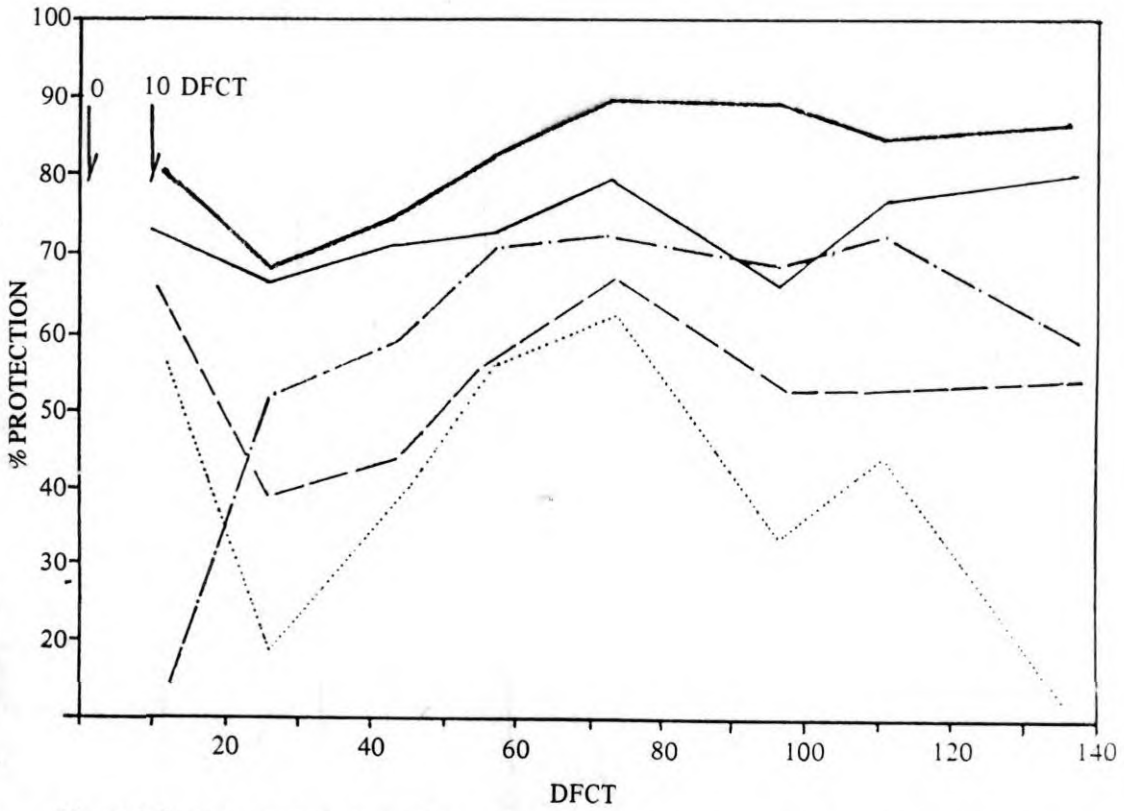

Figure 1. Long term protection of cocoa from Helopeltis *by insecticides applied with pneumatic knapsack sprayer.*

— ϑ-HCH —— propoxur - - - - dioxacarb

In the fogging trials, short term recordings are as in *Table 2*. Here only permethrin was seen to be statistically comparable to HCH. However, long term records (*Figure 2*) showed in addition to permethrin, propoxur and decamethrin to possess similar control trends.

TABLE 2. RESULTS OF TRIALS WITH ALTERNATIVE INSECTICIDES AGAINST *HELOPELTIS THEOBROMAE* APPLIED BY FOG

11 Days after treatment			*26 Days after treatment*		
Chemical	*g a.i./ha*	*Mean % Mortality**	*Chemical*	*g a.i./ha*	*Mean % Mortality**
Control	–	3.88 ab	Control	–	0.00 abc
Dioxacarb	140	20.66 ab	Dioxacarb	140	26.92 abc
Propoxur	75	42.07 a	Decamethrin	5	50.41 ab
Decamethrin	5	42.49 a	Propoxur	75	51.19 ab
γ – HCH	125	43.33	γ – HCH	125	53.11
Permethrin	25	45.50	Permethrin	25	61.79

* Data transformed by Arcsin $\sqrt{x}$ prior to ANOVA. Means not followed by the same letter are significantly different ($P < 0.05$) by Duncan's multiple range test.

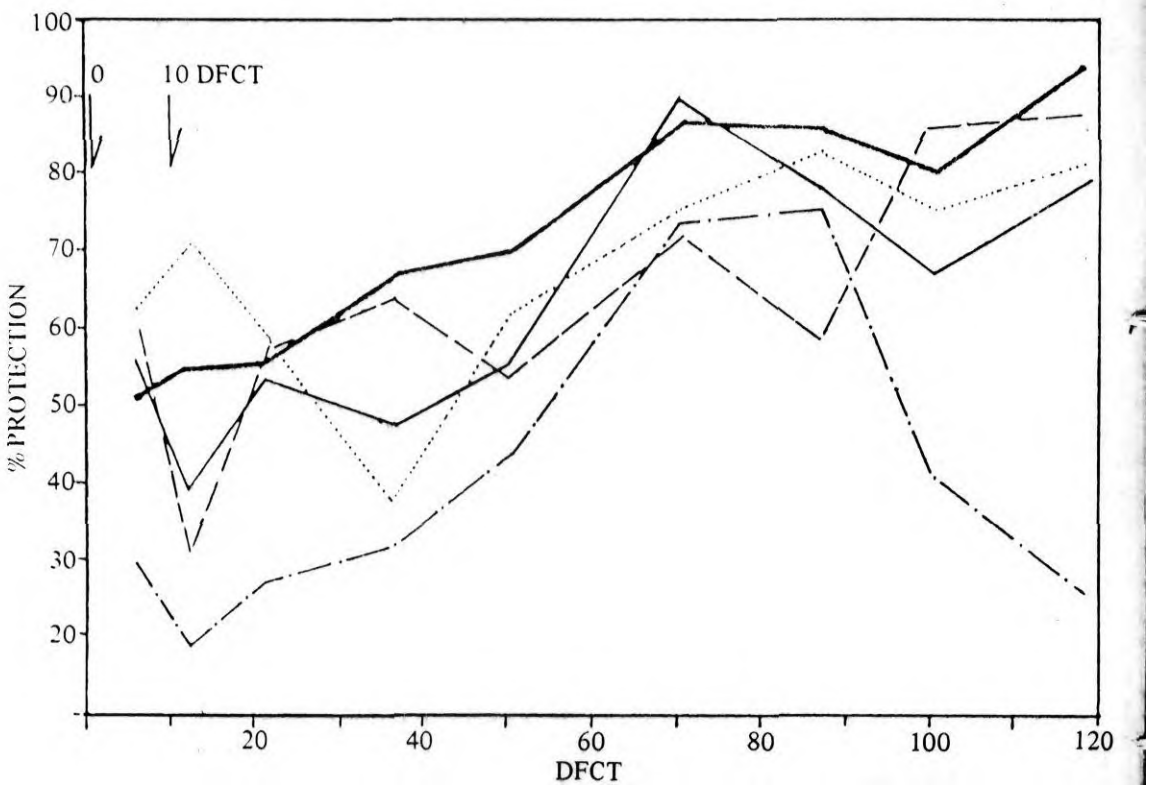

Table 3 shows short term evaluation with isoprocarb to be statistically comparable with that of propoxur and HCH.

Results of spraying trial in immature cocoa against *Helopeltis* is shown in *Table 4*. It was seen that a single spray with all treatments was sufficient to totally suppress fresh damage, subsequent two sprays being able to prevent fresh damage up to the end of the 108 days' recording. *Table 5* records control trends of chemicals against mealybugs. It was seen that the systemic insecticides (dimethoate, monocrotophos, acephate) or treatments with systemic insecticides incorporated (HCH + acephate, HCH + dimethoate) provided the most consistent control over entire period of recording. Gamma HCH, methamidophos (an exception in the systemic insecticides' control trend), endosulphan, isoprocarb and decamethrin were seen to provide acceptable control after the 3 rounds' spraying but long term suppression of insect numbers was less than that of forementioned systemics. Of the treatments, cypermethrin provided the poorest control. There were in fact indications of mealybugs increasing in activity in plots (judging from the negative % protection elicited from 12 DFCT onwards) with treatment by the chemical. Control by decamethrin was also unsustained. For aphids, it was seen that all chemicals were effective against the pest, with dimethoate, monocrotophos, cypermethrin, isoprocarb and acephate being the most effective in that total control was attained throughout period of recording.

DISCUSSION

The origin for necessity to screen for alternative insecticides to gamma HCH for use against cocoa mirids stemmed from the development of resistance to the chemical by such pests in Ghana and Nigeria in the early 1960s. Efforts of the International Capsid Research Team (Collingwood, 1971) identified propoxur, bufencarb, carbaryl, fenitrothion, methomyl, promecarb, dioxacarb and monocrotophos as suitable alternatives both in terms of bioefficacy

TABLE 3. RESULTS OF COMPARATIVE TRIAL WITH ISOPROCARB APPLIED BY KNAPSACK SPRAYER

16 Days after treatment			*31 Days after treatment*		
Chemical	*g a.i./ha*	*Mean % Mortality**	*Chemical*	*g a.i./ha*	*Mean % Mortality**
Control	–	2.10	Control	–	3.20
Propoxur	75	79.30	Propoxur	75	68.80
Isoprocarb	156	82.14	γ – HCH	125	75.60
γ – HCH	125	86.22	Isoprocarb	156	77.32

* Data transformed by Arcsin $\sqrt{x}$ prior to ANOVA. Means were found to be significantly different from the control ($P < 0.05$) by Duncan's multiple range test.

TABLE 4. % SHOOTS WITH FRESH *HELOPELTIS* DAMAGE WITH DFCT

	Days From Commencement of Trial (DFCT)														
	0 DAT			*13 DAT*			*24 DAT*								
Treatment	*0*	*3*	*6*	*12*	*15*	*19*	*22*	*26*	*29*	*34*	*42*	*54*	*64*	*78*	*108*
HCH	70.2	5.5	–	–	–	–	–	–	–	–	–	–	–	–	–
Dimethoate	46.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Methamidophos	87.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocrotophos	65.0	2.5	–	–	–	–	–	–	–	–	–	–	–	–	–
Endosulphan	49.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cypermethrin	72.4	6.7	–	–	–	–	–	–	–	–	–	–	–	–	–
Isoprocarb	77.1	4.3	–	–	–	–	–	–	–	–	–	–	–	–	–
Decamethrin	62.8	2.7	–	–	–	–	–	–	–	–	–	–	–	–	–
Acephate	61.4	1.1	–	–	–	–	–	–	–	–	–	–	–	–	–
HCH+Acephate	69.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
HCH+Dimethoate	31.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Control	68.7	54.9	53.2	43.6	45.2	50.3	42.2	36.0	32.0	*28.6*	*30.2*	*29.1*	*16.2*	*20.3*	*12.1*

TABLE 5. % PROTECTION OF IMMATURE COCOA FROM MEALYBUGS WITH TIME

	Days From Commencement of Trial (DFCT)														
	0 DAT			*13 DAT*			*24 DAT*								
Treatments	*0*	*3*	*6*	*12*	*15*	*19*	*22*	*26*	*29*	*34*	*42*	*54*	*64*	*78*	*108*
HCH		50.0	83.1	20.0	100.0	100.0	100.0	100.0	100.0	65.4	29.7	21.3	–35.0	3.6	–33.0
Dimethoate		45.5	76.7	67.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Methamidophos		9.1	58.4	67.3	76.6	100.0	100.0	100.0	100.0	81.1	59.1	67.3	67.3	84.7	66.5
Monocrotophos		43.5	69.3	64.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Endosulphan		69.1	85.7	80.0	57.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	85.7	86.4
Cypermethrin		66.7	78.6	–80.0	–16.7	–62.5	–107.7	–71.4	–77.8	–15.4	–162.5	–50.0	–50.0	–14.7	–84.1
Isoprocarb		53.3	91.4	76.0	82.9	100.0	100.0	100.0	100.0	91.8	62.5	40.0	40.0	60.0	75.5
Decamethrin		0.0	100.0	20.0	100.0	100.0	100.0	100.0	–3.0	37.7	–46.3	–44.0	–71.0	69.5	59.1
Acephate		70.4	89.3	70.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
HCH+Acephate		0.0	67.9	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
HCH+ Dimethoate		91.0	100.0	83.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

and freedom from taint of beans. Further work in Nigeria (Omole and Ojo, 1981) added chlorpyrifos, isoprocarb, quinalfos and Perfektan[R] to the list. More recently, work in Ghana (Owusu-Manu, 1983) also identified the synthetic pyrethroids to be promising. These however were reported to suffer from the disadvantage of high cost.

Foregoing findings were echoed in present studies in that the first series trials showed propoxur to be the most bioefficacious alternative when applied as a spray. Dioxacarb followed closely propoxur's trend when both short and long term recordings were considered. It was however surprising that the pyrethroids did not in this case match said carbamates in bioeffectiveness. As spray coverage was consistent between treatments it could be surmised that fumigant effects of the chemicals, more specifically that of propoxur (Marchant, 1971), could have resulted in the difference. On the other hand, poorer results by the pyrethroids could also mean that rates used or spraying technique or a combination of both could be deficient.

Results of the fogging trials were contrasting to those of the sprayed ones in that the pyrethroid permethrin, over the short term, provided the most significant performance as an alternative to HCH. In the long term, decamethrin and propoxur also showed comparable effectiveness to HCH, highlighting the suitability of the pyrethroids for control of *Helopeltis* when applied as a fog. Such performance could be attributable to the better coverage offered by the application technique. On the other hand, the poorer control by dioxacarb strongly indicates unsuitability of its use by the same technique, underscoring necessity to verify effectiveness of a promising treatment with various application methods.

Although only a short term trial was conducted with isoprocarb, foregoing trails have shown all such recorded treatments that were significantly comparable to HCH to also perform well in the long term. It could thus be expected that isoprocarb's performance would follow suit, agreeing with the West African finding of the chemical to be a suitable alternative.

It is clear that from present work, all chemicals at rates tested, could be used as alternatives to HCH with proviso that isoprocarb and dioxacarb be applied as medium to high volume spray, the synthetic pyrethroids as fog and propoxur as both fog and spray. However an analysis of cost showed cost/hectare of decamethrin (5g a.i./ha), permethrin (25g a.i./ha), dioxacarb (140g a.i./ha), propoxur (75g a.i./ha), isoprocarb (156g a.i./ha) and gamma HCH (125g a.i./ha) to be M$22.14, 15.30, 12.15, 8.70, 6.86 and 6.56 respectively, meaning that isoprocarb and propoxur would be the more cost effective alternatives. Of the two, propoxur seems to be the more versatile in terms of suitability to be applied with both high volume and ULV applicators. The synthetic pyrethroids, as with West African findings, were the most expensive to use. Lastly, it is obvious that gamma HCH is the most cost-effective chemical and coupled with its suitability to use with most modes of application, gives reason to the chemical being the first choice for *Helopeltis* treatment in the country.

In immature cocoa, all insecticides tested proved to be highly effective against *Helopeltis*. As good coverage was attained when spot spraying the

relatively low shoots, the importance of this aspect of insecticide treatment against the pest is emphasised.

In the chemicals' effects on mealybugs, the systemic insecticides proved to be the most potent while on the other side of the scale the synthetic pyrethroids generally provided short term to ineffective control. Such a finding provides us with clear guidelines as to the group of insecticides to use against such pests, fulfilling a basic purpose of any screening programme. As to the aphids, it was seen that all of the 11 chemical treatments were effective against the pest, meaning that they would be controlled by insecticide treatment rounds for other pests of cocoa. This perhaps could be significantly contributive to the aphids being generally inconsequential in the crop.

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REFERENCES

ANON. (1983) Possibilities for the use of natural enemies in the control of *Helopeltis* spp. (Miridae). *Biocontrol News and Information.* 4(1): 7–11.

AZHAR, I. (1984a) Seasonal and daily activity patterns of *Helopeltis theobromae* Mill. and their implications in field control. *1984 International Conference on Cocoa and Coconuts.* (Preprint).

AZHAR, I. (1984b) Natural and cultural control i the management of selected cocoa pests. In *Inte grated Pest Management in Malaysia.* Malay Pl. Prot. Soc. (ed. B.S. Lee *et al.*). pp 335.

COLLINGWOOD, C.A. (1971) *Cocoa capsids in Wes Africa: Report of the International Caps d Re search Team, 1965/1971.* London, Cocoa, Chc colate and Confectionery Alliance, 91 pp., 24 Figs

CONWAY, G.R. (1971) *Pest of cocoa in Sabah an their control.* Sabah State Ministry of Agricultur and Fisheries, 125 pp.

DZOLKHIFLI OMAR, KHOO, K.C., RITA MUHAMAD AND HO, C.T. (1984) Preliminar study of resistance of 4 populations of *Helopelti theobromae* Miller to γ –HCH, propoxur and dioxa carb. *1984 International Conference on Cocoa an Coconuts.* (Preprint).

HENDERSON, C.F. AND TILTON, E.W. (1955 Tests with acaricides against the brown whea mite. *J. of Econ. Ent.* 48: 157–161.

MARCHANT, H. (1971) Evaluation of insecticide for the control of cocoa capsids in Ghana. *FA Pl. Prot. Bull.*, 19(5): 97–109.

OMOLE, M.M. AND OJO, A.A. (1981) Field trial with insecticides and spraying equipments t control cocoa mirid *Sahlbergella singularis* Hagl in Nigeria. *Proc. 8th Int. Cocoa Res. Conf. Carta geria*, pp. 339–343.

OWUSU-MANU, E. (1983) The evaluation of th synthetic pyrethroids for the control of *Distan tiella theobromae* Dist. in Ghana. *9th Int. Coco Res. Conf. Togo, Nigeria.* 9 pp. (Preprint).

TAN, G.S. (1974) *Helopeltis theivora theobromae* o cocoa in Malaysia – Damage and control. *Mal Agric. Res.* 3: 204–212.

TAYLOR, J.G., HO, C.T. AND LIM, T.M. (1982 A mechanical thermal fogging system for control ling *Helopeltis theobromae* Mill in cocoa. In *Proc Int. Conf. Pl. Prot. in Tropics*, Kuala Lumpur 1982, pp 695–704.

YOUDEOWEI, A. (1970) Timing insecticide appli cation to control the cocoa capsid *Sahlbergell singularis* Hagl. in Nigeria. *International Pes Control.* 12(5): 13–16.

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