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FIELD EVALUATION OF PALM-BASED EMULSIONS IN WATER (EW)-INSECTICIDE FORMULATIONS AGAINST INSECT PESTS ON LONGBEAN AND CABBAGE

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ABSTRACT

The performance of palm-based emulsions in water (EW)-insecticide formulations was evaluated in the field against insect pests on longbean and cabbage. The insecticides used were deltamethrin and lambda-cyhalothrin. Phytotoxicity symptoms were also not observed on the treated crops.

Statistical analyses (DMRT, P<0.05) on differences between treatments indicated that the palm EW-formulations were equally effective or significantly better than the commercial EC-formulations in controlling the pests on longbean and cabbage crops. Higher cabbage yields were observed using the commercial EC-formulations [2.8% a.i. (w/w) deltamethrin and 2.5% a.i. (w/w) lambda-cyhalothrin] and two palm EW-formulations [2.5% a.i. (w/w] lambda-cyhalothrin at the recommended and lower dosage (10 and 7.5 ml/ 10 litre, respectively), followed by the other two palm EW-formulations [2.8% a.i. (w/w) deltamethrin at the recommended and lower rate].

*The untreated plots gave the highest number of fruit damage in longbean and the highest number of multiple heads (*i.e.*, no yield) in cabbage when compared to the treated plots. In addition, no phytotoxicity symptom was observed in both the bean and cabbage crops, meaning that the crops showed good tolerance to all the treatments.*

Keywords: palm-based inert ingredients, EW-insecticides, longbean, cabbage.

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INTRODUCTION

Insecticides comprise about 20% (w/w) of the total pesticides marketed in Malaysia. Of this percentage, more than 55% are in the form of emulsifiable concentrates (EC), which consist of 100% solvents derived from petroleum (MCPA, 2002). However, there is increasing demand for safer and more convenient formulations, *e.g.*, emulsions in water (EW) instead of EC-insecticide formulations (Abdullah and Mohtar, 1993; Tadros, 1995; Ismail *et al*., 1998; Ismail, 2000; Mulqueen, 2003; Ismail *et al.*, 2004a; 2005). The EW-insecticides offer many advantages over the conventional EC-insecticide formulations such as: the EWs being aqueous-based formulations, they may cause less medical problems (*e.g.*, skin and eye irritations) to the end-users or operators. They may also be less phytotoxic to plants. The formulations are less expensive to produce as instead of oil, more than 70% water is used.

Furthermore, the shift from petroleum-based to natural-based materials as inert ingredients in insecticide formulations shows a change in preference by the consumers (Cornish *et al*., 1993; Srivastava and Prasad, 2000). Other advantages of

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the natural-based materials are being renewable, environmental-friendly and less flammable due to higher flash points, as well as causing fewer medical problems and allergies to the end-users. As the prices for petroleum-based solvents have increased significantly recently, palm-based materials have good potential in replacing petroleum-based materials in EW-insecticides instead of the current EC-insecticide formulations.

The Malaysian Palm Oil Board (MPOB) has invented several palm-based EW-insecticide formulations (Ismail, 2000; Ismail *et al*., 2004b; 2005). These products have undergone complete physical stability and laboratory-scale efficacy tests. The results also indicate that the palm-based EW-insecticides have good potential in controlling pests in the agricultural sector, *e.g*., vegetables, oil palm trees and fruits, and may also be used in the public health sector. As the performance and phytotoxicity of these palm-based EW-insecticides have yet to be field-tested, the paper therefore discusses the preliminary results on the performance of palm-based EW-insecticide formulations against insect pests on certain vegetable crops in the field.

METHODOLOGY

Materials

Insecticides. The insecticide formulae tested comprise: palm EW-deltamethrin, 2.8% a.i. (w/w); palm EW-lambda-cyhalothrin, 2.5% a.i. (w/w) – both at the recommended dosage and at lower dosage; commercial EC-deltamethrin, 2.8% a.i. (w/w); and commercial EC-lambda-cyhalothrin, 2.5% a.i. (w/w).

Experimental plot. Two experimental fields for cabbage and longbean, respectively, were used.

Types of insects. The insecticides were tested against cabbage foliage feeder (*Plutella xylostella*), cabbage webworm (*Hellula undalis*) and leaf feeder (*Crocidolomia binotalis*) on cabbage, and longbean borer (*Maruca testulalis*).

TABLE 1. TREATMENTS USED IN THE EXPERIMENTS ON LONGBEAN AND CABBAGE

Code	Treatments (insecticides)	Dosage (ml/10 litre)
T1	Untreated (control)	-
T2	Commercial EC-deltamethrin, 2.8% a.i. (w/w)	4.6
T3	Commercial EC-lambda-cyhalothrin, 2.5% a.i. (w/w)	10.0
T4	Palm EW-deltamethrin, 2.8% a.i. (w/w)	4.6*
T5	Palm EW-deltamethrin, 2.8% a.i. (w/w) – lower rate	3.45
T6	Palm EW-lambda-cyhalothrin, 2.5% a.i. (w/w)	10.0*
T7	Palm EW-lambda-cyhalothrin, 2.5% a.i. (w/w) – lower rate	7.5

Note: * Recommended rates.

Experimental Procedure

The experiment was conducted using a Randomized Complete Block Design (RCBD) with three replicates. Seven treatments were carried out as listed in *Table 1*. Each treatment was randomly placed within each replicate. Every plot contained three rows of longbean or cabbage plants planted with 20 plants per bed. The planting distance used was 50 cm within a row and 60 cm in between rows; hence, the total plant number per treatment plot was 60. In addition, a traditional wood-trellis method was used to support the longbean plants throughout the experimental period.

Palm-based inert ingredients (*Figure 1a*) were used to prepare the EW-insecticide formulations (*Figure 1b*).

a b

Figure 1. (a) Palm-based inert ingredients, and (b) EW-insecticide formulations.

Applications of the insecticides (*Figure 2*) were carried out at five-day intervals. The chemicals were applied using a conventional knapsack sprayer with a solid cone nozzle at a spray volume around 1000 litre ha^{-1}.

a

b

Figure 2. Application of palm EW-insecticide solutions on (a) longbean and (b) cabbage in the field.

For longbeans, the data on the percentage of damaged beans at each harvest only (at intervals of six days, from 54-90 days after planting), were considered in the data analyses. In the cabbage experiment, larval counts were made for *P. xylostella* and *C. binotalis* on the plants at different stages from 36-56 days after planting. At maturity, only the marketable heads were harvested and weighed. The fruit damage to longbeans, total larval counts of the cabbage pests, and cabbage yields were analysed using the SAS procedure (DMRT for the separation of means at the statistical level of $P<0.05$).

RESULTS AND DISCUSSION

The performance and phytotoxicity effects of the palm EW-insecticides were field evaluated and compared to the commercial EC-insecticides.

Longbean

No phytotoxicity symptom was observed on the bean crops in all of the treatment plots as the crops showed good tolerance to all of the treatments applied. Statistical analysis (DMRT, $P<0.05$) among the treatments (*Table 2*) indicated that the palm EW and the commercial EC-formulations were not significantly different, *i.e.*, they were equally effective against the pest, except at 78 days after planting (DAP) when the palm EW-formulations gave significantly better control of the pest than the commercial EC-formulations (*Figure 3*). Moreover, the lower dosage of palm EW-formulations for both deltamethrin and lambda-cyhalothrin, gave equally effective control against the pest as when the recommended dosage was used.

Statistical analysis of the overall mean percentage of bean damage indicated that the untreated plots gave the highest number of bean damage when compared to the treated plots (*Figure 4*). However, T3 (a commercial EC) gave the lowest percentage of bean damage followed by T6, T7, T4 (all three being palm EWs), T2 (commercial EC), and T5 (palm EW).

TABLE 2. THE MEAN PERCENTAGE OF DAMAGED FRUITS INFESTED BY *M. testulalis* AT HARVESTS VARYING BY SIX-DAY INTERVALS

Treatment	% of fruits damaged at various harvest intervals (days after planting)							Mean
	54	60	66	72	78	84	90	
T1	18.59a	18.41a	17.90a	20.59a	35.76a	30.35a	31.86a	24.6a
T2	11.43c	8.37c	6.80c	12.25b	33.73ab	22.53bc	18.79b	15.64bc
T3	17.46ab	8.30c	6.84c	7.51bc	28.10bc	15.91d	12.24bc	13.76cd
T4	15.02abc	10.39c	6.20c	7.32c	25.49c	21.95bc	12.92bc	14.70cd
T5	18.52a	14.46b	13.59b	6.90c	14.48d	26.44ab	18.87b	18.53b
T6	15.30abc	9.79c	9.57c	5.60c	15.37d	18.40cd	18.25b	14.23cd
T7	12.84bc	7.56c	9.52c	8.54bc	11.74d	20.91bcd	17.36b	13.84cd

Note: In the columns, the same character means there is no significant difference between treatments ($P<0.05$, DMRT).

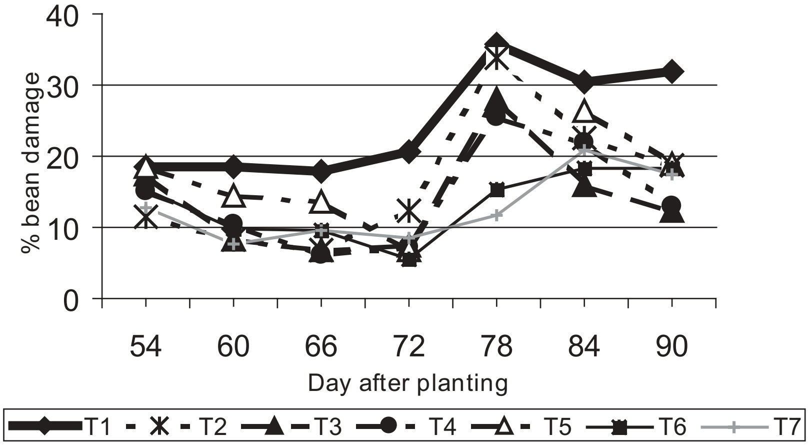

Figure 3. Percentage of longbean damage due to fruit borer infestation at various harvests.

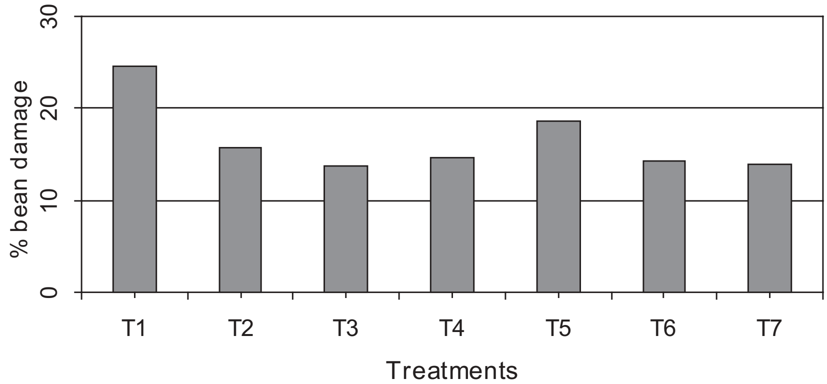

Figure 4. Mean percentage of beans damaged from the total number of the beans harvested.

Cabbage

No phytotoxicity symptom was observed on cabbage in all the treatments, indicating good tolerance of the cabbage crops to the insecticides being tested. The pest data (*Table 3*) for *P. xylostella* and *C. binotalis* were recorded randomly on 10 plants per replicate at 36, 43, 50 and 56 days after planting. The extent of infestation by *H. undalis* or cabbage webworm was reflected by the number of plants bearing multiple heads. Infested shoots produce multiple shoots or heads comprising about three or four smaller heads, which were unmarketable and therefore considered as losses and recorded as no yield.

Pest infestation by *C. binotalis* and *P. xylostella* generally increased with time towards the harvest stage of cabbage (*Table 3*). However, the numbers of *P. xylostella* were not significantly different among the treatments. This could be because the pest had become resistant to the chemicals as reported by many researchers in the highlands as well as in the lowlands (Yusof and Lim, 1992). Generally, the treated plots gave significantly lower numbers of

TABLE 3. THE MEAN NUMBER OF INSECT LARVAE RECORDED ON 10 PLANTS (cabbage) AT VARIOUS CROP AGES

Treatment	No. of *P. xylostella* at various crop ages (DAP)				Total No. of larvae	No. of *C. binotalis* at (DAP) various crop ages				Total No. of larvae
	36	43	50	56		36	43	50	56	
T1	1	1.67	2.33	1.33	6.33a	40.3	13.7	7	6	67a
T2	0	1	2	4	7a	0.67	5.67	25.3	18.3	50ab
T3	0	0.33	6	6	9.67a	0	5.33	14.7	5	25c
T4	0	0.33	5	3	6.67a	0.33	10	14.7	8.33	33.33bc
T5	1	0.67	8	1	10.67a	6	6.67	14.7	5	32.33bc
T6	0	0.33	7.67	3	11a	0.33	1.33	9.33	13	24c
T7	0	0.67	4.33	5.67	10.67a	0.33	3.67	9	16	29bc

Note: In the columns, the same character means there is no significant difference between treatments (P<0.05, DMRT).

C. binotalis, the foliage feeder, as compared to the untreated plots (DMRT, $P<0.05$).

All the treatments (*i.e.*, T2, T3, T6, T7, T4 and T5) were equally effective against the pests on cabbage. However, statistical analysis of cabbage yields indicated higher yields in T6 and T7 (palm EWs with lambda-cyhalothrin), followed by T2 and T3 (commercial ECs), and then by T4 and T5 (palm EWs with deltamethrin) (*Figure 5)*. Furthermore, the untreated plots (T1) gave the highest number of plants with multiple heads (*i.e.*, no yield) (*Figure 6*), meaning that they had been heavily infested by the cabbage webworm. The results also showed that the treatments T6 and T7 (palm EWs) were as effective as T2 and T3 (commercial ECs), and were significantly better than T4 and T5 (palm EWs) in controlling the cabbage webworm.

CONCLUSION

The results from the evaluation on field efficacy show that the palm EW-formulations with 2.5% a.i. (w/w) lambda-cyhalothrin at the recommended or lower dosage (10 and 7.5 ml/10 litre, respectively) and commercial EC-formulations with 2.8% a.i. (w/w) deltamethrin and 2.5% a.i. (w/w) lambda-cyhalothrin were equally effective in controlling insect pests for both longbean and cabbage in the field. Higher cabbage yields were also observed with the commercial EC-formulations and these two palm EW-formulations, followed by the remaining two palm EW-formulations (*i.e.*, 2.8% a.i. (w/w) deltamethrin at the recommended and lower dosage). The untreated plots had the highest number of fruit damage for longbean and the highest number of multiple heads (*i.e.*, no yield) for cabbage when compared to the treated plots.

In conclusion, the palm-based materials have good potential in substituting petroleum-based materials in agrochemical formulations. Furthermore, the palm EW-insecticides may form the basis for a future trend in crop care and public health sectors, in place of the conventional EC-insecticides currently used in Malaysia.

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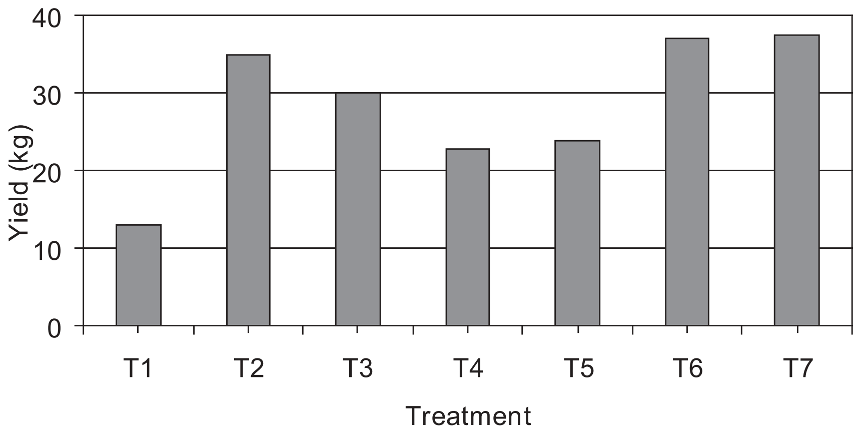

Figure 5. Mean yields of cabbage (kg plot^{-1}) from the various treatments.

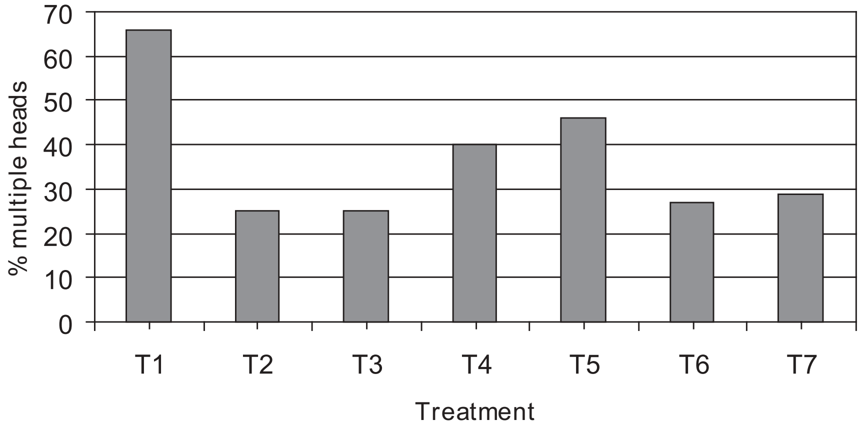

Figure 6. Mean percentages of plants with multiple heads from the various treatments.

REFERENCES

ABDULLAH, A R and MOHTAR, Y (1993). Pesticide formulations – present trends and recent developments. *The Planter*, *69(802)*: 3-13.

CORNISH, A; BATTERSBY, N S and WATKINSON, R J (1993). Environmental fate of mineral, vegetable and transesterified vegetable oils. *Pestic. Sci*., *37*: 173-178.

ISMAIL, A R; DZOLKIFLI, O; OOI, T L and SALMIAH, A (1998). Pesticide formulations based on oleochemicals derived from palm and palm kernel oils. *The Planter*, *74(862)*: 9-18.

ISMAIL, A R (2000). Palm-based insecticide formulations. *MPOB Information Series*. *No. 90.*

ISMAIL, A R; OOI, T L and SALMIAH, A (2004a). Environment-friendly palm-based inert ingredient for EW-insecticide formulations. R&D Exhibition and Competition at I-Tex 2004, Mid Valley Exhibition Centre, Kuala Lumpur, 20-22 May 2004.

ISMAIL, A R; OOI, T L and SALMIAH, A (2004b). Environment-friendly palm-based inert ingredient for EW-insecticide formulations. *MPOB Information Series No. 236*.

ISMAIL, A R; CHAN, Y P; OOI, T L; SALMIAH, A and CHUA, S H (2005). Environmental friendly EW-insecticide formulations for crop care and public health sectors: a future trend in Malaysia. *Proc. of the PIPOC 2005 International Palm Oil Congress.*

MCPA (2002). *Annual Report*. Malaysian Crop Care and Public Health Association. 47 pp.

MULQUEEN, P (2003). Recent advances in agrochemical formulations. *Advances in Colloid and Interface Science*, *106*: 83-107.

SRIVASTAVA, A and PRASAD, R (2000). Triglycerides-based diesel fuels. *Renewable and Sustainable Energy Reviews*, *4(2)*: 111-133.

TADROS, FT (1995). Emulsions. *Surfactant in Agrochemicals*, *54*: 93-132.

YUSOF, O and LIM, B K (1992). Diamondback moth in Malaysia. *Training Manual of Integrated Pest Management of Diamondback Moth in Cabbage in Malaysia*. MARDI, AVRDC, DOA. Kuala Lumpur, Malaysia.