RESIDUAL APPLICATION OF INSECTICIDES FOR PROTECTION OF BAG-STACK RICE UNDER TROPICAL STORAGE

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In store studies were conducted on the effectiveness of insecticide formulations and method of applications of contact insecticides as bag-stack sprays for protection against insect reinfestations in two goverrntment's central rice storages. At LPN Seremban store, the reinfesting *Tribolium castaneum* and *Oryzaephilus surinamensis* populations were significantly reduced at each successive forthnightly sprays. No difference was observed in the efficacy of wettable powder compared to emulsifiable concentrate insecticides pirimiphos-methyl, fenitrothion, deltamethrin and permethrin applied as water diluted spray on the jute bag-stacks. At LPN Port Kelang Godown, spraying bags as layer-by-layer spray as the stack was built did not show advantage compared to normal method of spraying the faces of the stack.

It is recommended that individual stores should routinely monitor infestations to assess the effectiveness and relevance of present bag-stack spraying practice as part of routine pest control procedure. The usefulness of this residual treatment technique can be enhanced through integration with space application of insecticide and covering stack with cloth sheets.

INTRODUCTION

In developing countries bag-stack storage is the most common method of storing grains and other raw durable commodities. Protection against insect infestations in the normal ventilated-type storage building consists of sheeted fumigation, supplemented with application of contact insecticides as space and residual treatments. In Malaysia, residual fabric spray (storage structures and to faces of bag-stack) is commonly practiced in both goverrntment and private storages. The frequency of residual treatments varies, but is usually less frequent than thermal fogging, which is the most common method of space insecticide application. Though generally perceived effective in controlling insects, store managers often cast doubt on the economic advantage of residual sprays to bag-stacks, considering the cost incurred in large storage, and the limited scientific informations available on the treatment efficacy, frequency, effectiveness of insecticides and formulations that are based on trials in large practical storage.

This paper will report studies conducted to assess the effectiveness, insecticide formulations, and methods of applying residual treatments to bag-stacks for insect control under tropical storage conditions.

MATERIALS AND METHODS

Treatments

All studies were conducted in two milled rice stores owned by goverrntment's Paddy and Rice Authority (LPN). Central rice storage in Malaysia are in jute-bags in stacks of varying sizes in ventilated horizontal storage buildings. Current insect control practices consist of fumigation with phosphine gas upon entry of the stock, supplemented with insecticide treatments, as thermal fog, twice weekly and residual spraying the storage structures and bag-stacks once a week or forthnightly.

Trial I at LPN Seremban store involved all the 1900 t rice in 10 stacks in the single unit storage building. The studies were conducted to assess the effectiveness of residual spraying to the external faces of bag-stacks at forthinghtly interval, which was the store's standard spraying frequency. Wettable powder and emulsifiable concentrate formulations of four insecticides were tested at standardised dosage and dilution.

Trial II was conducted in one of the six storage buildings 2000 t capacity located at LPN Port Kelang. The main objective was to evaluate three residual spraying methods, namely : as one time application to the bags, layer-by-layer as the stack was built, or to external faces of the stack only ; and to stack faces at monthly interval. The dosages of toxicants applied in the first two were for 12 months protection, but proportionately split for each application in the third method. The efficacy of wettable permethrin and pirimiphos-methyl was also compared at each spraying method tested (7 stacks 200 t, including control stack). Except for fumigation, routine insecticide treatments in the adjacent storage buildings were ceased for the duration of this trial.

Details of the treatments for both trials are summarised in Table I. All rice was fumigated with phosphine tablets at dosage of 3 g/t in Trial I and 2-5 g/t in Trial II for 10-15 days exposure period. Variations in fumigation dosage in the later trial were part of separate studies on fumigation. Varying the fumigation dosage did not affect the insecticide trial results since all stacks achieved the

minimal 100 ppm residual gas limit after 10 days, which is the local guide for successful fumigation. To avoid variations due to fresh infestations with the entry of new rice stocks, the spraying trial was terminated after 6 and 13 weeks in Trial I and Trial II respectively.

Sampling

The effectiveness of the treatments were assessed based on the magnitude of the reinfesting insect populations. Adult insects, which were mainly *Tribolium castaneum* (H.), and to lesser extent *Oryzaephilus surinamensis* (L.), were monitored by trapping in bag traps. The bag trap measures 15 x 8 cm made of perforated plastic (2 mm mesh) containing 150 - 200 gm rice, added with a spoonful of brown yeast as attractant, was inserted at ca. 0,4 m from external face of the stack at 4 replicates per stack. Live and dead adults were counted from the sifted bait grain every 3 days in Trial I and weekly in Trial II. Bait trapping was used for its convenience, speed and reliability in sampling insect infestations in bag-stacks. **Hodges** *et al.* (1986) in studying insect monitoring techniques in rice stores, concluded that insect counts from bait traps were proportionate to populations from spear-sampling from bags.

RESULTS

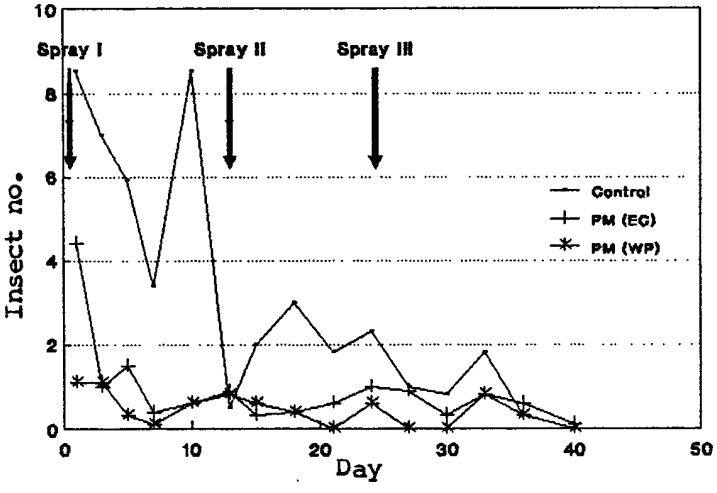
Effectiveness of spraying, insecticides and formulations

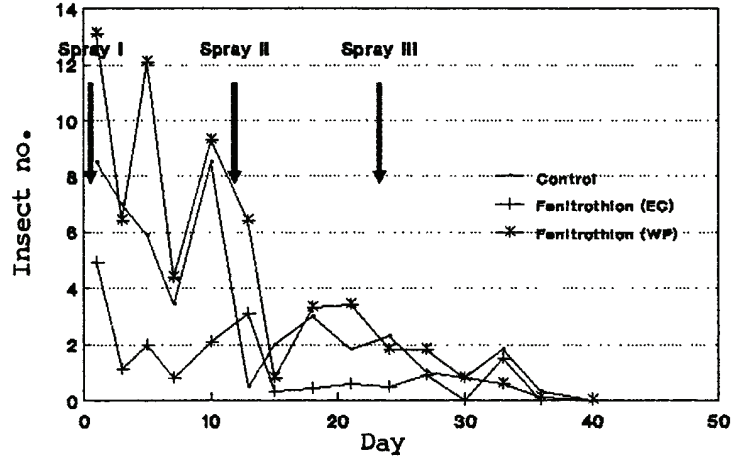
The relative magnitude of reinfesting *T. castaneum* and *O. surinamensis* in stacks as a measure to compare the effectiveness of wettable powder with emulsifiable concentrate of each of the four insecticides is shown in figure 1. Statistical analyses on the performance of the spraying programme, insecticides and the formulations used, based on mean insect count for all sampling dates per treatment, is given in Table 1. Each successive residual sprayings of insecticides to bag-stacks significantly ($P < 0,01$) reduced the reinfesting populations. Both formulations showed similar residual efficacy on the jute bag-stacks. Also, organophosphates pirimiphos-methyl and fenitrothion applied as 2 % diluted sprays provided similar effectiveness with synergised synthetic pyrethroids deltamethrin and permethrin at 0,5 % spray.

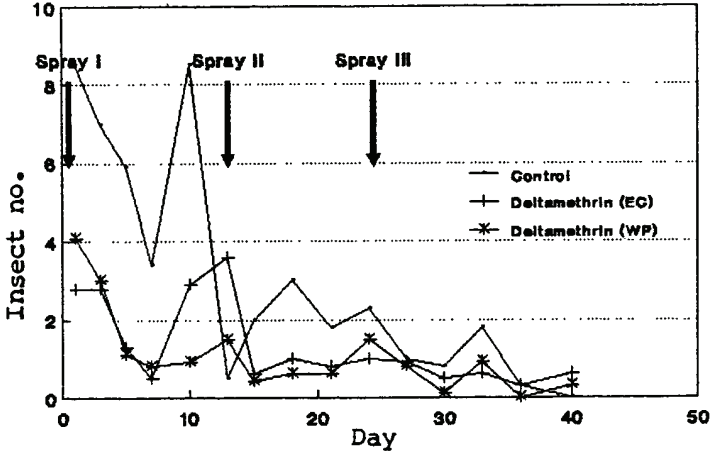
Effectiveness of spraying methods

Figure 2 shows the relative fluctuations in the reinfesting *T. castaneum* and *O. surinamensis* in bag-stacks with different methods of residual treatments. As indicated in the figure, and statistical analyses using Duncan's Multiple Range Test showed residual spraying did not provide protection against reinfestations when compared to untreated stack. Spraying every bags as the stack was built (layer-by-layer, LL) did not show advantage compared to spraying to external faces of the stack as once application (OSA) or monthly treatment (OSM). Comparison of the efficacy of permethrin and pirimiphos-methyl also showed the difference between the two and with the untreated stack was not significant.

The population of the storage beetles reaching pre-fumigation level 5-6 weeks after fumigation. The mean weekly insect count for the first 5 weeks for all the seven stacks increased by 14 X compared to average populations of the remaining 7 weeks. The high insect activity at this period coïncide with completion of a generation of storage insects under tropical storage, which in Malaysian ventilated stores fluctuates daily at 26 - 35 Celcius and 55 - 100 % relative humidity. The peak emergence of new generation adults possibly







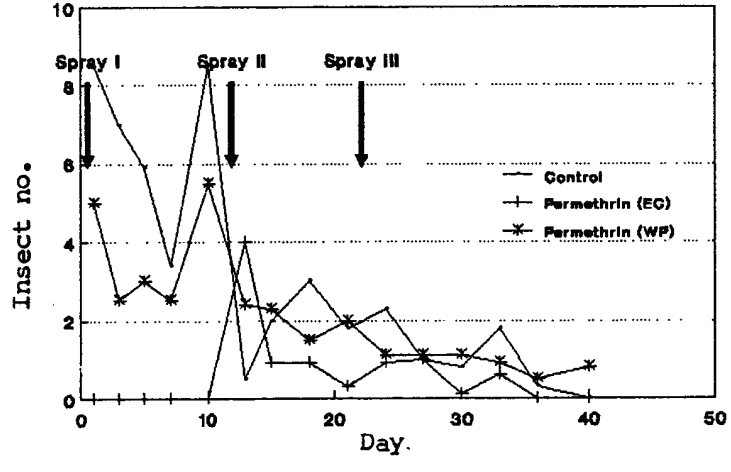


Figure 1: Comparing emulsifiable vs wettable powder formulations of four insecticides for efficacy as jute bag-stack spray

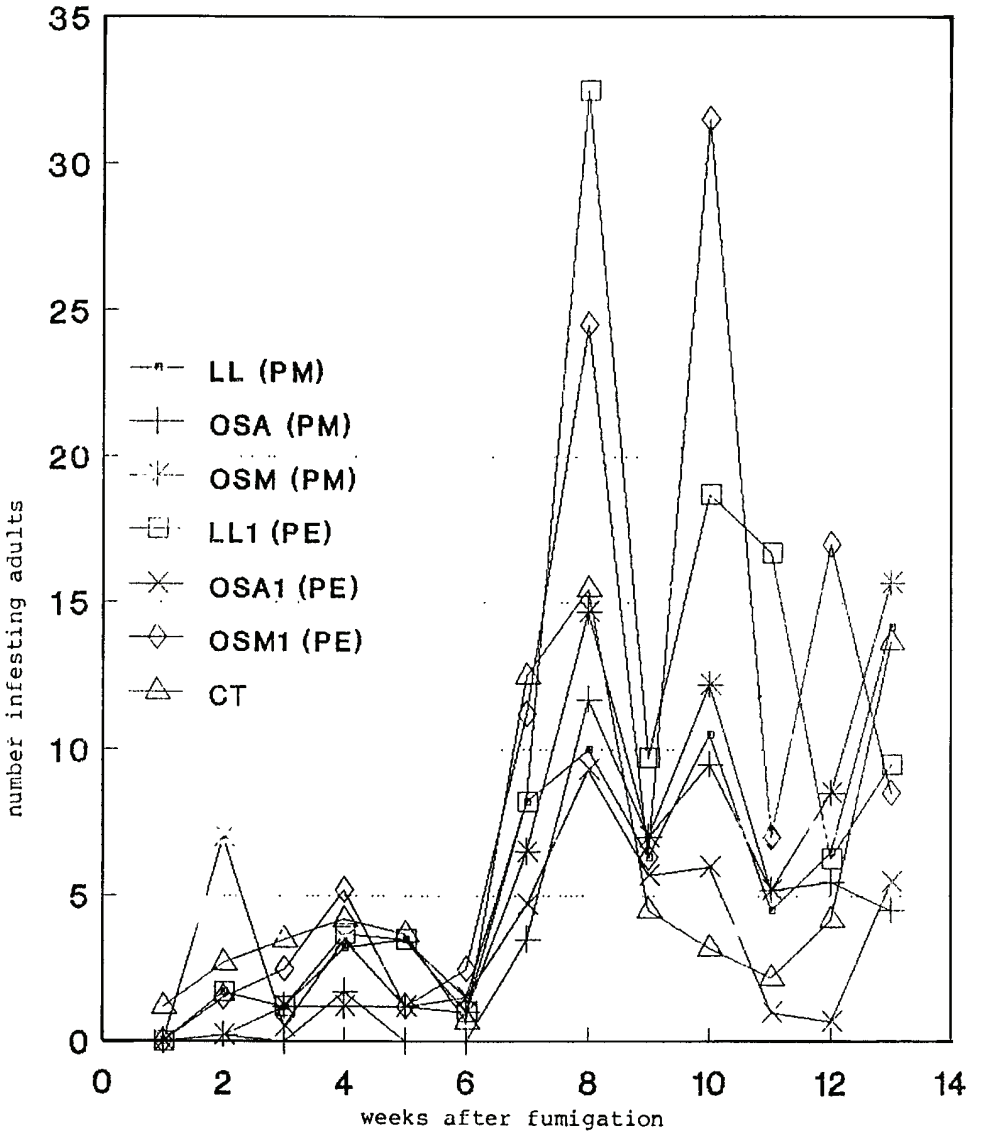
Table 1 : Summary of treatments on residual application of contact insecticides as bag-stack spray in milled rice storage

Trial I : Wettable powder (WP) vs Emulsifiable concentrate (EC) as forthnightly spray (LPN, **Seremban**, 1985)

Insecticide	Formulation	Dosage and application 1 g/m^2	Rice (Stack) x tonnage
Fenitrothion	Sumithion 50 EC Sumithion	1 gm^2 ai 5 L/100	2 x 180 t
Pirimiphos-	Actellic 50 E Actellic 40 WP	1 g/m^2 ai 5 L/100 m^2	2 x 180 t
Delramethrin	Cislin 2,5 EC Cislin 2,5 WP	0,25 g/m^2 5 L/100 m^2	2 x 220 t
Permethrin	Perigen 10 E Coopex 25 WP	0,25 g/m^2 5 L/100 m2	2 x 220 t
Control	-	-	2 x 150 t

Trial II : Spraying methods (LPN, **Port Kelang**, 1988)

Insecticide	Layer by layer	Stack faces once only	Stack faces monthly	
Permethrin Coopex 40 WP	60 mg/m^2 ai 5 L/100 m	60 mg m ai 5 L/100 m	5 mg m ai 5 L/100 m	3 x 200 t
Pirimiphos- Actellic 40 WP methyl	2000 mg m ai 5 L/100 m	2000 mg m ai 5 L/100 m	167 mg m ai x 12 5 L/100 m	3 x 200 t
Control				1 x 200 t



LL- Layer-by-layer; CT- Control;
OSA- External faces once application;
OSM- xternal faces monthly application

Figure 2 : Comparing relative effectiveness of bag-stack spray by three methods using wettable powder pirimiphos-methyl (PM) or permethrin (PE)

Table II : Comparing effectiveness of bag-stack sprays and insecticide formulations

Insecticide	DMR Ranking
Fenitrothion (WP)	3,5 a
Control	2,5 b
Permethrin (WP)	2,0 b
Deltamethrin (EC)	1,1 a
Deltamethrin (WP)	0,9 c
Fenitrothion (EC)	0,8 c
Pirimiphos-methyl (EC)	0,6 c
Permethrin (EC)	0,5 c
Pirimiphos-methyl (WP)	0,4 c
Spray No.	
I	2,8 a
II	1,1 b
III	0,4 c

Means in the same letter are not significantly different

originated from adjacent storages and/or the progeny of the initial, reinfesting population in the bag-stacks.

DISCUSSION AND CONCLUSION

The above evaluations in large show the effectiveness of residual treatment to jute bags is not consistent. The treatment can be very effective in one store (LPN Seremban), but not effective at all in another (LPN Port Kelang). The type of insecticide or the formulations is not crucial in determining the efficacy of the treatment. Improving the spraying technique, such as by spraying on eack layer of the bags as the stack is built showed no different in reducing insect reinfestations compared to spraying direct to bag-stacks.

The above findings indicated that each store needs to individually assess the relevancy of this method of insecticide application. Individual storage conducting appraisal of its performance should do so under normal stocking practices, with limited treatment parameters, and over prolonged assessment period.

In reviewing researches on fabric spraying, **Webley** (1985a) noted that efficacy depended more on the nature of the treated surface than differences between insecticides. The results from this study confirmed the general perception and findings from laboratory trials, that applying insecticide deposits on jute fabric provides poor insect control compared to polypropylene, or storage structures such as concrete or galvanised iron (**Webley**, 1985b).

The usefulness of residual insecticide treatment to both the storage structures and to a post-fumigated bag-stack, lies in integrating the treatment with space application as a mean to reduce reinfestation pressure, and covering stack with cloth sheets as physical barrier (**Webley**, 1985b ; **Rahim**, 1985). Finally, we wish to emphasise that present stack spraying routine should be complimented with continuous insect trapping programme, as a measure to assess the effectiveness of present practices (insecticides and frequency of treatment).

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REFERENCES

Hodges R.J., Halid H., Bees J.M. and **Sarjono J.** (1985) - Insect traps tested as an aid to pest management in milled rice stores.
J. stored Prod. Res. 21, 125-229.

Rahim M. (1985) - Storage of fumigated milled rice under perforated and ventilated plastic covers. In : Semple R.L. and Frio A.S., Research and development systems and linkages for a viable grain post-harvest industry in the humid tropics : proceedings of an internal seminar, Manila, Philippines, 6-9 August 1985. Proceedings of the 8 th Asean Technical Seminar on Grain Post-Harvest Technology, 129-134.

Webley D.J. (1985a) - Fabric spraying for pest control in grain storage. In Champ B.R. and Highly E. ed. Pesticides and humid tropical grain storage systems : proceedings of an International Seminar, Manila, Philippines, 27-30 may 1985. ACIAR Proceedings N° 14, 299-302.

Webley D.J. (1985b) - Use of pesticides in bag storage of grain. In Champ B.R. and Highly E. ed. Pesticides and humid tropical storage systems : proceedings of an international seminar, Manila, Philippines, 27-30 may 1985. ACIAR Proceedings N°14, 303-311.

APPLICATION D'INSECTICIDES DE CONTACT POUR LA PROTECTION EN MILIEU TROPICAL DE LA FARINE DE RIZ CONTRE LES REINFESTATIONS D'INSECTES

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RESUME

Du riz moulu empilé en 7 piles de 200 t a été fumigé à la phosphine à des doses de 1 - 5 g/t. On a étudié la capacité des insecticides comme la perméthrine ou le pirimiphos-méthyl (poudre mouillable) à empêcher la réinfestationselon les méthodes d'application suivantes : i) application couche par couche pendant l'empilement ; ii) application sur les surfaces extérieures des tas ; iii) application extérieure à intervalles mensuels. La réinfestation a été contrôlée en utilisant divers types de pièges.

La perméthrine et le pirimiphos-méthyl se sont tous deux montrés efficaces et ont réduit la réinfestation pendant 3 à 5 semaines. Les populations de *Tribolium castaneum* (Herbst.), l'espèce piégée le plus fréquemment, a resurgi graduellement après cette période pour finalement atteindre au bout de 13 semaines le niveau qu'elle avait avant la fumigation. L'efficacité de l'application par couches ne diffère pas significativement de celle consistant à traiter les surfaces extérieures. Cette dernière méthode, avec une seule application à un dosage calculé pour permettre une protection de 12 mois (perméthrine 60 mg/m^2 ; pirimiphos-méthyl 2.000.mg/m^2) ne diffère pas significativement de celle consistant à appliquer cette même dose mais en la fractionnant mensuellement.

Il est recommandé que les traitements des piles de sacs dans les magasins de type ventilé soient réalisés sous forme d'application spatiale (fumée, brouillard) plus simple que les autres types d'applications. Les pièges refuges ont été montré très attractifs et satisfaisants pour surveiller les populations d'insectes.