MARDI Res. J. 18(2) 1990 : 185–189

Evaluation of four rodenticidal dust for the control of *Rattus argentiventer* in rice fields

(Penilaian empat jenis debu racun tikus untuk pengawalan *Rattus argentiventer* di sawah padi)

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Key words: rodenticide, coumatetralyl, warfarin, pyrinuron, zinc phosphide, dust, rice

Abstrak

Debu-debu racun tikus koumatetralil, warfarin, pirinuron dan zink fosfid telah dinilai di sawah untuk kawalan tikus sawah, *Rattus argentiventer*. Keempat-empat jenis racun tikus menunjukkan prestasi yang baik dengan mengurangkan bilangan lubang yang aktif. Dalam ujian yang pertama, 0.5% warfarin, 3% pirinuron dan 3% zink fosfid memberi kesan yang sama dalam mengurangkan aktiviti lubang tikus. Dalam ujian yang kedua dan yang ketiga, 0.5% warfarin pada kadar 20 g satu lubang memberi kawalan yang lebih baik daripada 0.75% koumatetralil dan mencapai pengurangan aktiviti lubang tikus sebanyak 84-100%. Debu racun tikus memberi kawalan yang berkesan terhadap *R. argentiventer* pada peringkat padi bunting dan cara ini disyorkan untuk mengawal tikus sawah pada peringkat padi berbunga.

Abstract

Coumatetralyl, warfarin, pyrinuron and zinc phosphide dust were evaluated in rice fields for the control of *Rattus argentiventer*. All the four rodenticides gave significant reduction in the number of active rat burrows. In the first trial, 0.5% warfarin, 3% pyrinuron and 3% zinc phosphide dust achieved the same degree of reduction in rat burrow activity. In the second and third trial, 0.5% warfarin at 20 g/burrow gave better control than 0.75% coumatetralyl, achieving 84-100% reduction in rat burrow activity. Rodenticidal dust gave effective control of *R. argentiventer* during the reproductive phase of the rice crop and this method is recommended for rat control at this growth stage of rice.

Introduction

In Europe and the United States, rodenticidal dust had been used to control commensal rodents in areas where baiting did not give the desired control. The anticoagulants and gamma-BHC had been used against rats in rubbish dumps (Meehan 1976). Rowe and Chudley (1963) reported the successful use of anticoagulant dust surrounding poisoned water baits. Alpha-naphthylthiourea, red squill, zinc phosphide and pyrinuron had been formulated for use in the dust form (Marsh and Howard 1977). Poisonous dust is applied in several ways, as patches on runways or other areas frequented by rodents, around the openings and on the floors of bait containers or blown into burrows, between walls or into spaces occupied by rodents (Marsh 1973). Rodenticidal dust is recommended in

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situations where bait acceptance is poor. In rice fields, bait acceptance is very poor when the rice crop reaches booting stage. Rats *(Rattus argentiventer)* prefer to feed on the crop and the baits applied at this stage are largely ignored by the rats (Lam 1982). As soon as the rice reaches the booting and heading phases, rats construct burrows on the bunds for reproduction (Lam 1980). The rats are then vulnerable to any control measures aimed at their burrows. Calcium cyanide was popularly used in rat control campaigns, usually after harvests. In view of its high risks in use, it is not generally recommended to farmers. The high cost and risk to users have led to the exploration of other equally effective and more economic control methods. This paper describes the evaluation of four rodenticidal dust for the control of *R. argentiventer* in rice fields.

Materials and methods

Preparation of rodenticidal dust

Technical grade coumatetralyl (99.8% a.i.), pyrinuron (99.8% a.i.) and commercial grade zinc phosphide (minimum 80% a.i.) were mixed with talcum powder (calcium carbonate dust) to formulate 0.75% coumatetralyl, 3% pyrinuron and 3% zinc phosphide dust. The warfarin dust used was a commercial formulation containing 0.5% warfarin.

Determination of rat burrow activity

Rat burrow activity was determined during the reproductive phase of rice in MARDI Research Centre, Bumbong Lima (Trial 1), Permatang Pa'Elong (Trials 2 and 3) and Sungai Dua (Trial 3). All rat burrows in the study areas were located and their activities determined. Burrows were sealed with soft mud and were deemed active if they were reopened the next day.

Treatment

All active burrows recorded were then treated with the selected rodenticidal dust and were subsequently examined after 9 days.

In Trial 1, three rodenticidal dust, i.e. 0.5% warfarin, 3% zinc phosphide and 3% pyrinuron dust were evaluated in the rice fields of MARDI Research Centre, Bumbong Lima. Each rat burrow was treated with 20 g of the poison dust. The dust was applied into the burrow with a long spoon caliberated to dispense approximately 20 g of the dust. Each rodenticidal treatment was replicated five times and 18-27 burrows were dusted per replicate. The treatments were assigned randomly to the replicates. A control with similar replicates was also included.

In Trial 2, two rodenticidal dust, i.e. 0.75% coumatetralyl and 0.5% warfarin were evaluated in Permatang Pa'Elong at two rates, 10 and 20 g per rat burrow. Each treatment was replicated five times, including control.

In Trial 3, 0.75% coumatetralyl and 0.5% warfarin were evaluated in Permatang Pa'Elong and Sungai Dua at two rates, 10 g and 20 g per rat burrow. This trial was carried out to study the performance of the two rodenticidal dust in different localities.

Post-treatment determination of burrow activity

All treated rat burrows were sealed with mud on the eighth day after treatment and burrows reopened (active) or closed (inactive) were recorded on the ninth day. Assessment of the treated burrows for activity was done on the ninth day because a majority of the rats would have succumbed by the eighth day on exposure to anti-coagulant rodenticides. The untreated rat burrows (control) were similarly examined and recorded at each stage of the trials. The data on reopened burrows were used for statistical analyses to determine the effectiveness of the various rodenticidal dust.

Data analysis

Analysis of variance was conducted on the number of active burrows, and differences in the controlling effect were subjected to the Duncan Multiple Range Test (DMRT).

Table 1. Efficacy of three rodenticidal dust (20 g per burrow) against *Rattus argentiventer* in Bumbong Lima

Treatment	No. active rat burrows Treated/ recorded	Post-treatment	Reduction* active burrow (%)	Corrected** reduction (%)
Warfarin (0.5%)	108	23	78.7b	68
Pyrinuron (3%)	106	25	76.4b	64
Zinc phosphide (3%)	110	25	77.3b	65
Control	110	72	34.5a	0

* Duncan's Multiple Range Test, $p = 0.05$; treatments with the same letter are not significantly different

** Abbott's formula (Abbott 1925)

Table 2. Efficacy of coumatetralyl and warfarin dust against *Rattus argentiventer* in Permatang Pa'Elong

Treatment	No. active rat burrows Treated/ recorded	Post-treatment	Reduction* active burrow (%)	Corrected** reduction (%)
Warfarin (0.5 %)				
20 g/burrow	103	5	95.1c	93
10 g/burrow	101	16	84.2b	77
Coumatetralyl (0.75 %)				
20 g/burrow	83	30	63.9b	47
10 g/burrow	132	35	73.5b	61
Control	100	68	32.0a	0

* Duncan's Multiple Range Test, $p = 0.05$; treatments with the same letter are not significantly different

** Abbott's formula (Abbott 1925)

Abbott's formula (Abbott 1925) was used to correct the percentage of reduction in the number of active rat burrows. Abbott's formula was P = [(P* - C)/(1 - C)] x 100, where P = % corrected reduction; P* = % reduction; C = % reduction in control.

Results

Trial 1

Warfarin, pyrinuron and zinc phosphide performed equally well at the concentrations tested *(Table 1)*. Results showed that all the three rodenticidal dust had significant controlling effect on the rat population (F ratio = 21.55**; 3 d.f.; $p < 0.01$). All treatments gave significant reduction in active burrows compared with control. Warfarin dust gave 68%, pyrinuron 64% and zinc phosphide 65% control respectively *(Table 1)*.

Trial 2

Warfarin and coumatetralyl dust at the two rates tested caused significant reduction in the active burrow count (F ratio = 13.94**; 4 d.f.; $p < 0.01$). Warfarin 0.5% at 20 g per rat burrow gave the greatest reduction in active burrow (93%) followed by warfarin 0.5% at 10 g (77%). Coumatetralyl 0.75% at 10 g and 20 g gave reductions of 61% and 47% respectively. Warfarin at 20 g was significantly more effective than warfarin at 10 g, and coumatetralyl at 10 g and 20 g. However, there were no significant differences between warfarin at 10 g and coumatetralyl at 10 g and 20 g *(Table 2)*.

Trial 3

In Permatang Pa'Elong, warfarin dust performed significantly better than coumatetralyl dust at the two rates studied,

Table 3. Efficacy of coumatetralyl and warfarin dust against *Rattus argentiventer* in Permatang Pa'Elong and Sungai Dua

Treatment	No. active rat burrows Treated/ recorded	Post-treatment	Reduction* active burrow (%)	Corrected** reduction (%)
Permatang Pa'Elong				
Warfarin (0.5 %)				
20 g/burrow	31	0	100.0c	100
10 g/burrow	36	4	88.9c	85
Coumatetralyl (0.75 %)				
20 g/burrow	40	22	45.0ab	26
10 g/burrow	63	24	61.9b	49
Control	27	20	25.9a	0
Sungai Dua				
Warfarin (0.5 %)				
20 g/burrow	52	5	90.4b	84
10 g/burrow	65	12	81.6b	70
Coumatetralyl (0.75 %)				
20 g/burrow	43	8	81.4b	70
10 g/burrow	68	11	83.8b	74
Control	83	51	38.6a	0

* Duncan's Multiple Range Test, $p = 0.05$; treatments with the same letter are not significantly different
** Abbott's formula (Abbott 1925)

but in Sungai Dua there was no significant difference in their performance. However, all treatments except coumatetralyl at 20 g in Permatang Pa'Elong were significantly different compared with the control *(Table 3)*. Combined analysis of data indicated that there were differences in the efficacy of the rodenticidal dust between Permatang Pa'Elong and Sungai Dua (F ratio = 7.1*; 1 d.f.; $p< 0.05$). There were also significant differences in the performance of warfarin and coumatetralyl between the two study areas (F ratio = 30.6**, 1 d.f.; $p< 0.01$).

Discussion

Rodent control with poison dust takes advantage of the innate grooming behaviour of rodents. The poison dust is laid in areas where rodents frequent, and the dust picked up by the fur and feet is ingested during grooming. The advantages of this control technique are that the rodents do not suspect the source or cause of illness resulting from ingestion of the poison and so do not change their feeding habits as with poison baiting.

In the rice field environment, rats *(R. argentiventer)* construct burrows for reproduction during the reproductive phases of the rice crop (Lam 1980). At these breeding seasons, rats especially females are vulnerable to control measures directed at the nests. Rodenticidal dust was very effective against rice field rats (Trials 1, 2 and 3) at the reproductive stage of the rice crop. All the rodenticidal dust tested showed significant reduction in the number of active rat burrows in the trials. Particularly effective was 0.5% warfarin dust applied at the rate of 20 g per rat burrow opening (Trials 2 and 3) giving reductions in active burrows of above 80%. Also, during this period when litters are produced female rats are very susceptible to anticoagulants. Anticoagulants will cause females to die during parturition through the complete loss of blood as clotting was inhibited by the anticoagulants. The helpless young born would die without maternal care. This would effectively prevent rats from multiplying in the fields and would reduce rat infestation in the following crop.

Warfarin and coumatetralyl showed some differences in their performances between trial sites in Permatang Pa'Elong

and Sungai Dua. Warfarin 0.5%, at the rate of 20 g per rat burrow was very effective in Permatang Pa'Elong, giving 95-100% reductions in rat burrow activity. In Permatang Pa'Elong, warfarin performed significantly better than coumatetralyl but no significant differences were detected at Sungai Dua. These differences in efficacy could be due to the inherent differences between the study areas (e.g. topography and soil characteristics) and also the differences in rainfall patterns. The efficacy of the rodenticidal dust could be affected or reduced during very heavy rainfall or flooding. The nature of the dust used in the formulation is also an important factor influencing the efficacy of the poison.

The above studies showed that poison dust could be used to control rats during the reproductive phases of the rice crop. Control measures implemented at this stage of the rice crop over a large area would reduce tremendously the rat population levels infesting the subsequent rice crops and would contribute to the reduction of crop depredation by rats, thus increasing rice yields.

Acknowledgement

The author is grateful to Mr Mohd Salleh Abd Aziz and Mr Lee Ah Kaw for technical assistance, and Mr Yap Beng Ho for statistical analyses.

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Accepted for publication on 13 June 1990