EVALUATION BETWEEN WAX BLOCK AND FARMER STANDARD PRACTICE OF RODENTICIDE CHLOROPHACINONE ON RICE RAT, *RATTUS ARGENTIVENTER*

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ABSTRACT

Rice is the food crop that uses the largest single-use of land in terms of acreage. Nearly 90% of rice is produced in Asia. Rodent pest casually cause losses between 5 – 10% of rice during pre-harvest stage. Among the species of rats found in rice fields in Malaysia are the Rattus argentiventer and Bandicota indica. One of the popular and effective method in managing rat pest in rice field is the use of anticoagulant rodenticide. So far, chlorophacinone had not been tested on Rattus argentiventer in rice field. On the other hand, chlorophacinone is safer to barn owl compared to bromadiolone. The objective of this study is to evaluate the effectiveness between wax block and farmer standard practice of rodenticide chlorophacinone on rice rat, Rattus argentiventer in rice field. Result indicated that wax block had the lowest bait consumption with 13.1 ± 1.2 compared to farmer's standard practice with 23.8 ± 1.2 and control with 90.5 ± 2.4 starting at 42 day after application (DAA). Apart from that, wax block was also the fastest treatment to achieve bait consumption below 20% at 42DAA compared to standard practice at 49DAA. Both wax block and farmer's standard practice were able to reduce the burrow activity to 7.4% and 7.3%, respectively at 49DAA compared to control at 49.7%. Collectively, wax block had achieved better result compared to the standard practice. Besides, wax block and its inert ingredient was palatable for the rats in the rice field and had shown no neophobic issues. Conclusion, wax block is user-friendly, less-toxic to the natural enemies as compared to SGAR, have minimal cost and can provided huge returned to the farmer.

Keywords: rice field, Rattus argentiventer, chlorophacinone, rodenticide

INTRODUCTION

Rat is a major pest in rice production; the annual pre-harvest losses in rice production as a consequence of rodents activities ranges from 5% in Malaysia to 17% in Indonesia (Geddes 1992, Singleton & Petch 1994). Rat activities in rice field can cause damage right the early stage of newly sown or transplanted rice, rice stalk vegetative, grain filling, post-harvest to storage stages (Brown et al., 2017). Among the common rat species found in rice fields are *Rattus argentiventer*, *Bandicota indica* and occasionally *R. rattus diardii* especially near human habitation (Maisarah & Noor, 2019).

There are two suggested economic threshold level for rat damage in rice field; 4% tiller (Kishore & Rao, 2010) and 25% rice hill loss (Van Elsen & Van de Fliert, 1991). Typically, rat breeding dynamics in rice field follows the rice phenology; commences with maximum breeding from tillering to harvesting stage. The number of annual planting seasons also largely influenced the frequency of the rat breeding cycles. Rat pest population grows rapidly in response to conducive environmental conditions (Brown et al., 2017). There are wide range of rat pest management options in the rice field. These methods can be broadly categorised as chemical, biological, mechanical and cultural. These include trapping, barrier installation, habitat modification, rodenticide application, reliance on predators or propagation of one and repellent (Brown et al., 2017). The objective is to reduce crop loss due to rat activities.

The most widely used control method in the rice field is application of anticoagulant rodenticide. Anticoagulant rodenticide was formulated to overcome bait shyness. The mode of action is by blocking vitamin K that is essential for blood clotting. The rat succumbs to internal bleeding (haemorrhage) after several days ingesting the rodenticide. There are two generations of anticoagulants rodenticides available in the market; the first-generation anticoagulants rodenticides (FGAR) and the second generation anticoagulant rodenticides (SGAR). The difference between FGAR and SGAR is the former requires multiple feeding over a period until a sufficient quantity of poison has been ingested.

The anticoagulant rodenticide tested on rice field rat for FGAR are warfarin (Sarwar, 2015) and coumatetralyl (Atta *et al.,* 2018), while for SGAR are bromadiolone (Lam, 1985), difethialone (Saravanan *et al.,* 2003), brodifacoum (Sarwar, 2015) and flocoumafen (Lam, 1990). As for chlorophacinone, there is no study conducted so far on *Rattus argentiventer* in rice field. Recent rodenticide residual study showed chlorophacinone residue found in barn owl pellet was 17.2% - 27.4% only, lower than bromadiolone residue recorded at 27.2% - 34.5%; indicating chlorophacinone residue was retained for a shorter period in the rat tissue relative to bromadiolone (Salim *et al.,* 2014). Thus the risk of secondary poisoning to barn owl from chlorophacinone is lower compared to bromadiolone.

Based on the two points given above, the objective of this study is to evaluate the effectiveness between wax block and farmer standard practice of rodenticide chlorophacinone on rice rat, *Rattus argentiventer* in rice field. Wax block is a rodenticide bait formulated using 0.005% chlorophacinone and manufactured by FGV Agri Services Sdn. Bhd. for rat pest control and sold under tradename Butik S®. The wax block has been proven to be effective in controlling rat in oil palm plantation (Muhammad Idrus & Cik Mohd Rizuan, 2019). It is a relatively safe to be applied in combination with barn owl natural propagation compared to SGAR as the former poses less risk in terms of secondary poisoning effects to natural predator of rats (Badruladzha, 2012).

MATERIALS AND METHODS

FIELD EVALUATION OF DIFFERENT CHLOROPHACINONE RODENTICIDE IN RICE FIELD

The study was to evaluate the bait consumption between wax block, farmer standard practice and blank rice grain on rats in rice field. This study was conducted at Parit 13, Sungai Besar, Selangor (3°43'28.1"N 101°05'13.7"E). The trial started in April 2020, a week prior to rice planting. The rice variety was MR210 and planted by direct seeding or broadcasting.

There were three treatments i.e. wax block (0.005% chlorophacinone), farmer's standard practice (0.005% chlorophacinone) and control (blank bait) (Figure 1). Each treatment had three replicates; each comprised of a plot about 1.2 ha in size giving a total area of 3.6 ha per treatment. All the replicates had a buffer plot of 1.2 ha between each other. This buffer plot was used to eliminate the possibility of rat to eat multiple treatments during trial interval. All replicates had 80% - 90% of rat active burrow during pre-treatment assessment. Then all the treatments were randomly assigned according to Completely Randomised Design (CRD).

Treatment application was conducted by using the replacement round baiting (Wood & Fee, 2003). All the treatments were conducted after one week of pre-treatment and continued at weekly intervals until the bait consumption was less than 20% (Wood & Fee, 2003) or active burrow count dropped to within 5% to 10%.

For each replicate, a single unit of treatment bait was applied on the earth bund at 3 meter (10 feet) interval with a total of 28 baits. A single unit of wax block comes in 10g solid-wax rodenticide bait with concentration of 0.005% chlorophacinone. Wax block can withstand the elements in the environment, durable, conspicuous in the field and deliver the active ingredient efficiently to the target pest (Wood & Fee, 2003). For farmer's standard practice, a handful of the soaked rice grain represented a unit of bait (5 ~ 10g per unit). Farmer's standard practice is a bait that needed to be prepared by the farmer themselves. It is a rice grain soaked in liquid chlorophacinone formulation, whereby 1kg of rice grain was soaked in 20ml of 0.25% chlorophacinone mixed in 980ml of water for at least 24hrs. The final product had 0.005% chlorophacinone concentration. For control, a single unit of bait composed of 10g of untreated rice grain packed in a mesh bag.

Figure 1. One bait unit for each treatment, wax block (left), farmer's standard practice (middle) and control (right)

The assessment were bait consumption and active burrow counts. For bait consumption, missing or vacant bait at treatment point was considered as a sign of bait uptake by the rat. This assessment was conducted simultaneously with the treatment application on weekly basis as suggested by Wood & Fee (2003).

While for the active burrow assessment, all rat burrows entrance discovered on the assessment bunds were tagged and covered with mud or dirt by using trowel. Fresh or active burrows counts were based on the signs of breaching of the covered burrow openings on the following day. The breaching will leave a sign of freshly dug earth and uncovered burrow entrance. The freshly dug earth is usually in wet lumpy form with a size varies from 2 cm to 5 cm in diameter (Figure 2). The active burrow count then will be calculated into rat population abundance based on Metwaly *et. al* (2009) and Maisarah & Noor (2019) as follows:

$$\frac{\text{Total active burrow entrance}}{\text{Total number of burrow}} \times 100 = \% \text{ population}$$

Figure 2. Assessments of active burrow counts. Opening of covered burrow and sign of freshly dug earth indicated an active burrow activity.

DATA ANALYSIS

Percentages of bait consumption and active burrows on each treatments were statistically compared with one-way ANOVA and Tukey test for mean separation. All the statistical tests were conducted with the IBM SPSS version 20, IBM Corporation, Armonk, New York (Calvin, 2003). Appropriate variance structures were selected and a significance level of $P < 0.05$ was used throughout.

RESULTS & DISCUSSIONS

FIELD EVALUATION OF DIFFERENT CHLOROPHACINONE RODENTICIDE IN RICE FIELD

Through preliminary trapping, the major rat species identified at the study site is *Rattus argentiventer*. Its habitat is primarily cultivated areas, such as low-land rice field or *Imperata* grassland (Harrison, 1951). It is a medium-sized rat with wholly silver-grey belly in the midline with whiter flanks. It is often implicated for depredations on rice and field crops. Crowned as the most damaging rodent to rice crops. (Marshall, 1977; Leung et al., 1999). *R. argentiventer* has a more specialised diet as it is associated with rice fields and open grasslands (Singleton and Petch, 1994). It exacted around 5% of pre-harvest losses in Malaysia while 17% in Indonesia (Geddes, 1992; Leung et al., 1999).

Table 1 shows there was a significant difference on bait consumption between wax block, farmer's standard practice and control throughout the trial period. Wax block had the lowest bait consumption with 13.1 ± 1.2 compared to farmer's standard practice with 23.8 ± 1.2 and control with 90.5 ± 2.4 starting at 42DAA. Apart from that, wax block was also the fastest treatment to achieve bait consumption below 20% at 42DAA compared to standard practice at 49DAA. Consumption of bait reduced gradually in time due to the reduction in pest population in treated area (Mushtaq *et al.*, 2012; Atta *et al.*, 2018).

In this case, wax block had reduced rat population efficiently compared to the farmer's standard practice. In oil palm, the replacement round baiting reduced rat damage from 15% to 4% in 8 weeks (Wood & Fee, 2003). One of the reasons why the wax block is effective in rodent control is that it is a solid bait rodenticide using particulates of maize grain, supplement of oil palm and animal protein that is attractive towards rat (Wood & Fee, 2003) while preventing bait shyness (Brown *et al.*, 2017).

The application of a rodenticide mix by farmers is not based on a fixed protocol, with no standard measurements for the rodenticide mix which is perfectly understandable as they have no access to facilities or apparatus. In contrast, the commercially formulated bait comes as a standard product that can be readily applied under most weather conditions. Another drawback of the crude rodenticide mix is the liquid formulation can easily leach into the soil and the possibility of the bait turning stale from the reaction of the rice grain.

Rice grain bait was used in this trial to match the rat diet in rice field (Kamal & Hossain, 2003). As rat is naturally neophobic, it may possibly avoid any unfamiliar food, structure and surroundings (Barnett, 1958). High bait consumption of control throughout the trial indicated that the control plot had not affected by the rodenticides.

At 28DAA, all treatments had reduction in bait consumption maybe due to the fertilizer or herbicide application at the rice field. During this time, the workers will be moving along the bunds that treated with baits which disturbed the rat foraging activities. Based on personal experience in oil palm plantation, rat caught by using live trap will reduced significantly when conducted at area treated with herbicide.

Table 1: Percentage of bait consumption

Treatment	7DAA	14DAA	21DAA	28DAA	35DAA	42DAA	49DAA
Wax block	90.5 ± 7.8 a	50.0 ± 5.5 a	31.0 ± 3.1 a	19.1 ± 2.4 a	21.4 ± 2.1 a	13.1 ± 1.2 a	11.9 ± 1.2 a
Standard practice	92.9 ± 4.1 a	63.1 ± 6.3 ab	39.3 ± 4.1 a	21.4 ± 2.1 a	26.2 ± 3.1 a	23.8 ± 1.2 b	19.8 ± 1.2 b
Control (blank)	84.5 ± 2.4 a	75.0 ± 4.1 b	72.6 ± 3.1 b	37.3 ± 8.6 b	82.1 ± 2.1 b	89.3 ± 2.1 c	90.5 ± 2.4 c

Note: Means in column with different letters are significantly different at P < 0.05 (by One-way ANOVA and post hoc by Tukey test).

Table 2 showed that both wax block and farmer's standard practice were able to reduce the burrow activity to 7.4% and 7.3%, respectively at 49DAA compared to control at 49.7%. The control result can be compared to the result from a study by Maisarah & Noor (2019) in Jitra, Kedah, where non-treated rice field area recorded high active burrow i.e. 30%. Active burrow counts reflects the current rat population status whether any control measures are effective or otherwise.

Mostly rat burrow in rice field had single entrance based on data provided by Nolte *et al.* (2002). From here we can conclude that all the burrows were occupied by different rat family and reduction in active burrow directly proportional to the reduction in rat population.

Table 2: Percentage of active burrow on different treatments

Treatment	PRE	7DAA	14DAA	21DAA	28DAA	35DAA	42DAA	49DAA
Wax block	81.7 ± 1.8 a	66.2 ± 4.2 a	30.3 ± 3.2 a	19.3 ± 2.4 a	9.4 ± 0.4 a	9.8 ± 0.8 a	8.2 ± 0.6 a	7.4 ± 0.2 a
Standard practice	87.0 ± 5.1 a	66.0 ± 4.1 a	27.9 ± 4.8 a	13.7 ± 2.1 a	7.6 ± 1.4 a	8.0 ± 0.5 a	7.6 ± 0.3 a	7.3 ± 0.1 a
Control (blank)	92.7 ± 3.2 a	65.5 ± 6.0 a	56.3 ± 3.5 b	50.5 ± 2.3 b	47.6 ± 2.2 b	48.7 ± 2.1 b	49.4 ± 1.8 b	49.7 ± 1.6 b

Note: Means in column with different letters are significantly different at P < 0.05 (by One-way ANOVA and post hoc by Tukey test).

Previous literature stated that frequency of multiples rats found in burrow increased at post-harvest stages (Nolte *et al.,* 2002). Another literature stated a total of 14,158 rats had been caught in 2 sites during 2001 dry season in Indonesia (Singleton *et al.*, 2005). Despite the high rat population and infestation, rice field yield can improve from 2.5 tonne/ha to 4.4 tonne/ha through effective control. Extra yield from effective control worth 250 usd while rodenticide application cost is only 2 usd, this mean farmer gets extra cash when investing on proper rodenticide application (Wood & Fee, 2003).

Based on the previous literature above, wax block is recommended in rice field application for two campaigns per season at two weeks before planting and two weeks before the booting stage based on the level of fresh damage to the plant was more than 5%. The baits are placed along the bunds at 10-15 m apart at weekly intervals until the bait acceptance drop to below 20% or the rice plant damage below 5%. Notably, the baiting rounds should stop when the active burrows decrease to less than 10%.

The usage of 0.005% chlorophacinone wax block to control rat infestation in rice field is the best approach for the farmer. It provides huge profit returned while providing a safer environment to the barn owl, human and other mammals with just a minimal additional cost needed. This product will be registered under SIPP (Skim Insentif Penanaman Padi), which is a subsidized scheme provided by the government. Product registered under this scheme will have lower price, which mean can be afforded by the farmer.

CONCLUSION

0.005% chlorophacinone wax block showed better performance in rodenticide consumption, this product able to reduce the rat population faster than the farmer's standard practice of using rice grain. The wax block had been proven to effectively deliver the poison under the field condition. Besides, the wax block has not showed any neophobic issue and it is palatable for the rat pest in the rice field. Apart from that, wax block is user-friendly, less-toxic to the natural enemies as compared to SGAR, have minimal cost and can provided huge returned to the farmer.

ACKNOWLEDGEMENT

We would like to express sincere thanks to Amco Niaga Sdn Bhd for the collaboration on conducting this research. A token of appreciation to the late Allahyarham Sukri Taib Ismail on his contribution for the previous rodenticide project in rice field. Many thanks to Dr. Then Kek Hoe, Head of Operation and En. Noor Hisham Hamid, CEO of FGV (R&D), for their comments and approval to publish this paper.

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