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# Application of Trap Barrier System combined with cage trap for controlling rats in rice field

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## Abstract

*Rice-field rat is a main pest of rice. Yield reduction caused by rat is quite high, because rats attack rice plant at all stages. One of the efforts applied to control rats is by using Trap Barrier System combined with cage trap. The objective of this research was to identify species of rat attacking rice plants and investigate the presence of rat by their footprints. The experiment was conducted in Jalur 6 Village Sumber Mulya, Sub-district Muara Telang, District Banyuasin, South Sumatra. One hectare of farmer's rice field, divided into 3 sub-plot. Each sub-plot was planted with variety paddy of Inpari 22 (sub-plot A), Inpari 33 (sub-plot B), and Inpari 43 (sub-plot C). The number of cage traps was 6 traps per sub-plot. Observations were made 7 times, with an interval of 10 days. Results showed species of trapped rats in the research area was Rattus argentiventer, in which number of males was higher than females. Morphologically, the size of males were bigger than female. Number of footprints did not reperesentative the number of trapped rats. Inpari 43 variety was more preferred by rats because damage intensity was the highest than other two rice varieties.*

*Keywords : Cage trap, footprints, Trap Barrier System (TBS), rodent.*

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## 1. Introduction

Tidal land is a land where water is fluctuated influenced by rise and fall of sea level, while swampy land is a land where water conditions depends on rain [1]. Tidal land has high potential to be used as productive agricultural land, especially in the context of food self-sufficiency [2]. If tidal lands are well managed, their productivity is comparable to that of other agricultural lands[3]. Rice is a strategic food commodity for which its production needs to be increased to meet the population growth rate, in relation to dependence of people on rice as their staple food [4].

Rat is an omnivore animal, a pest of almost all of staple, perennial, and horticultural crops [5]. Damages of rice crop caused by rat could be found almost every province in Indonesia [6]. In Indonesia, there are more than 150 identified rat species belong to 48 genus and more than 150 species [7] [24] [25]. Nine species has been identified as potential pest of rice crop [8]. Rice-field rat (*Rattus argentiventer* Rob & Kloss) is well known as important pest in Indonesia [7]. According to [8] the dominant species of rat living in rice cultivation areas is Rattus argentiventer .

As one of main pests of rice, rice-field rat is the most damaging pest in every crop season [7]. The slivering behaviour of rat causes more serious damages and results in five folds more serious damages compared to their feeding capacity [9]. The attack of rat at generative stage causes fatal damages because the crop cannot recover to make new tillers [7]. In District Tulungagung East Java province, in 2011, the total of rice field was 25 thousand hectares, in which 80 hectares failed to harvest because of rat invasion [10].

One of innovations in controlling rice-field rat is by using trap barrier system (TBS) [11]. The cage rat trap commonly be used was made from bamboo or wire [12]. The combination between cage trap and TBS has been implemented as rat control technology which effectively

caught high number of rats [9] [23]. The use of trap is an alternative control method which is considered to be safer for wild animal and environment [12]. The use of TBS to control rats has been popular in some countries such as Australia, Indonesia, Philippines, Vietnam, and China 13 [13].

The TBS trap start attract rat since the beginning of trap placing and continously throughout rice growing season 14 [20]. According to Kanwal et al (2016) application of TBS has been able to reduce number of rat nest in maize cultivation areas in Punjab, Pakistan [13]. The use of TBS was also considered to be more efficient and able to control rice-field rat in Bangladesh [10]. TBS is recommended as a component to be integrated in the integrated control of rat in endemic areas with high population [14]. The objectives of research were to investigate species and number of rats attacking rice field, morphological characteristics, their footprints and rice damaged caused by rats.

## 2. Materials and Methods

Research was carried out in Jalur 6 Village Sumber Mulya, Muara Telang Sub-district, Banyuasin District, South Sumatera Indonesia (104º 53' 16.3" and -2º 34' 30"). The research was started from November 2017 until January 2018.

The experiment was conducted in one hectare of farmer's rice field, which were devided into 3 sub-plots with a size of 100m x 10.033 m for each. Each sub-plot was planted with Inpari 22 (sub-plot A), Inpari 33 (sub-plot B), and Inpari 43 (sub-plot C) varieties. Variety of paddy was used as tretatment because it was assumed that rats will choose one variety among other varieties.

The number of rat traps was 6 traps per sub-plot resulted in 18 traps per hectare. Observations were done 7 times with 10 days of interval, and each observation took 3 consecutive days. The observations were made at 30, 40, 60, 70, 80 and 90 days after planting, respectively. Each observation (rat population, rat footprints, and plant damage) was carried out for 3 consecutive days.

### 2.1 Land preparation.

Land management was done by plowing the land at 25-30 cm deepness. After being plowed, water trench of 50 cm width, was made surround the plowed land. The seeds to be planted were soaked in water for 48 hours. The soaked seeds were then placed in porous sack and put in humid place for 24 hours. Before planting the seeds, plastic fiber of 60 cm height was set up on the trench surrounding the planting area, supported with bamboo sticks at an interval of 1 meter.

The lower end of the plastic fiber was set to be in the water to prevent rats entering rice planting area. Rice seeds were planted using drum seeder with spacing of 20x20 cm. However, after planting the seeds, there was heavy rain during the night and disturbed the plant spacing. Fertilizers were given three times, i.e. at 7-15 days after planting, with 150kg NPK and 150 kg urea; at 25-30 days after planting with 100 kg NPK and 50kg urea; and at 40-45 days after planting with 100 kg urea and 125 kg NPK.

### 2.2 Rat trap establishment.

Cage traps (40 cm x 20 cm x 20 cm) made from chicken wire were placed in previously determined places. They were placed in the morning, and in the evening it was put mud on rat-bridge previously layered with plastic sheet. First observation was made in the following day (24 hours after trap placement). All cage traps were collected and the cage trap doors were closed during observation.

Trapped rats were killed by sinking the cages containing rats into water for 10 minutes. All dead rats were collected and the empty traps were placed again in their original places. The identified rats were buried. Observation was done according to previously determined time interval

### 2.3 Counting the number of rice plant samples damaged or consumed by rats.

There were 15 sample sub-plots in the plot area of 1 hectare, five sub-plots of 1 x 1 m from each of the three rice varieties planted. All of the 15 sample sub-plots were taken purposively 15 [25]. Calculation of damage intensity was done by using following formula:

$$p = \frac{a}{b} \; x \; 100\%$$

where:
P = Percentage of damage plants
a = Number of plant attacked in a sub-plot
b = Number of plant per sub-plot

### 2.4 Rats Identification

The trapped rats were identified by using rat identification key according to Aplin et al (2003) [16] and Chaval (2011) [17], based on the following criteria:

1. Total body length (PT): the length from end of nous to the end of tail, ventral measurement.
2. Length of head and body (BK): total length minus tail length.
3. Tail length (E): measured from anal based to tail end.

4. Length of ear (T): measured from ear base to the far end of the ear.
5. Body weight (B): measured using weighing scale.
6. Number of nipples
7. Hair color (back, chest, ears)
8. Counted the number of male and female rats.

**2.5 Observation of rat footprints:**

1. Cover rat-bridge, previously layered with plastic, with mud.
2. Observing rat footprint in the morning a day after trap placement, by counting the number of rat foot-print and taking the photograph.
3. In the next evening, the rat-bridge was covered with mud again.

Data of rat population, footprint, crop damage and paddy production was analysed descriptively and presented in table form.

## 3. Results and Discussion

**Number of trapped rats**

Number of trapped rats was found 214 individues. The average trapped in both varieties of Inpari 43 and Inpari 33 was 12.2 individues while in variety of Inpari 22 was 6 individues (Table 1).

Table 1. Number of trapped rats in each rice variety

| Observation | Number trap rats (individues) in Rice Variety | | | Total |
|---|---|---|---|---|
| | Inpari 43 | Inpari 33 | Inpari 22 | |
| 1 | 1 | 0 | 3 | 4 |
| 2 | 1 | 0 | 2 | 3 |
| 3 | 2 | 7 | 2 | 11 |
| 4 | 7 | 7 | 5 | 19 |
| 5 | 34 | 36 | 13 | 83 |
| 6 | 31 | 31 | 11 | 73 |
| 7 | 10 | 5 | 6 | 21 |
| Total | 86 | 86 | 42 | 214 |
| Average | 12.2 | 12.2 | 6 | |

Number of trapped rats in earlier time of trap application was quite low, but it was increasing along the change of rice growth stage. The highest number of trapped rats was at flowering stage (5th observation), followed by ripening stage (6th observation).

According to [22], the highest number of trapped rats was occurred at flowering stage. Early fruiting stage until milky ripening stages was a period of rice stages preferred by rats, because rice released aromatic fragrance, and the rice'grain are still soft [18]. In the fruiting stage, besides releasing aromatic fragrance, carbohydrate contained in the panicles was under transition from liquid to solid, and it was highly preferred condition by rats [12].

Application of Trap Barrier System (TBS) combined with cage trap could reduced number of rats attacking rice and suppressed its population growth. The number of rats trapped during the experiment was 214 individues. If TBS was not established in rice cultivation area, those rats would definitely invade the cultivation area, and such number of rats could cause harvest failure.

The varieties rice cultivated (i.e. Inpari 43, Inpari 33 and Inpari 22) were early ripening varieties and harvesting at 110 days after planting [19]. Among of those varieties, varieties of Inpari 43 and Inpari 33 were more preferable to rats. This could be seen from the percentage of trapped rats in these two varieties could reach 40%while in Inpari 22 only 20% (Figure 1).

Number of trapped rats was higher because this experiment was conducted in the first season of rice cultivation. No rice field in surrounding experimental location. Farmer in this area usualaly only cultivate rice only once due to water limitation. Therefore, when farmer try to cultivate rice in the second season, they will face obstruction in producing rice, in which rats were the most important one. Eventhough local goverment suggested to do twice rice cultivation every year, farmer did not do that because of no any economically benefit from their effort (personal communication with famers in Jalur 6 Village Sumber Mulya).

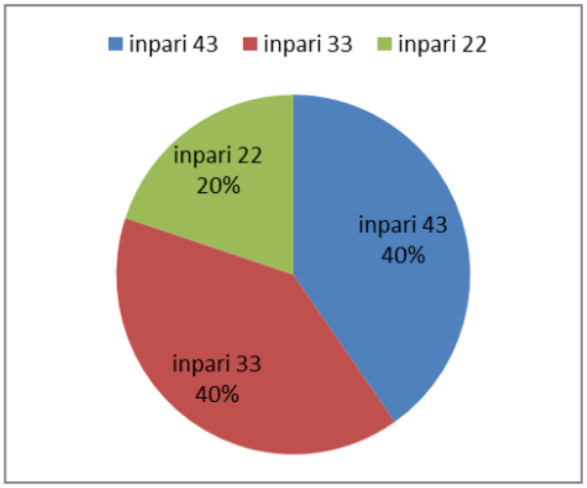


Figure 1. Percentage of trapped rats in each rice varieties

Besides counting total number of trapped rats, they were also grouped according to their sexual identity. Number of male trapped rats was 118 individues, while female was 96 individues (Table 2).

Table 2. Number of male and female rats trapped in each rice variety

| Sexual category | Number of trapped rats (individues) | | | Sub-total |
|---|---|---|---|---|
| | Inpari 43 | Inpari 33 | Inpari 22 | |
| Male | 51 | 42 | 25 | 118 |
| Female | 35 | 44 | 17 | 96 |
| Total | 86 | 86 | 42 | 214 |

Number of trapped rats from the first to the last trapping were dominated by male rats. Among of all trapped rats, more than half were male, 55% male and 45% female (Figure 2). In the world of rodents, there was a job decription between males and females. Males were looking for food for other member of family and for himself while females were staying at their nest to take care their off springs [17] [22].

Male rates dominated the trapped rats because male rats were more active in looking for spouse and feed compared to female rats. Male rats also like to collect their feed in their nests. This is done to avoid their natural predators such as snake, eagle and owl [12]. Therefore, in this experiment number of males found in rice field was higher than females.

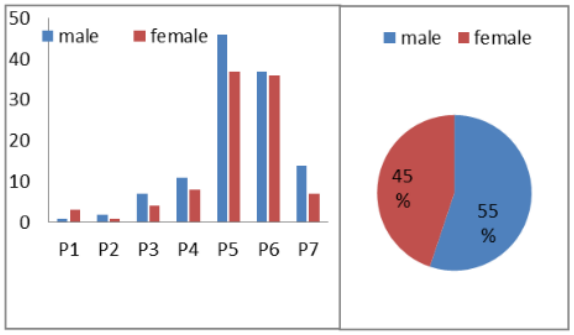


Figure 2. Number of trapped rats trapped over 7 observations in the first cropping season. (A). Number of male and female of trapped rats, (B). Percentage of male and female rats

The highest number of trapped males was found in the late fruiting stage (5th observation). In milky ripening stage (6th observation) number of males and females rats were similar (Figure 2A). In these two phases of growth, female rats started to come to reproductive phase and they spent more time in the nests making female rats consume less feed than males.

This is in accordance to Sudarmaji which stated rice-field rats reproduce mostly at the reproductive stage of rice plants. One female could reproduce three times in one cropping season and was able to produce 30 young mice. Five females from the first reproduction would reproduce 50 young mice, therefore in one cropping season, an adult female could produced 80 progenies [19]. Among of trapped rats in this research, 96 individues were females (Table 2). If one female could produce 80 progenies in one season, the trapped female rats would have produced 7,680 progenies. Such number of rats would be able to cause harvest failure of thousands hectares of agricultural fields.

**Morphological characteristic**

The trapped rats were identified based on morphological characteristic according to [17] i.e.: medium in size, yellowish brown of dorsal color with black dots on hairs, silvery white to grey of ventral color, dark brown of tail color, female rats have 12 nipple or 6 pairs with nipple position as: 1+2+3, orange tassel in front of young rat ears, usually this color fade away as the rats getting older.

The length of head and body was 130-230 mm and the length of tail was 110-160 mm [7]. Based on the above characteristics, it could be determined that species of trapped rats in the experimental area was Rattus argentiventer. Other morphological characteristics can be seen in the following table (Table 3):

Table 3. Morphological characteristics of maleand female rats trapped in application of TBS and cage trap in various rice varieties.

| *Rattus argentiventer* | Male (n=118) | Female (n=96) |
|---|---|---|
| Weight (g) | 156.5 ± 41.9 | 105.2 ± 25.4 |
| Total length (cm) | 35.9 ± 2.8 | 32.9 ± 2.4 |
| Length of head-body (cm) | 18.6 ± 1.8 | 16.7 ± 1.3 |
| Length of tail (cm) | 17.2 ± 1.7 | 16.2 ± 1.2 |
| Length of front legs (cm) | 2 ±0.10 | 1.9 ± 0.10 |
| Length of rear legs (cm) | 4 ± 0.16 | 3.8 ± 0.2 |
| Length of ears (cm) | 2 ± 0.06 | 1.9 ± 0.07 |
| Length of head (cm) | 5.3 ± 0.3 | 4.9 ± 0.3 |

It can be seen in Table 3 the average weight of males was higher than that of females. Male rats had average weight of 156.5 g, while female had the average weight of 105.2 g. This might be because the coverage area of male rats is wider than that of the female. Male rats are more active in looking for feeds. While female rats tend to spend more time in their nests when rice entering generative stage. This also in accordance with [12] who stated that female rats are spend more time in the nests to give birth, breasting, and go out only once in a while to

look for feeds.

Rat species distribute over low altitude in South Thailand, Cambodia, and Vietnam, along Mekong River to South Laos, and along Malaya Peninsula, also almost in all big islands in Indonesia such as Sumatra, Sumatera, Java, Kalimantan, and Sulawesi. The rat species are also found in Papua New Guinea, and in islands of Cebu, Luzon, Mindanao, Mindoro, and Negros in the Philippine [17].

**Rats foot prints**

Rat foot print was also important to be observed. With the presence of rat footprint on the rat bridge indicated there were efforts from rats to enter to rice cultivation area to look for feed. The highest number of rat footprints was found in the first observation when rice cultivation was at vegetative stage (Table 4). The highest number of foot print was found in Inpari 33 variety, i.e. 604 footprints, while in Inpari 43 and Inpari 22 were 307 and 324 footprints, respectively. In the next observations, the number of footprint varied. In Inpari 33 variety, 4th observation was showed no footprints of rats. It was predicted that there was no rats pass the mud bridge or because of bad weather (Table 4).

Table 4. Number of rat footprints found during seven observations in each rice variety

| Variety | Number of footprints during observation | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Inpari 43 | 307 | 77 | 208 | 588 | 370 | 122 | 186 | 1858 |
| Inpari 33 | 604 | 180 | 338 | 0 | 39 | 271 | 159 | 1591 |
| Inpari 22 | 324 | 116 | 195 | 124 | 54 | 75 | 250 | 1138 |

Number of rat footprints counted in the three rice varieties was quite different. The highest total number of foot print was found in Inpari 43 ie 1858, followed by Inpari 33 and Inpari 22 with number of footprint were 1591 and 1138, respectively (Table 4).

The number of rat footprint counted was influenced by weather conditions when observation was conducted. Basically, rat footprints can be easily seen if the place was covered by mud or dust [20] [26]. This research was conducted during cropping season Rojo (first cropping season) and the observations were conducted from November to January, during rainy season, and there was Super Moon phenomenon which cause very high rise of sea level.

This situation greatly influenced the counting of rat footprint, because heavy rain erased the footprint, and high rise of sea level cause the rat-bridge 2 submerge and make rat footprint disappear. High number of rat footprints did not indicate high number of caught rats, because the number of rat footprints counted was not comparable to the number of trapped rats.

In some cases it was found a lot of footprints in mud-bridge but no rat was trapped, in contrarly, there were only few footprints on the bridge but a lot of rats were trapped. This because female rats have smaller coverage of activities than male rats, female rats would only look for feed around their nests [21]. Such activities cause a lot of footprints made on the set rat-bridge.

**Rice damaged by rats**

Rice damage observation was showed in Figure 3. In the first observation, no damage was found. At the time rice plant was still small and this was not attracted to rats. The first damage was noticed during second observation in Inpari 43 variety. The severest damage was found during the third observation, followed by the fourth and fifth observations and was seen in Inpari 22 variety. At sixth observation, no new damage was found in sample plots. It was predicted at that time, rats attacked rice plant outside the sub plots.

The observation of damages caused by rat was conducted in 5 sub-plots of each rice variety. Each sub-plot showed different damage intensity (Figure 3a). It can be seen that the highest damage intensity was occurred in sub-plot 5 compared to the other four sub-plots.

Total damage intensity in Inpari 43 variety was more than 6%, while in Inpari 33 and Inpari 22 varieties, damage intensity were less than 5% (Figure 3b). Inpari 43 variety was more preferable variety to rat compared to other two varieties due to high damage intensity suffered by Inpari 43. According to [15], economic threshold of rats in rice field is >5%. If damage has reached more than 5%, the pest should be controlled [15].

A

B

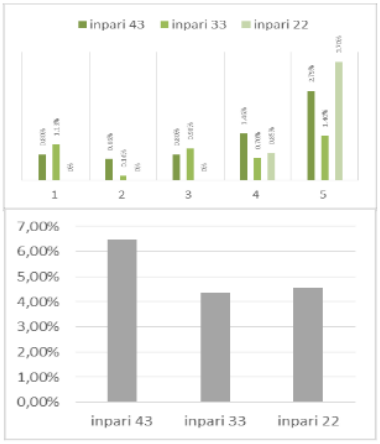


Figure 3. Damage intensity caused by rat per 7 observations in each rice variety.
A. damage intensity per sub-plot per variety,
B. total damage intensity per variety.

## 4. Conclusion

The species of trapped rats in the research area was *Rattus argentiventer*, in which number of males was higher than females. Morphologically, males were bigger than females. Number of footprints did not reperesentative the number of trapped rats. Inpari 43 variety was more preferred by rats because damage intensity was the highest than other two rice varieties.

## 5. Acknowledgement

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