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RICE AS A TRAP CROP FOR THE RICE FIELD RAT IN MALAYSIA

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ABSTRACT: The potential of rice as a trap crop for the rice field rat, Rattus argentiventer. was clearly illustrated by the studies conducted in 60.7 ha of newly rehabilitated rice land in Pcrmatang Pauh and in the MARDI Research Centre's rice fields in Bumbong Lima. The rice crop was very attractive to the rats, especially at the reproductive phase. The combination of a physical barrier and traps was very effective in exploiting rice as a trap crop for rice field rats. The trapping patterns indicated a massive influx of rats from the surroundings for a period of three weeks in Permatang Pauh and of a lesser degree in Bumbong Lima. In Permatang Pauh, adult male rats caught ranged in weights of 116-293 g and females 85-230 g. Very few subadults were caught, only 2.3% or 35/1550 measured, whereas in rice fields cultivated continuously, young and adult rats were caught (84 adults to 116 young, or 58% of the rats caught were subadults and juveniles) as in the case of the population in Bumbong Lima. The sex ratio in the Permatang Pauh population showed a preponderance of males in the first two weeks but eventually more females appeared in the 4th and 5th week. The overall sex ratio was 1236 males to 1107 females (a ratio of 1.12:1), which did not depart from the expected ratio of 1:1. The total number of rats caught was 2343 in the first season but in the second season only 24 rats, 22 R. argentiventer (16 males and 6 females; sex ratio of 2.7:1) and a pair of Rattus rattus diardii were caught in Permatang Pauh. In the Bumbong Lima population, the sex ratio for adults was 37 males to 47 females (0.7:1) and in the young 75 males to 41 females (1.8:1). Rats were attracted to the crop only when the adjacent areas were harvested and, as the crop in the surrounding areas matured, the number of rats caught declined and reached zero at the booting phase. Rice at the early reproductive phase is an effective lure for the rice field rats and thus could be used as an efficient trap crop for its control.

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INTRODUCTION

The utilization of trap crops for pest and disease control had been very successful in some agricultural situations (van den Bosch and Messenger 1973, van Emden 1980, Stern 1981, Martin and Woodcock 1983). In plant disease control, trap crops are species of plants which are highly susceptible to a pathogen of a primary crop and are planted so as to be attacked by the pathogen at an appropriate time, and both the trap crop and the pathogen are then destroyed in a single operation, leaving the primary crop relatively free from attack by the pathogen (Leach 1981). In the case of insects, plants attractive to insect pests are effective lures. The plants preferred by the insects are planted between rows of the crop or at the field edges and the trap plants, when infested, are collected and destroyed as in the case of plant disease control, or left to prevent the crop proper from being attacked (Martin and Woodcock 1983). Alternatively, the insect pests concentrated onto particular small areas of a field by trap crops can be destroyed with locally applied insecticide (van Emden 1980). The principle of trap cropping had been particularly successful in the control of plant nematodes (Leach 1981). The rice field rat, Rattus argentiventer (Robinson and Kloss), is a serious pest of rice, Oryza sativa L. (Lam 1982). Conventional methods of chemical control are extremely difficult and ineffective in situations where there is a large sudden influx of rats from the uncultivated areas. In such situations, an efficient trap crop, which enables the effective removal of the invading rats, could overcome the massive rat depredation and complete crop loss. This paper examines the potential of rice as a trap crop for the control of R. argentiventer in peninsular Malaysia.

MATERIALS AND METHODS

Study 1

This study was conducted in a 60.7 ha block of abandoned rice field, rehabilitated for the first time after being idle for several years in Permatang Pauh, Seberang Perai, Peninsular Malaysia. This block of fields was within a contiguous area of about 320 ha of abandoned rice fields. The rehabilitated area was planted with 40.5 ha of Sekembang (Blocks C, D, E, and F) and 20.2 ha of Makmur (Blocks A and B). Cultivations of the fields started on August 1985 and the first field was transplanted on 12 September 1985 (Season I). Systematic rat control measures were carried out in the planted area and its periphery where chemical control and field sanitation were practiced. The cultivated area was divided into six blocks and a plastic fence of 0.3 mm thick polyethylene at a height of 45 cm was erected for each block (Fig. 1). The construction and design of the plastic fence and the placement of the trapping device are as shown in Fig. 2. A trapping device (Fig. 3) is then placed at various points within the fence and the trap-sites are as indicated in Fig. 1. The fence and traps were in place when the crop in the whole block was at an average age of 46 + 6 (mean± S .E.) days after transplanting (DAT). The oldest crop (Block A) was 66 DAT and the youngest crop (Block E) was 28 DAT. A total of 39 traps were set, trapline A--12, trapline B-6, trapline C--10 andtraplineD--ll traps (Fig. 1). The fence and the traps were examined daily. Any breakage in the fence was mended. Rats caught daily were sexed and recorded in the field. Rats that survived the journey back to the laboratory were measured and sexed. Standard physical measurements were made in millimeters and the weight in grams, respectively. The fence and traps were removed at harvest.

The above study was continued in the following season (Season II) with the same 60.7 ha planted with the varieties MR84 and MR85. MR84 was direct-seeded in Blocks A, B, and C, covering an area of 26.7 ha and MR85 was transplanted in Blocks C, D, E, and F, covering an area of 34 ha (Fig. 1). Part of Block C, 4 ha, was transplanted. The first field (Block C) was direct-seeded on 28 March, Block B on 30 March and Block A on 1 April 1986. Blocks C, D, E, and F were transplanted, starting on 10 April and completed on 26 April 1986. During crop growth rat control measures were carried out in the cultivated area and its periphery as described for the first season. The plastic fence was erected and traps were placed when the earliest crop was 97 days after sowing (DAS) on 3 July 1986. Daily trap records were made and any breakages in the fence were repaired. A total of 26 traps were set, trapline A-8, trapline B-7, trapline C-5 and trapline D-6 traps. The fence and traps were removed at harvest. Data were collected as described in the first crop season.

Study 2

This study was conducted at the research fields of MARDI Research Centre, Bumbong Lima, Seberang Perai. The study area comprised of 0.5 ha, which was planted with six crop stages at any time of the year, i.e., fallow, 5 DAS, 69 DAS (young ear formation), 95 DAS (heading), and ripening, is part of a block of 14.5 ha of rice fields. The planted area was 0.35 ha and each crop stage comprised of 0.06 ha and the variety planted was Kadaria. A plastic fence with a trapping device (as indicated in Study 1) was set up on 3 March 1986. The layout of the crop stages in the study area and the traps are given in Fig. 4. At this time (3 March 1986) the surrounding fields (14 ha) were being harvested, including the adjacent 15.6 ha rice fields of the Department of Agriculture. A total of 6 traps were set and the trap sites were numbered 1-6 (Fig. 4). The fence and the traps were examined daily and any breakage in the fence was mended. The number of rats caught daily was recorded and the rats were then sexed and measured. Trapping was discontinued on 5 August 1986, after a period of 2 weeks. Rat control measures were carried out in the fields adjacent to the study area at the start of the crop season. The fields were baited with 0.05% warfarin wax-cubes as soon as half the 14.5 ha rice land was transplanted or sowed. Baits were applied at weekly intervals for 8 weeks at the rate of 60 bait points per ha. At the flowering stage, all rat burrows were treated with 20 g of 0.5% warfarin dust.

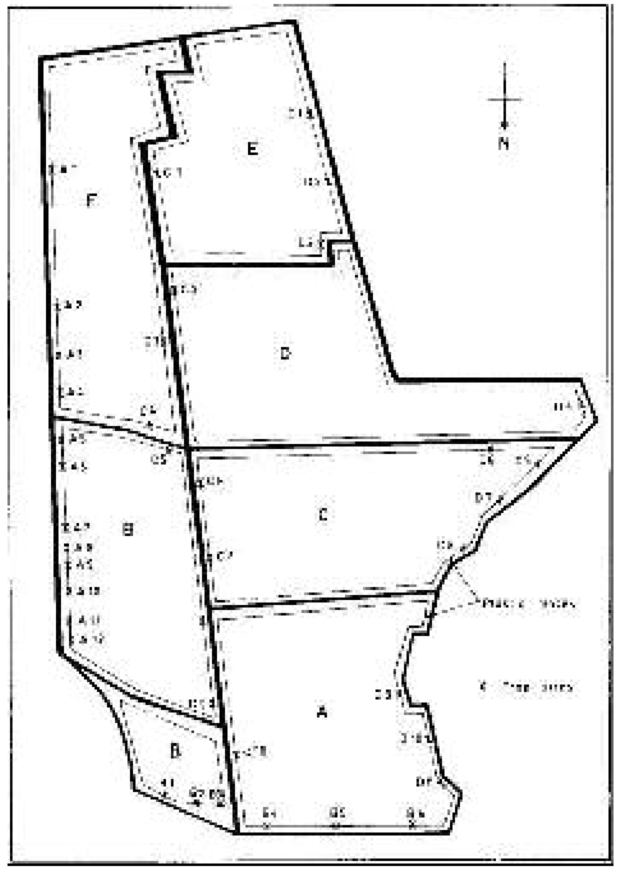

Fig. 1. The fenced rice crop at Permatang Pauh and the trap sites of trap-lines A, B, C and D (Season I).

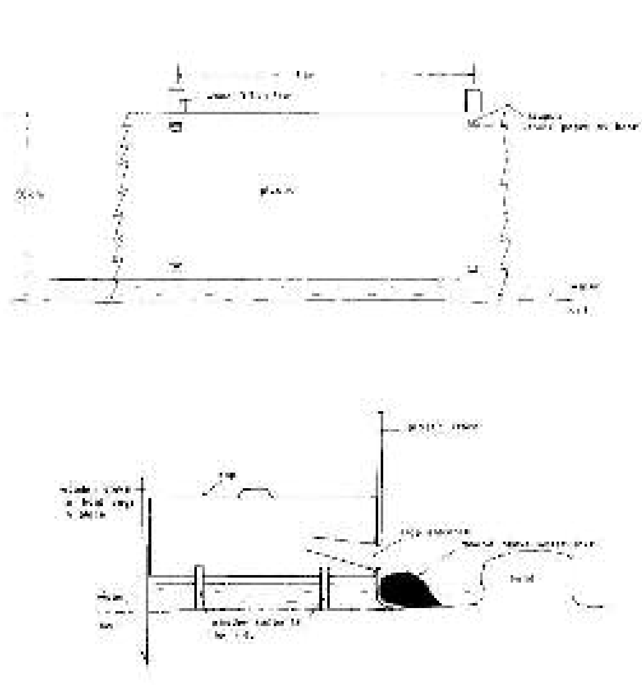

Fig. 2. Design and construction of the plastic fence and the placement of the trapping device.

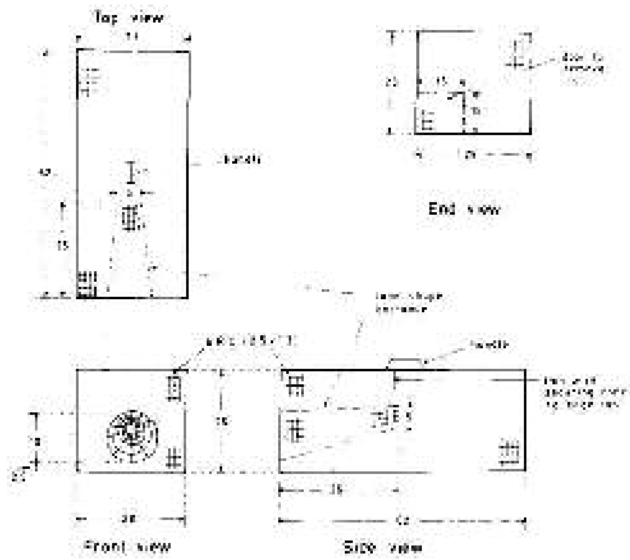

Fig. 3. Design of the trap (All measurements are in centimeters).

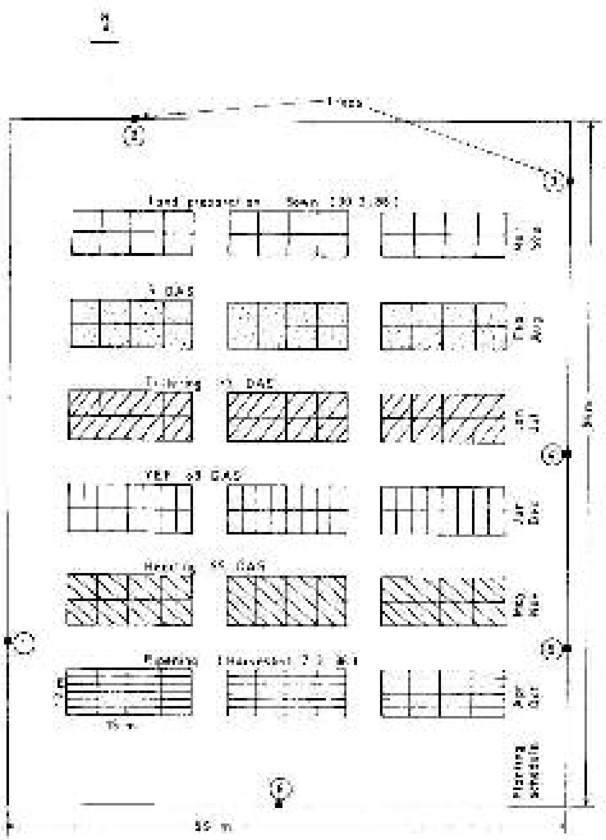

Fig. 4. Crop stages within the rat-proofed rice plot of 0.4956 ha at 5th March 1986 and trap placements. (The planted area was 0.3456 ha and at any one time, 0.0576 ha of the same crop stage was present. The variety planted was Kadaria; DAS - days after sowing, YEF - young ear formation).

RESULTS

Study 1

Trapping pattern: The trapping pattern of R. argentiventer over a two month period during Season I in the 60.7 ha study area is given in Fig. 5. The number of rats caught peaked on the 13th day and the number caught at this first peak was 142 (73 males and 69 females). There was a second peak one week later on the 20th day and the number caught was 128 (66 males and 62 females). The trough between the two peaks was 76 (Fig. 5). After the second peak, the number of rats declined quite rapidly to 26 on the 28th day. From day 28 to 38, the number fluctuated between 18 to 33 rats and from day 39 onwards, the number of rats caught was 10 and below. The trapping pattern did not show any correlation with rainfall (Fig. 5).

Total number of rats caught in the first four weeks was 1953 (243 in the first, 645 in the second, 675 in the third, and 390 in the fourth week) and this comprised 83.4% of the 2343 rats caught over two months. Trapping successes of the four traplines are given in Table 1. Trapline A accounted for 51.4 % of the rats caught during the first month of trapping and it had also the highest mean number of rats caught per trap (Table 1). The number of rats caught per trap per day ranged from 1 -25 and the total number caught per trap for the study period ranged from 2-224.

Table 1. Mean number of rats caught per trap and total number of rats caught at each trapline during the first four weeks in the Permatang Pauh study area (Season I).

Trapline	Mean + S.E./trap	Total rats trapped	% of total trapped
A	5.02 ±0.28 (1-23)	1003	51.4
B	3.51 ±0.30 (1-14)	390	20.0
C	2.36 ±0.18 (1-9)	229	11.7
D	4.94 ± 0.54 (1-25)	331	16.9
Total		1953*	100.0

* This constitutes 83% of all the rats caught during Season I in Permatang Pauh.
0 Figures in parentheses denotes range in number of rats caught per trap.

After the third week of trapping, snakes began to appear in the traps but none were caught after the 30th day (Fig. 5). The species of snakes commonly caught were the Indo-Chinese rat snake, Pytaskorroskoros (Schlegel); the copper-head racer. Elaphe radiata (Boice): the common cobra, Naja naia sputatrix Boie; the triangle keelback, Natrix trianguligera (Boie) and less frequently, the reticulated python, Python reticulatus (Schneider).

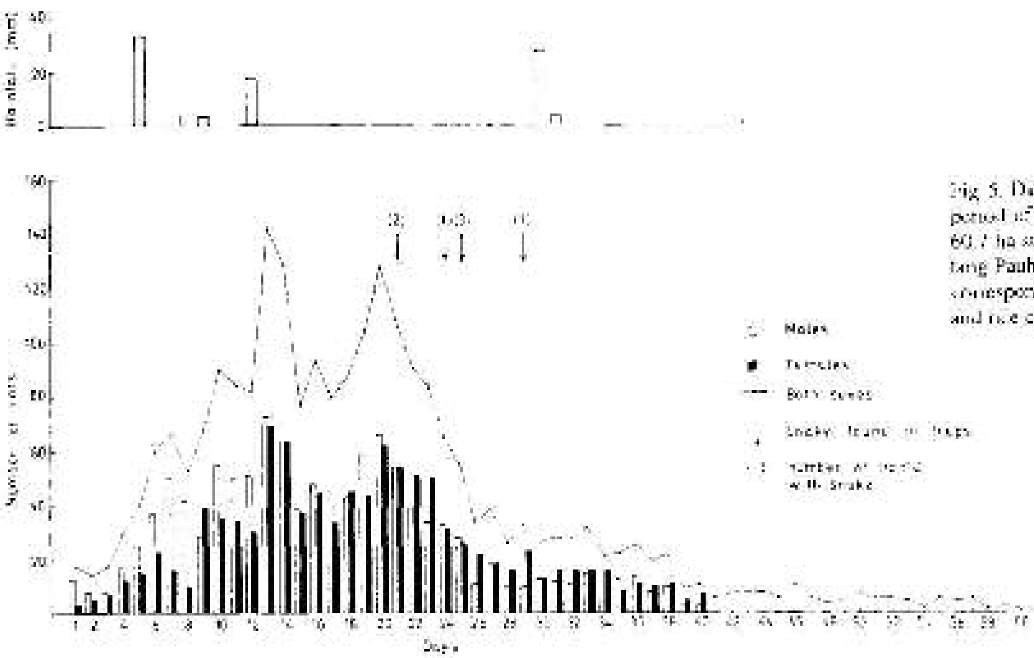

Fig. 5. Daily rat catches over a period of two months in the 60.7 ha study area in Permatang Pauh (Season I) and the corresponding rainfall pattern and rice crop phase.

In Season II, the trapping pattern did not show a massive influx of rats from the adjacent areas. Daily capture did not exceed five rats and a total of 22 R. argentiventer and two Rattus rattus diardii (Jentink) were caught. Five snakes, three cobras, and two copperhead racers, were caught in the traps.

Population structure: The population structure of rats caught inSeasonIconsistsof35subadults, 14malesand21 females, out of 1550 rats measured. Mean weight of male subadults was 103.6 + 2.7 g, with a range of 85-113 g and for females was 68.5 ± 4.3 g, with a range of 47-85 g. The heaviest male and female weighed 293 g and 230 g, respectively. In males, 65% weighed 155-215 g but in females 74% weighed between 100-155 g.

During Season II, only adult rats were caught. Mean weights of males and females were 201.3+ 14.6gand 176.8 + 20.3 g. The heaviest male and female recorded were 280 g and 210 g, respectively.

Sex ratio: The overall sex ratio was 1236 males to 1107 females, a ratio of 1.12:1. This did not depart significantly from the ratio of 1:1 (chi-square=3.55, P>0.05, 1 d.f.). However, there was a preponderance of males in the first two weeks. In the first week rats were caught in a ratio of two males to one female, and in the second week 1.3 males to one female were caught. Although more females appeared in the traps from the fourth to sixth weeks, the sex ratios were not significantly different from the expected ratio of 1:1.

There was a preponderance of males caught (16 males to 6 females) during Season II for R. argentiventer with a sex ratio of 2.67 males to one female. One male and one female Malaysian house rat, R. rattus diardii were also trapped.

Trapping pattern: The trapping pattern of R. argenuventer over a period of 105 days is given in Fig. 6. Rats were caught daily about one week after the surrounding fields were harvested and only the fenced study area was left with standing crop. From day 20 to day 50, rats continued to arrive from the surrounding areas and the trapping pattern showed two peaks, one at day 37(13 rats) and the second at day 45 (25 rats). From day 20 to 50, a total of 164 rats (98 male and 66 female young and adults) were caught and this comprised 77.4% of the final total of 212 rats caught in the study. After day 50, less than four rats were caught daily until the end of the study (Fig. 6).

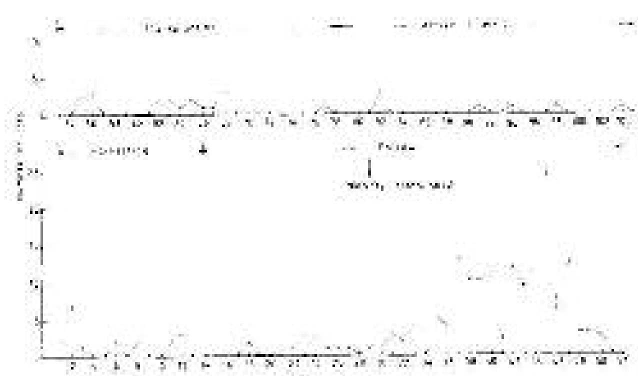

Fig. 6. Number of rats trapped in relation to the crop stage of fields outside the rat-proofed plot during a period of 105 days (5th March -18th June 1986).

Trap success at the six trap sites was as follows: trap no. 1--52 rats; no. 2--10 rats; no. 3-3 rats; no. 4-48 rats; no. 5--48 rats; no. 6-51 rats (Fig. 4). The highest number of rats per trap was 10 (5 males and 5 females). Traps nos. 1 and 6 accounted for 103 (48%) and trap nos. 3-5,99 rats (47%) out of 212 rats caught. Total number of rats caught per trap at the end of study ranged from 3-52. The number of rats caught per trap per day ranged from 1-10.

Population structure: Out of a total of 212 rats captured, 200 survived and were weighed and sexed in the laboratory. The Bumbong Lima population was represented by three age classes: juveniles, subadults, and adults. There were 22 juveniles, 94 subadults, and 84 adults of both sexes. The heaviest male and female recorded were 230 g and 211 g, respectively. Juveniles and subadults comprised 58% of the rats measured. Sixty-seven percent of the males weighed less than 85 g, and in the case of females 47% weighed less than 85 g. However, 67.9% of the males and 71.6% of the females weighed less than 115 g.

Sex ratio: The overall sex ratio (young and adults) was 112 males to 88 females, giving a ratio of 1.3:1 and this did not depart significantly from the ratio of 1:1 (chi-square=1.44; P>0.05, 1 d.f.). The sex ratio of adults also did not depart significantly from a ratio of 1:1.

DISCUSSION

Rice was found to be an effective trap crop for the rice field rat, R. argentiventer. in the above studies. Rats were attracted to the rice especially at the reproductive phase of the crop. In Permatang Pauh, high numbers of rats were attracted to the 60.7 ha crop in Season I. The efficacy of rice in luring rats from the surrounding areas was well illustrated by the subsequent poor catch in Season II. There was a hundred-fold decrease in the number of rats caught. This dramatic decline in numbers was also reflected in the negligible rat damage suffered by the crop in Season II. Only a few plants were damaged compared with 20% damage in Season I. Even fields adjacent to the project across the road planted by farmers at a later date in Season I (which had suffered severe rat damage in the past seasons) were not affected. The effective removal of the invading rats also prevented successful reproduction and this explained the lack of juveniles in Season II in the Permatang Pauh population.

In spite of its small crop area in the Bumbong Lima study, the 0.35 ha crop attracted a total of 212 rats which further illustrates the attractiveness of rice to R. argentiventer. especially if it is the only standing crop in the area. These rats were caught in spite of the systematic treatments with warfarin in the adjacent fields which otherwise would be left to reproduce and depredate the crop in the following crop season.

From the position of the various traplines, it was found that more than half (51 %) of the rats came from the abandoned rice lands from the east side of the Permatang Pauh project area. However, rats were attracted from all areas adjacent to the planted area. This was observed similarly in the Bumbong Lima study where rats were attracted from all the surrounding fields but with more rats from the direction of the larger contiguous cultivated areas. The number of rats trapped per trap per day ranged from 1 -25 in Permatang Pauh, and this indicated rats from abandoned rice lands were gregarious when foraging for food. In contrast, family groups were caught in traps in normal rice lands as indicated by trap catches in the Bumbong Lima study in which juveniles and subadults formed 58% of the rats caught.

The population structure of the rat population sustained by the abandoned rice fields in Permatang Pauh indicated a stable population. This was reflected in the fact that the majority of rats (97.7%) were adults and no juveniles were caught. In contrast, the Bumbong Lima population showed a high proportion of young which made up 58% of the trapped rats. This population structure was expected in areas that were continuously cropped. Rats, R. argentiventer. breed during the reproductive phase of the rice crop (Lam 1980), whereas in the abandoned rice lands in Permatang Pauh, where rice was not planted for the past 5 years, breeding activity of the rats was less intense in such a stable environment. Similar evidence pertaining to this reproductive strategy was observed in the single-cropped areas (Lam 1979). Rats in more stable environments were more K-selected compared with populations in continuously cropped areas where the environment undergoes regular drastic changes through cultivation and harvesting activities of the rice crop were more r-selected (Lam 1979). It has been suggested that species inhabiting strongly seasonal environments are likely to be more r-selected than those inhabiting areas of reduced seasonality (MacArthur and Wilson 1967, King and Anderson 1971, Roughgarden 1971). K-selected species have longer life spans (Pianka 1970) and this could explain the presence of larger rats in the Permatang Pauh population, indicating that the rats are living longer under the stable environment of abandoned rice lands. The presence of various species of snakes did not have a significant effect on the rat population in abandoned rice lands as indicated by the high rat population. Snakes appeared in the traps three weeks after the start of trapping and were caught as they followed the rats into the cultivated area.

Rice has proven to be an effective lure for the rice field rats, and this could be exploited for the control of this pest in situations where a high influx of rats from the surrounding areas was expected. This technique of trap cropping would be very useful for areas with very high rat infestations and in situations where large numbers of rats continue to move into the crop, chemical control would not be able to stem the tide of rat invasion. This trap crop technique could be further refined by the identification and use of rice varieties that are highly preferred by rats. This would enhance further its effectiveness as a trap crop.

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