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USE OF CARBON DISULFIDE AS ATTRACTANT FOR TRAPPING AND RODENTICIDE BAITING OF *Bandicota bengalensis* (GRAY)

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ABSTRACT

Management of rodent with rodenticide and trapping is frequently ineffective due to bait or trap shyness and neophobia. A study was conducted in the laboratory of Vertebrate Pest Division, BARI, Gazipur and field to increase the attractiveness of bait or trap to *B. bengalensis* and enhance the consumption of novel food by using different concentration of carbon disulfide (CS_2). Study revealed that addition of CS_2 improved bait acceptance of food. Five ppm concentration of CS_2, rat consumed significantly greater amount of cereal bait than untreated plain wheat bait. In semi-natural field test, significantly greater number (59%) of rat was trapped in CS_2 scented bait than without scented bait (41%). In the field study higher population reduction (85-91%) was achieved with CS_2 scented zinc phosphide bait than without scented zinc phosphide bait (50%). That is 80% higher reduction of rodent population was achieved with CS_2 treated zinc phosphide bait. From this study we conclude that CS_2 can improve the efficiency and consumption of poison bait and can increase trap success.

Keywords: Carbon disulphide, trapping, baiting, rat

INTRODUCTION

Rats and other rodents such as mice cause considerable economic harm (Brooks et al., 1990). In particular, agricultural losses are believed to substantial (Marsh, 1988) and damage is likely to increase in the future as conservation tillage practice become more widespread (Castrale, 1987). In addition to crop damage, commensal rodents and other pest species undermine and weaken structure (Timm, 1982, Marsh 1988) and chew through electrical and telephone cables. They also serve as primary reservoirs or hosts to vectors for human and livestock diseases (Gratz, 1988).

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Bandicoot rat *Bandicota bengalensis* is major agricultural and urban pest is Bangladesh or South Asia, It occupies communal burrows and can reach very high local populations densities (Aplin, et al., 2003). Rodenticide baiting and trapping is the common approaches to its control but their efficacies are often affected due to behavioural avoidance of poison baits and traps such as bait acceptance problems related to bitter taste, sub-lethal toxicosis and subsequent condition aversion (Prashad et al., 1987, Prashad and Kochar, 1995, Prakash and Ghosh, 1992, Reidinger, 1995). Olfactory stimuli from rodenticide bait or food within trap are important in improving their efficacies as the odour cues (Semio-chemical) together with food flavour guide food seeking behaviour of rats over a distance. In gas chromatography/mass spectroscopic experiments that were designed to identify candidate semi-chemicals, Galef et al. (1988) found that carbon disulfide (CS_2) is present on the breath of rats at a concentration of approximately 1ppm has been shown previously to mediate socially- induced food choices. When 0.1-10 ppm concentration of CS_2 was applied to food and presented to house mice, *Musmusculus*. a) Consumption increased significantly; b) bait station containing scented food were entered more frequently and for longer period than bait station containg unscented food (Bean et al., 1988). Mason et al. (1988) speculate that CS_2 could enhance the consumption of rodenticide bait formulation and would increase the effectiveness of traps by attracting the rodents towards the device. In Bangladesh no experiment was conducted with semio-chemicals to attract the rodents towards the bait station or trap station. So the present experiment was designed to increase the attractiveness of CS_2 *Bandicota bengalensis* and to determine whether it would significantly enhance the consumption of novel food and to determine the consumption and efficacy of poison in field condition.

MATERIALS AND METHODS

The study was undertaken at laboratory and field condition. The laboratory study was conducted at Vertebrate Pest Division, BARI, Gazipur and field study was undertaken at Dinajpur and Rajshahi districts during October 2010 to December 2012.

Laboratory study

Single *Bandicota bengalensis* were released in each of the room. The average body weight was 180 g. Each of the room measured 3.2 x 2m. Rooms were well protected from the predators. Before starting the experiment the rat were allowed to establish their normal activities for seven days. During that time rat food and water was supplied at *ad libitum*.

Bait station preparation: Two PVC pipes, 10 cm diameter and 50 cm long were taken for making bait station. One end of these pipes was closed with tin lid and the other end remained open. Bait materials was kept at the closed end of the pipe, so the rats have to travel 50 cm to get the food. One of the pipe was used as 'control' treated bait station and other was used as CS_2 treated bait station inside the CS_2 treated pipe, a vial filled with 10 ml of 1 ppm concentration of CS_2 was attached to the PVC pipe immediately above the bait and was filled with 6 cm cotton wick that protruded 2 cm from the mouth of the vial. A fine solution of 3 levels (1, 5 and 10 ppm) CS_2 was prepared by diluting reagent grade CS_2 in distilled water and agitating for approximately 30 minutes. In the “Control” bait station same procedure was repeated. The vial was filled 10 ml distilled water instead of CS_2 solution. One bait station was placed in one end of the room and another bait station was placed in other end of the room.

One such bait station was placed in each of the three levels (concentration) of CS_2 tested solution. During the experiment 20 g plain wheat seed was used as bait. Bait consumption was recorded every day. Water supply was *ad libitum* for the entire test animal during the study period. Food consumption taking into account the spillage was recorded for 3 consecutive days by changing the position of bait station to avoid the effect of any site preference on feeding.

Simulated field evaluation of the effect of CS_2 on trapping *B. bengalensis*: This study was conducted in the rodent enclosure. Each of the rodent enclosure measured 6.2 x 4.4 m. Enclosure was well protected from the predators. Enclosures are covered with grasses. Rodent can established their normal burrow system in the enclosure. A group of 10 rats was released and maintained on food and water *ad libitum* for 7 days before the start of trapping experiment. Twenty live traps were set in the enclosure, 10 CS_2 treated trap in one side and another 10 untreated traps in opposite side. The data was recorded in the next morning. This experiment was replicated 10 groups of 10 rats each.

Field evaluation of zinc phosphide baiting with CS_2: The experiments were conducted at farmer’s wheat fields in two different areas at Dinajpur and Rajshahi districs of Bangladesh. In all locations clear signs of rodent infestation were detected. There were three treatment viz. CS_2 + 2% zinc phosphide bait + pre-bait, CS_2 + 2% zinc phosphide bait, 2% zinc phosphide bait and control (where no poison was used). Two method were used to determine the populations density in each location mentioned before treatment.(1) The active burrow count method(El-Gawad and Ali, 1982) (2) The foot tracks activity (using tracking tile) method. (El-Sherbiny and Awad, 1987). Twenty active burrows/spots were used for each treatment. Before applying treatment all the active burrows were identified properly. Twenty tracking tiles (20 x 20cm) for foot tact activity were used for each treatment. Foot tracts activity were taken for two night for both pre and post treatment operation. The pre and post treatment rodent population was determined by using both of this method.

Ten (10) gram of zinc phosphide bait was placed near the burrow opening or runway on a piece of paper. CS_2 was placed near the bait with in a vial filled with CS_2 solution with 6 cm cotton wick that protruded 2 cm from mouth of the vial. Ten gram of poison bait was placed near the active burrow for consecutive three days.

Bait was given in the evening and was collected in the next morning. Each treatment was replicated in three places in each location. Consumption was recorded every day. Efficacy of the treatment was judged on the basis of rodent activity and percent reduction in population was calculated.

Data analysis

The significance of the differences between consumption of CS_2 treated and untreated baits and trap success were determined by the independent student *t*-test. The means with standard error were also calculated. Analysis of random complete block design (RCBD) was employed to find out significance of differences in food consumption in the field trials. Field data were analysis by one way analysis of variance and means were separated by LSD at 0.05% probability level. In all statistical test percentage data were transformed to arcsine to stabilize variance. STAR software version 2.0.1 (2014) was used for analyzed the data.

RESULT AND DISCUSSION

Acceptance of CS_2 scented bait by *B. bengalensis*: Addition of CS_2 improved bait acceptance by *B. Bengalensis*. The rat consumed a significantly greater amount of the cereal bait containing 5 ppm concentration of CS_2 than the untreated plain bait (Table1). The average bait consumption in the 5 ppm concentration of CS_2 treated bait and untreated plain bait was 8.05 ± 1.70 g and 5.96 ±1.09 g respectively for male. Female rats consumed 6.08 ± 0.24 g for CS_2 treated 3.28 ± 0.28 g for untreated bait.

Table 1. Mean consumption levels of CS_2 treated bait and plain (control) bait for three days in the observation test

Concentration (ppm)	Body weight (g) and sex	Mean daily consumption (g)		Acceptance (%)
		Plain bait	cs_2 treated bait	
1	161.3 M	6.16 ± 1.65	6.53 ± 2.48 ^{ns}	51.5
	168.3 F	6.69 ± 1.99	9.02 ± 1.81*	57.4
5	171 M	5.96 ± 1.09	8.05 ± 1.70 *	57.5
	152 F	3.28 ± 0.28	6.08 ± 0.24*	65.0
10	175 M	3.25 ± 0.89	4.15 ± 1.03^{ns}	56.1
	162 F	6.20 ± 0.78	6.22 ± 0.84^{ns}	50.0

ns= non-significant * significant differences between mean values P = 0.05, student *t*-test

Similarly, at 1ppm concentration, the consumption of CS_2 treated bait was significantly higher than the untreated bait by female (t=3.94 p=6.017) but no significance differences was observed in the case of males. CS_2 treated bait consumption was higher in female than male except 5 ppm concentration. But Mason et al. (1988) recorded completely different information while they were working with Norway rat *Rattus norvegicus*. They found that the consumption of CS_2 bait (10.7 ± 2.79) was three times higher than the consumption (3.2 ±1.19) of plain bait. Presence of CS_2 significantly enhanced the bait consumption of *Musmusculus*, *Rattus rattus* and albino rat and the rodents spent more time in the bait enclosure (Bean at al., 1988, Prashed, 2002 and Shumake et al., 2002) Females were more responsive to CS_2 than males. Sometimes the rats remove plain bait and hoard in the CS_2 treated bait station.

Table 2. Consumption of CS_2 treated and without CS_2 treated zinc phosphide poison bait by rat in field condition

Treatments	Pre-bait consumption (g)		Consumption of zinc phos. poison bait (g) *		Consumption of zinc phos. poison bait/spot /day (g) **	
	Dinajpur	Rajshahi	Dinajpur	Rajshahi	Dinajpur	Rajshahi
CS_2+poison bait + pre-bait	355	430	191.6 ± 9.39 a	214.8 ± 5.98 a	3.19±0.21 a	3.58 ± 0.27 a
CS_2+poison bait	-	-	129.9 ± 10.15ab	148.3 ±7.13 b	2.17 ± 0.30 b	2.47 ± 0.42 ab
Poison bait	-	-	90 ± 7.64 b	102.5 ± 7.37 b	1.49 ± 0.25 b	1.66 ± 0.28 b
Level of significant	-	-	s	s	ns	ns

Mean followed by same letter does not differ significantly at 5% by LSD.

*Average of three places, 20 burrows places $^{-1}$

** Mean of three days

Effect of CS_2 scent on trapping of *B. bengalensis* : During trapping inside the rodent enclosure 59 % rats were in trapped CS_2 treated trap and 39 % rats in untreated trap) (t=2.37 p= .041) (Figure 1). Prashad (2002) observed that a greater number of rats, *Rattus rattus* were trapped with cereal bait containing 1 % concentration of CS_2 treated bait both in pen and field experiment.

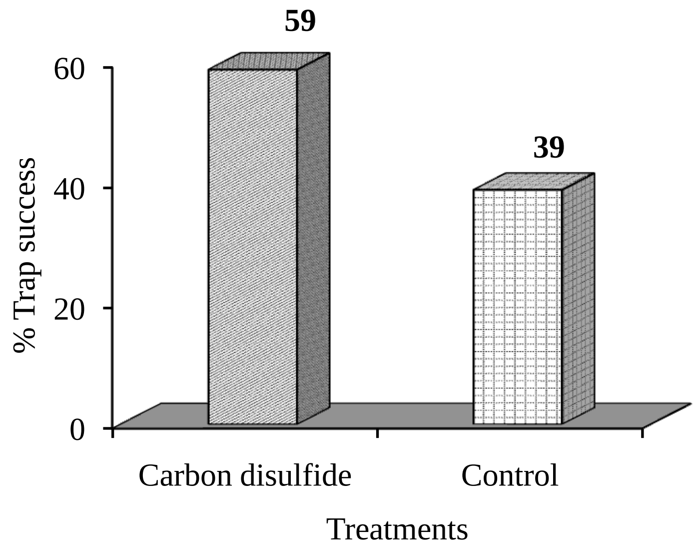

Figure 1. Trap success (%) in carbon disulfide treated and control in live trap at rat enclosure.

The effect of CS_2 scent in field is present in table 2 to 4. The total consumption of CS_2 scented poison bait differed significantly without CS_2 scented poison bait. The highest total consumption of zinc phosphide was recorded from the treatment where CS_2 scented zinc phosphide bait adding with pre-bait (191.6 g and 214.8 g) and the lowest total consumption was recorded from the treatment Zn_3P_2 poison (90 or 102 g) bait where no CS_2 scent was used in both the location in Dinajpur and Rajshahi respectively. By adding CS_2 zinc phosphide, bait consumption was increased by 109 to 112% (with pre-bait) and 43 to 45% (without pre-bait). The daily consumption/ spot (g) of poison bait was followed the same trend as total consumption and significantly differed among the treatments. The efficacy of different treatments is presented in table 3 and 4. CS_2 + poison bait + pre-bait provide the highest (85-90%) reduction and zinc phosphide without CS_2 provided only 50% reduction of rat. That is 80% higher reduction of rat population was achieved with CS_2 treated poison bait.

Table 3. Field efficacy of CS_2 treated and without CS_2 treated poison bait for controlling rodent using active burrow count method

Treatments	No. of pre-treatment active burrow		No. of post-treatment active burrow		% Population reduction	
	Dinajpur	Rajshahi	Dinajpur	Rajshahi	Dinajpur	Rajshahi
CS_2+poison bait + pre-bait	60	60	6	5	90	91.67
CS_2+poison bait	60	60	9	8	85	86.67
Poison bait	60	60	29	31	51.60	48.33
Control (Reference)	60	60	57	56	5	6.67

Table 4. Field efficacy of CS_2 treated and without CS_2 treated poison bait for controlling rodent using foot tracts activity method

Treatments	No. of pre-treatment foot tracts activity		No. of post-treatment foot tracts activity		% Population reduction	
	Dinajpur	Rajshahi	Dinajpur	Rajshahi	Dinajpur	Rajshahi
CS_2+poison bait + pre-bait	115	108	17	13	85.22	87.96
CS_2+poison bait	117	106	22	21	81.20	80.19
Poison bait	105	112	52	55	50.48	50.09
Control (Reference)	109	103	102	99	6.42	3.88

Possibly, in the present study the attractiveness of CS_2 indicates neophilia or curiosity for a novel odor. CS_2 is a sulphur containing chemical. Sulphurus odors are usually avoided by herbivores and attract carnivores (Sullivan et al., 1988, Notle, 1994). Omnivorous rats like *Bandicota bengalensis* are attracted to sulphurus odor (CS_2) in the present study also attract *Rattus rattus* (Prashad, 2002), *R. norvegicus* (Mason et al., 1988) and *Musmusculus* (Bean et al., 1998). This compound was also found as a component odor in the breath of rats and mice (Gelaf, 1988; Mason et al., 1994). CS_2 act as a safety signal odor when rat encounter new food or new places, thus reducing their neophobic reaction and increase food acceptance and consumption levels. Food odors made familiar to rat can reduce bait container neophobia in wild rats (Watkins et al., 1999).Our output also reliable with those of Bean et al. (1998) and (Mason et al., 1988) in which Carbon disulphide scent producing more attraction in rat than no scent. CS_2 scented zinc phosphide bait consumption increased 109 to 112% than non-scented bait and also increased the rat population. Similarly, use of CS_2scented bait increased the efficiency of trap and reduces trap shyness. In pen trial, Pashad, (2002) observed higher consumption of rodanticide bait containing Zinc phosphide bromadiolone and difethialone by colonies of 10 *R. rattus* also increased the efficiency of trapping and baiting using CS_2scented food in field condition. Similar result was obtained by Shumake et al. (2002) i.e., zinc phosphide poison bait consumption was increased by adding CS_2 in food.

CONCLUSION

However our present study indicated that use of artificial semio-chemical CS_2 could increase the acceptability and consumption of novel food and also the efficacy of zinc phosphide bait.

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