Pakistan J. Zool., vol. 37(4), pp. 269-274, 2005.

Comparative Field Efficacy of Some Additive Formulated Baits Against Rodent Pests of Wheat Crop in Sindh, Pakistan

AMJAD PERVEZ, SYED MUZAFFAR AHMED, ABDUL AZIZ KHAN AND SHAHER BANO LATHIYA

Vertebrate Pest Control Institute, Southern-zone Agricultural Research Centre, Pakistan, Agricultural Research Council, University Campus Karachi-75270 (AP, SMA), Pakistan Agricultural Research Council, Islamabad (AAK) and University of Balochistan (SBL)

Abstract.- Bait formulations of egg mixed zinc phosphide (2%), brodifacoum and bromadiolone (0.005% each) were tested against fields rats in wheat crop of Sindh, Pakistan. To evaluate the effectiveness of trials, the study was conducted at three growth stages of wheat *i.e.* tillering stage, grain hardening stage and mature grain stage. Fifty bait stations were placed in seven hectare of wheat cultivation area. Mean daily consumption of brodifacoum bait remained the highest *i.e.* 25.63±4.11g / bait station / day followed by bromadiolone (12.00±3.77g) and zinc phosphide bait *i.e.* 2.65±0.72g / bait station / day. Efficacy of the trials was assessed through 97.74% reduction in counts of live burrows and 2.14% reduction in tiller damage / 0.5 meter quadrate with brodifacoum bait. The present investigation suggested that egg mixed brodifacoum bait has more potential in enhancing bait acceptance followed by bromadiolone and zinc phosphide against field rodents of Sindh, Pakistan.

Key word: Efficacy, bait acceptance, brodifacoum, bromadiolone, zinc phosphide, wheat.

INTRODUCTION

Wheat is the most important food crop of Pakistan hence it is immensely important for the national economy. It is highly vulnerable to rodent attack right from sowing till harvesting (Shafi *et al.*, 1991). The crop is damaged mainly by the three to four rat species which are considered economically important. The lesser bandicoot rat, *Bandicota bengalensis* is the predominant rat species followed by *Millardia meltada, Nesokia indica, Tatera indica* and *Meriones hurrianae.* Survey conducted in the Punjab and North Western Frontier Province (NWFP) showed an average of 3% losses to wheat from field rats with 5% of the farms suffering over 10% loss to wheat crop (Beg *et al.,* 1977). In the areas where wheat cultivation is followed by rice, the losses were serious (Fulk *et al*., 1980).

Although several methods are being practised worldwide to minimize these losses but poison baiting is the most widely used method. However the main draw-back is the development of bait shyness as rats after initial intake rapidly learn to avoid eating a poisonous mixture or particular cereals used as bait base and become bait shy (Howard and Marsh, 1970; Bhardwaj and Khan, 1980). Some rats *e.g.* deer mice *(Peromyseus)* can remember an unpleasant association with toxic bait for many months (Howard and Marsh, 1970).

Extensive laboratory trials have been conducted to refine the existing rodent control strategy to make it more efficient through mixing some locally available bait additives (Shafi, 991; Shafi *et al.,* 1993; Pervez *et al.,* 2000, 2003). Present study aimed to translate the result of laboratory studies into development of a formulated bait package for the small farmers which should be effective, palatable and economically feasible for them.

MATERIALS AND METHODS

Selection of study sites

The study area was selected under wheat cultivation in Nawabshah district, Sindh (26° 15’ N, 68° 25’E, Fig. 1). The experimental area comprising of 28 hectare was divided into four blocks (three treatments and one control) using a randomized block design. The treatment blocks were comprised of brodifacoum (0.005%), bromadiolone (0.005%)

0030-9923/2005/0004-0269 $ 8.00/0

and zinc phosphide (2%). Minimum distance of 340 meter was maintained between blocks corresponding to the home range of inhabiting rodents (Fulk *et al.,* 1980).

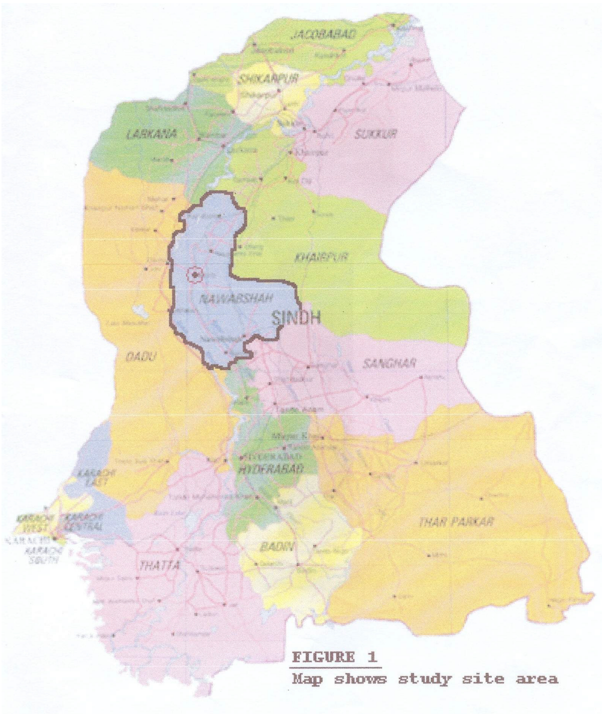

Fig. 1. Sindh map shows study site/area.

Poison bait preparation

Three rodenticides, zinc phosphide (an acute rodenticide), brodifacoum and bromadiolone (second generation anticoagulants) were used in this study. Wheat flour and broken rice were mixed with egg additive (Pervez *et al.,* 2000, 2003). The poison bait containing brodifacoum (2.5% master mix by Kukbo Pharma Co; Korea) was prepared containing a mixture of wheat flour, broken rice, additive and poison in a ratio of 46:46:3:5. Like-wise bait containing bromadiolone (0.25% master mix by LIPHA of Lyone, France) was prepared by mixing of wheat flour, broken rice, additive and poison in a ratio of 47.5:47.5:3:2. From zinc phosphide (master mix 80%) the bait was prepared by mixing wheat flour, broken rice, additive and poison in ratio of 47.8:47.7:2:2.5. All ingredients were mixed w/w.

Baiting technique

The trials were conducted at three growth stages of wheat crop tillering stage(7-8 weeks after sowing, WAS), flowering / grains hardening stage (10 WAS) and maturity stage (12 WAS). In each treatment blocks, seven hectare area was under wheat cultivation wherein 50 bait stations (points) were installed at equal distance from each other with 100 g bait / station. At each bait station, bait was offered for 5 days and was replenished daily. The bait was placed in earthen feeding cups which were fixed in soil. The bait offered was weighed with a pesola spring balance having an accuracy of 0.1 g. The bait consumption was recorded daily at 10 am to determine the relative intake of various formulated baits.

Evaluation of efficacy

Efficacy of the control trials was assessed through reduction in counts of live burrows. For this purpose, a day before treatment, all the active burrows were counted as pre-treatment census. For post-treatment census, in zinc phosphide treatment block, the census was done after one day. For anticoagulant baits *i.e.* brodifacoum and bromadiolone, post -treatment burrows census was done after two week period.

The success of the control operation was calculated as follows:

$$\% \text{ success} = a\text{-}b / b \times 100.$$

Where `a' and `b' represent number of live burrows at pre and post treatment census respectively.

The reduction in yield losses was also taken as a criteria of success of treatment. For this purpose, 35 quadrates (each measuring 0.5 sq meter) were taken from treatments and untreated (control) blocks at maturity stage of the crop. In each hectare, five samples approximately equidistant from one and other were selected along one of the diagonals. No sample was closer than three meter from edge of the field. All damaged and undamaged tillers were counted to calculate the yield loss.

In order to evaluate the bait consumption of various additive baits, three blocks comprising three treatments *i.e.* one acute and two chronic were selected using a randomized block design. An analysis of variance (ANOVA) test was used to determine the significance among various bait consumption and later on Duncan's (1955) multiple range test (DMRT) was applied to ascertain individual mean comparison.

RESULTS

Mean daily consumption of each bait formulation was evaluated at three growth stages of wheat crop (Table I) Mean bait intake of egg mixed brodifacoum was noted 25.63±4.11 g/station/day. Bait intake at tillering stage of crop was noted 20.45±4.85 g which almost doubled at flowering / grain hardening stage *i.e.* 43.69±5.91g. The bait intake however decreased at maturity stage *i.e.* 12.75±1.58. Under egg mixed bromadiolone bait, intake at tillering stage of the crop was recorded 8.00±1.10g which increased to 22.61±9.97g at flowering/grain formation stage but the value decreased to 5.40±0.22 g at maturity stage of crop.

In case of egg mixed zinc phosphide bait, the intake remained higher at tillering stage *i.e.* 4.90±0.80 g but no change in bait intake was observed at flowering / grain formation and maturity stage of the crop *i.e.* 1.27±0.38 and 1.80±0.99 g / bait station respectively.

Statistically significant difference was recorded in mean daily intake among baits type (F=6.82 df=1,6, P< 0.05). Mean separation by Duncan's multiple range test showed that egg mixed brodifacoum bait was significantly consumed more (25.63±4.11g) over other baits (p< 0.05). Likewise, rodent damage to tillers in wheat crop taken at pre-harvesting stage showed 2.14%, 2.07% and 3.39% in brodifacoum, bromadiolone and zinc phosphide treated blocks respectively compared with control (untreated) (Table II). Statistically the difference among various treatments and control was found to be significant. (F=6.73, df= 1, 6, P< 0.05).

The rodent population reduction related to various growth stages after treatments is given in Table III. The rodent population reduction varied at various growth stages of crop. At tillering stage, 77.60% reduction in rodent activity was recorded. However it increased with advancement in growth stages of crop *i.e.* flowering / grain formation stage and maturity stage. It was recorded 96.00 % and 98.75% respectively. Statistically, the difference in reduction of rodent activity among crop stages was recorded significant as compared to control (un-treated). (F=6.36; df=l, 6, P< 0.05).

The pre-treatment and post-treatment rodent activity index (Table-IV) was monitored by tracking tiles to assess rodent activity reduction after baiting with brodifacoum, bromadiolone (0.005% each) and zinc phosphide (2%) alongwith egg. The results of the field trials taken at harvesting stage of crop showed 97.74%, 93.33% and 88.10% reduction in rodent activity with brodifacoum, bromadiolone and zinc phosphide baits respectively. Statistically, the difference among treatments was found to be significant (F= 6.73; df= 1,6; P< 0.05).

DISCUSSION

Additive poison bait acceptance

Three rodenticides i.e. two second generation anticoagulants *i.e.* brodifacoum and bromadiolone and one acute rodenticide *i.e.* zinc phosphide each mixed with egg were tested in three separate blocks of wheat crop. Second generation anticoagulants are the rodenticides having characteristic of one dose but delayed mortality action unlike first generation anticoagulant rodenticides that require multiple feeding. In a study by Shafi *et al.* (1992) on field rodents of wheat, intake of brodifacoum mixed with egg shell remained the highest over other additive baits. Similar pattern of bait intake was recorded in bromadiolone bait. In the present study, whole egg was mixed in poison baits. The high intake of egg mixed brodifacoum bait over bromadiolone bait confirmed the results of Shafi *et al.* (1992) against field rodents of wheat.

Zinc phosphide, an acute rodenticides also showed high efficacy. High intake of egg mixed zinc phosphide is an important development, as this poison is known to cause bait shyness and bait aversion trend in rodents (Prakash, 1976). Thus the improved formulation of zinc phosphide may benefit the farming community as it still remains one of the most widely used rodenticides in the sub-continent.

Efficacy of control trials

In the present study, three census techniques

Table I.- Poison baits consumption in wheat crop at various growth stages.

Bait combinations offered	Mean bait consumption (gm±SE)			
	Tillering stage	Flowering / Grain formation stage	Maturity stage	Average bait consumption g±SE / station/day*
Brodifacoum (0.005%) with egg	20.45±4.85	43.69±5.91	12.75± 1.58	25.63±4.11a
Bromadiolone (0.005%) with egg	8.00± 1.10	22.61 ±9.97	5.40±0.22	12.00±3.77b
Zinc phosphide (2%) with egg	4.90±0.80	1.27±0.38	1.80±0.99	2.65±0.72c

*Means followed by the same letter (s) are not significantly different at the 5% level by Duncan's multiple range test (DMRT).

Table II.- Rodent damage to tillers in wheat cop after three different treatments of additive formulated rodenticide baits.

Treatment	No. of healthy tillers / quadrate	No. of damaged tillers / quadrate	Total No. of tillers / quadrate	Percentage tiller / quadrate
Brodifacoum (0.005%) with egg	70.32±0.61	0.48±0.16	70.80±0.56	2.14
Bromadiolone (0.005%) with egg	70.50±0.50	0.48±0.15	71.00±0.52	2.07
Zinc phosphide (2%) with egg	71.36±0.78	1.08±0.27	71.24±1.53	3.39
Control (untreated)	66.88±0.52	4.16±0.52	71.04±0.63	5.89

Table III.- Reduction in rodent population related to various growth stages of wheat crop followed by different treatments.

Growth stages of crop	Pre-treatment	Post-treatment	Reduction in rodent activity (%)
Tillering stage (7-8 WAS)	67	15	77.60
Flowering / grain formation stage (10 WAS)	75	3	96.00
Maturity stage (12 WAS)	80	1	98.75
Control (untreated)	78	83	-

Table IV.- Percentage reduction in rodent population treated with three different bait formulations in wheat fields.

Growth stages of crop	Pre-treatment	Post-treatment	Reduction in rodent activity (%)
Brodifacoum (0.005%) with egg	97	2	97.74
Bromadiolone (0.005%) with egg	75	5	93.33
Zinc phosphide (2%) with egg	84	10	88.10
Control (untreated)	86	93	-

i.e. bait intake, tiller damage assessment and burrow counts were employed which were expected to yield good results and valid inferences as referring to Kaukeinen (1979) that at least two methods should be followed in evaluating the efficacy of any candidate poison. High mean intake of brodifacoum in different poison baits *i.e.* 25.63±4.11g as well as in population reduction *i.e.* 97.74% is attributed due to high toxicity and mode of action of brodifacoum compared to bromadiolone. Poison baiting related to growth stages of crop showed less population reduction (77.6%) at tillering stage. Second treatment at flowering / grain formation stage gave upto 96.0% success while 98.75% rodent reduction was recorded during third baiting *i.e.* at maturity stage of the crop.

Under field situation, timing of baiting in relevance to stage of crop had a marked effect on the rodent control success. According to Posamentier (1981), at tillering and flowering stages, the crop becomes attractive to rats and mainly vegetative parts are eaten. As the rat population grows, the damage becomes more severe due to greater energy demands related to their reproductive activities (Fulk *et al.,* 1981). Finally at about maturity stage, because of the pressure due to the large rat population, wheat fields show high damage mainly related due to food and its cover requirements (Posamentier, 1989).

Poison baiting yielded 97.74%, 93.33% and 88.10% reduction in rodent population with brodifacoum, bromadiolone (0.005% each) and zinc phosphide (2%), respectively. Earlier field trials conducted by Shafi *et al.* (1992) to control rodent pests of wheat-crop, three baiting each at tillering, flowering and maturity stage of the crop gave 91.0% tiller damage reduction with brodifacoum and 86.0% with bromadiolone as compared to control (un-treated). The criteria of efficacy evaluation is slightly different in the present study than those of Shafi *et al.* (1992) and Pervez and Rizvi (1999) in wheat and paddy crops respectively. These findings are however in good agreement to both studies.

Similar results were obtained by Khan *et al.* (1988) with the usage of three formulations of zinc phosphide (2%) coumatetraly (0.0375%) and brodifacoum (0.005%) wax blocks. The percent reduction in rodent activity achieved was 88.8, 91.41 and 90.0 respectively while evaluating two bait delivery methods for rodent control in wheat crops, Hussain *et al.* (2003) obtained 92% and 92.2% reduction in live burrow activity with burrow baiting of zinc phosphide (2%) and coumatetraly (9.0375%), respectively. These results and that of present study showed that significant control of field rats in wheat crop can be achieved with the usage of additive formulated baits of zinc phosphide, brodifacoum and bromadiolone.

It is concluded from this study that egg additive with brodifacoum emerged as a highly acceptable and palatable bait followed by bromadiolone and zinc phosphide baits for field rodent control. Three poison baiting each at tillering, flowering / grain formation and maturity stage of wheat crop showed be practised to check depredation of rodent effectively and to enhance the crop productivity.

ACKNOWLEDGEMENTS

We wish to express our sincere. gratitude to Dr. M.M. Shafi (late) Director Vertebrate Pest Control Institute, Pakistan Agricultural Research council, Karachi for providing all necessary facilities to undertake the study. Malik Muhammad Qasim, Deputy Director, Dept. of Agric Extension, Govt. of Sindh is Acknowledged for facilitating in field trials. Thanks due to anonymous reviewer for improving the manuscript Financial support to conduct the study to first author by International Foundation for Science (IFS) Sweden through grant # C /2360-1 is thankfully acknowledged.

The paper is dedicated to the sweet memory of Dr. M.M. Shafi ex-Director VPCI/PARC Karachi who expired on 18th March 2005.

REFERENCES

BEG, M. A., KHAN, A., A. AND YASIN, M., 1977. Rodent damage to wheat crop in Faisalabad. *Pakistan J. Sci.,* **14**: 37-44.

BHARDWAJ, D. AND KHAN, J.A. 1980. Responses of *Rattus rattus* L. to feed previously used in a mixture for poisoning with zinc phosphide. *Proc. Indian Acad. Sci.,* **89**: 215-219.

DUNCAN, D.R., 1995. Multiple range and multiple F-test. *Biometrics,* **11:** 1-42.

FULK, G.W., SMIET, A.C. AND KHOKHAR, A.R. 1980 Movements of *Bandicota bengalensis* (GrayI873) and *Tatera indica* (Hardwicke 1807) as revealed by radio telemetry. *J. Bombay nat. Hist. Soc.,* **76**:457-462.

FULK G.W., LATHIYA, S.B. AND KHOKHAR, A.R. 1981 Rice field rats of lower Sindh, abundance reproduction and diet. *J. Zool.(London),* **193**: 371-390.

HUSSAIN, I., KHAN, A.A. AND MUNIR, S., 2003. Evaluation of two bait delivery methods for rodent control in rice and wheat crops In: *Proceedings of National workshop on rice-wheat systems in Pakistan*. Pakistan Agricultural Research council and Rice - Wheat consortium for the Indo-Genetic plains, December 11-12, 2003, Islamabad, Pakistan.

HOWARD, W.E. AND MARSH, R.E., 1970. Olfaction in rodent control. *Proc. 4th Vert. Pest Conf. West Sacramento, California*, March 3-5, pp. 64-70.

KAUKEINEN, D.E., 1979. Field method for census taking of commensal rodents in rodenticides evaluation. In: *Vertebrate pest control and management materials ASTM STP 680* (ed. J.R. Beck). American Society for Testing and Materials, Philadelphia.

KHAN, A.A., MUNIR, S. AND SHAKOORI, A.R., 1998. Development of underground baiting technique for control of rats in rice fields in Pakistan. *Inter. Biodet. Biodeg.,* **42**: 129-134.

POSAMENTIER, H., 1989. *Rodent in Agriculture, A review of findings in Bangladesh*, Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH, Germany, pp. 107.

POSAMENTIER, H., 1981 Rodent damage assessment methods in sown grain crops. *Bangladesh J. Zool.,* **9**: 87-89.

PERVEZ, A. AND RIZVI, S.W.A., 1999. Bait enhancement studies against rodent of economic importance in Pakistan. *Pakistan Fd. Agric. Rev.,* **1-2**: 34-36.

PERVEZ, A., RIZVI, S.W.A. AND AHMED, S.M., 2000. Laboratory evaluation of various additives as enhancers for bait acceptance in short-tailed mole rat, *Nesokia indica. Pakistan J. Zool.,* **32**: 352-354.

PERVEZ, A., AHMED, S.M. AND RIZVI, S.W.A. 2003. Evaluation of some additives to improve poison bait acceptance the lesser bandicoot rat, *Bandicota bengalensis. Pakistan J. Zool.,* **35**: 61-65.

PRAKASH, I., 1976. *Rodent pest management, principles and practices*. Central Arid Zone Research Institute Jodhpur. Mono graph. No.4, pp. 1-28.

SHAFI, M.M., 1991. *Some approaches to enhance poison bait acceptance in commensal and field rodents of economics importance in Pakistan*. Ph.D. thesis, University of Karachi, Karachi, pp. 120.

SHAFI, M.M., AHMED, S., AHMED, S.M. AND PERVEZ, A., 1991. Taste additives improve poison bait acceptance in Indian gerbil, *Tatera indica. J. Plant Protect. Tropics,* **8**: 77-83.

SHAFI, M.M., AHMED, S., PERVEZ, A. AND AHMED, S.M., 1992. Taste enhancers improve poison bait acceptance in field rodent damaging wheat crop. *Trop. Pest Mgmt.,* **38**: 214-217.

SHAFI, M.M., PERVEZ, A., AHMED, S. AND AHMED, S.M., 1993. Some approaches to enhancing poison bait acceptance in the lesser bandicoot rat, *Bandicata bengalensis. Trop. Sci.,* **33**: 350-358.

(Received 13 August 2004, revised 10 May 2005)