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# Evaluation of In-burrow Baiting Technique for Control of Rodents in Groundnut Crop

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**Abstract.-** We present the study results of the effectiveness of in-burrow rodenticide bait delivery method for controlling small rodents infesting groundnut fields of Pothwar region of Pakistan. Species of economic importance associated with the crop were: *Bandicota bengalensis, Nesokia indica* and *Tatera indica.* Formulated baits of zinc phosphide (2%) wax cake and broken rice; brodifacoum (0.005%) wax block and coumatetralyl (0.0375%) broken rice were subjected to evaluation. The baiting was initiated at the start of peg formation and stopped one week before harvesting the crop. After five bait applications the results indicated varied degrees of reduction in the burrow activities. These were reduced by 100, 48.3, 74.4 and 62.7% with the usage of baits of brodifacoum (0.005%), coumatetralyl (0.0375%) and zinc phosphide (2% wax cake and broken rice), respectively. However, the estimated mortality showed that all the bait formulations were equally effective i.e. ranging between 95 to 100 %. The study results suggest that 4 to 5 applications of the rodenticide baits are sufficient to obtain economic yields of groundnut crop.

**Keywords:** Anticoagulants, groundnut, Pakistan, rats, rodenticides, zinc phosphide

## INTRODUCTION

The groundnut (*Arachis hypogea*) crop is highly vulnerable to attack by field rats in Pothwar area of northern Punjab, Pakistan. Brooks *et al*. (1988) estimated 3.4% loss of the groundnut crop due to vertebrate pests (rodents, porcupines and wild pigs) in the present study area that equaled an average yield loss of 43 kg/ha. Earlier to this, Islam (1987) reported that vertebrate pests caused 17% reduction in groundnuts yield. On-farm yield constraints research studies in groundnut revealed that rats severely damage the crop in Pothwar and perceived it as the most significant constraint to high yields (Ali and Iqbal, 1984; Ali *et al*., 1984). A survey indicated that the majority of farmers (77%) of ground growing districts of Pothwar realize that vertebrate pests (rodents mainly) are a problem while 44% consider them as a limiting factor for increased groundnut production (Ahmad, 1991).

In India, losses to groundnut crop range from 4 to 26% (Prakash and Mathur, 1988), while Bindra and Sagar (1971) estimated 50 kg/ha average loss (range 30-76 kg/ha) of groundnut yield due to field rats in Indian Punjab. According to Parshad *et al.* (1987), the calculation to total yield loss due to complete and/or partial damage to plants through cutting and hoarding of pods by rodents showed 3.86% reduction in yield. Loss due to hoarding of groundnuts by field rats has also been reported from Japan (Yabe, 1981) and central India (Srivastava, 1970). Farmers in groundnut growing areas of the Saurashtra region (India) avoid sowing the summer crop because of heavy damage due to field rats. Rodent damage to groundnut crop has, also, been reported from the Philippines and China (Baltonado and Bongolan, 1985; Ishaq *et al*., 1980; Zhang *et al.*, 1998). In the North China Plain, peanuts are the favourable food of the rat-like hamster (*Cricetulus triton*). Zhang *et al.* (1998) reported that this hamster consumed 14.8 and 24% of the peanut crop in enclosure and field plots, respectively.

The principal rodent species associated with the groundnut crop in Pothwar area of Pakistan are: *Bandicota bengalensis, Nesokia indica, Tatera indica, Golunda ellioti* and *Mus* spp. (Brooks *et al*., 1988; Hussain *et al*., 2003). In India, *Rattus meltada*, besides *B. bengalensis* and *T. indica*, also infest ground crop (Anon, 1985), while in Nepal the crop is severely damaged by *B. bengalensis*

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(Bruggers and Brooks, 1984). Brooks *et al.* (1988) estimated damage of 2.4 and 1.0 % by *B. bengalensis* and *N. indica* to groundnut, respectively in the present study area. Very little published research is available on the control of rodent pests infesting groundnut fields in Pakistan and in South Asia. The present study aimed to assess the effectiveness on the usage of different bait formulations of anticoagulant and acute rodenticides by employing in-burrow baiting technique.

## MATERIALS AND METHODS

*Study site*

The experimental sites were located in Chakwal district (32° 56/ N 72° 54/ E), the major groundnut production area in Punjab province, and were about 100 km in the south of Islamabad-Rawalpindi. The five experimental sites were selected at village Umra after consultation with local agricultural functionaries, farmers and accessibility by metalled road. An adequate rodent infestation was of primary importance for developing the efficacy test data. Besides this, the agronomic practices, fertilizer inputs and crop varieties were similar on all sites. Approximately each experimental site was of 5.0 ha, with only one an equal sized reference area, and was located about 4-5 km apart from treated plots. The treated and reference fields were separated by 500-600 m, a sufficient distance to prevent dispersal between plots of the major damage causing rodent species, *B. bengalensis* (Fulk *et al*., 1980).

*Baits and baiting*

The tested ready-to-use baits were of zinc phosphide (2%) wax cake., zinc phosphide (2%) broken rice grain in polythene sachet., brodifacoum (0.005%) wax blocks, and coumatetralyl (0.0375%) broken rice grain in polythene sachet. Formulations of zinc phosphide were applied in quantities of 5 g (wax cake) or 10 g sachet per one open rat burrow. The anticoagulant rodenticide baits were used by placing a 5 g wax block of brodifacoum and a 35 g polythene sachet of coumatetralyl grain bait per one open rat burrow. The baiting technique involved the use of baits by inserting sachet/wax block/cake deep into the open burrow in the case of *B. bengalensis* or placement of baits inside the exposed main tunnel of burrow system of *N. indica* along the field dikes and inside the fields. The tunnel was exposed by chopping the dike into V-shape cut (Khan *et al.,* 1998). The baiting and burrow census started one week before peg formation stage of the crop or immediately followed by it. Five treatments with an interval of two weeks between applications were made and stopped one week before harvesting the crop. At this stage post-treatment burrow census was conducted. The treatments were evaluated by counting fresh/active burrows before/after each treatment and compared with burrow census data collected from the reference site. The estimated mortality or the percentage of population reduction of rats was assessed by using the following formula (Henderson and Tilton, 1955).

$$\% \text{ Mortality} = 1 - \frac{(t2 \times r1)}{t1 \times r2} \times 100$$

where

t = burrow census taken from treated field
r = burrow census taken from untreated field
t1, r1 = pre-treatment burrow census
t2, r2 = post-treatment burrow census

## RESULTS AND DISCUSSION

The results on the use of four formulated baits of the three rodenticides are summarized in the Table I. The data shown refer to the final treatment and assessment round. The active/live burrows were reduced by 100, 48.3, 74.4 and 62.7% with the usage of brodifacoum (0.005%) wax block, coumatetralyl (0.0375%) rice grain bait, zinc phosphide (2%) wax cake and zinc phosphide (2%) rice grain bait, respectively. The estimated mortality index based on the reduction in rat activity after five treatments were highly significant for all formulations. The calculated mortality was 100, 95.0, 97.6 and 96.4% for brodifacoum (0.005%) wax block, coumatetralyl (0.0375%) grain bait, zinc phosphide (2%) wax cake and grain bait, respectively. The pattern of reduction in rodent activity between the treatments with brodifacoum

**Table I.- Results of in-burrow delivery of acute and anticoagulant rodenticide baits for control of rodents in groundnut crop of Pothwar region of Pakistan.**

| Treatment | Area of crop fields (ha) | No. of active burrows (pre-treatment) | No. of active burrows after each treatment (% reduction) | | | | | Estimated mortality (%) |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | |
| Brodifacoum (0.005%) wax block | 5 | 67 | 34 (49.3) | 25 (62.7) | 16 (76.1) | 5 (92.5) | 0 (100) | 100 |
| Coumatetralyl (0.0375%) broken rice | 5 | 58 | 11 (81.0) | 6 (89.7) | 28 (51.7) | 42 (27.6) | 30 (48.3) | 95.0 |
| Zinc phosphide (2%) wax cake | 5 | 78 | 11 (85.9) | 5 (93.6) | 20 (74.4) | 32 (71.8) | 20 (74.4) | 97.6 |
| Zinc phosphide (2%) broken rice | 5 | 67 | 13 (80.6) | 8 (88.1) | 35 (47.8) | 20 (70.2) | 25 (62.7) | 96.4 |
| Reference | 5 | 115 | 183 | 292 | 466 | 743 | 1184 | -- |

wax blocks (Student's `t' value = 5.91; P = 0.002) and zinc phosphide wax cake (Student's `t' value = 3.54; P = 0.017) was highly significant while it was non-significant in case of zinc phosphide grain (Student's `t' value = 0.78; P = 47) and coumatetralyl grain (Student's `t' value = 0.14; P= 0.90).

On the reference site, initial burrow counts were 115 which increased to 1184 at the compound growth rate of 59.4% when the post-treatment census was taken. Based on the compound growth rate, open burrows on treated sites were calculated if there had been no treatments. It increased to 689, 595, 803 and 689 for brodifacoum, coumatetralyl, zinc phosphide wax cake and zinc phosphide grain, respectively. This clearly reflected the relative abundance of rats on the treated sites. The bandicoot rats, after moving inside the crop fields, burrow extensively with the result that a large number of holes are dug. Benefiting from the characteristic hoarding behavior of *B. bengalensis*, this baiting method can be recommended for rat control in groundnut crop. This method, apparently, did not present any hazards to non-target animal species (birds) and was environment-friendly. During this study, we did not observe/record any primary poisoning of non-target animal species in and around the experimental plots. Secondary poisoning of non-target species, in this study, was difficult to record because carcasses may have been scavenged before they were discovered by humans. It is, therefore, suggested that formulated baits of brodifacoun should be applied in such a way that these are not exposed to non-target animal species.

Just before or little after peg formation, the burrow systems of *B. bengalensis* were confined to field dikes. With the formation of nuts, these rats moved into the interior of fields and made, thereafter, extensive burrow systems (Malhi and Sheikher, 1986). When on dikes their burrows were open most of the time. At this stage if baiting is done, the reduction in rat numbers will be very high and costs on the bait inputs will be low while the economic returns will be on the higher side. *B. bengalensis* appeared to be more frequent in fields with higher plant densities while *N. indica* occurred more often in fields with lower plant densities (Brooks *et al*., 1988).

The burrowing behaviour and extensive use of multiple burrow systems is characteristic of *B. bengalensis*. Thus one burrow system may have 3-5 or more exits and entry holes (Malhi and Sheikher, 1986). Simple live censuses of holes will under-estimate the percentage reduction. Therefore, post-treatment reduction, calculated on the basis of compound growth rate, both on treated and reference sites, was more realistic.

The results of this study have shown that both grain and wax formulations were significantly effective against small rodents in groundnut crop. Parshad *et al.* (1987) obtained 26.1 to 72.4% reduction in rodents with brodifacoum and bromadiolone wax blocks and by 58% with single treatment of zinc phosphide in both irrigated and non-irrigated groundnut crop. Anonymous (1991) obtained 90, 90, and 87% reduction in rodent activity with burrow baiting of 0.005 % brodifacoum, 0.005% bromadialone and 0.0375% coumatetralyl, respectively in groundnut fields in Chakwal district, Pakistan. In another study, wax blocks of 0.005% bromadiolone and 2% zinc phosphide produced better results in respect of reduction in rodent activity and damage at flowering and pod maturity stages (AICRP, 1988). Hussain and Prescott (2006), while studying the bait consumption pattern, obtained 85.4% reduction in burrow activity of *B. bengalensis* in groundnut crop with the usage of 0.025% warfarin rice grain bait. Khan *et al*. (2009) obtained 61.6 and 59.2% increase in yields with the usage of grain baits of flocoumafen (0.005%) and coumatetralyl (0.0375%) with more than 20-fold economic return for both.

Farmers in the Pothwar area lack effective methods for controlling rats in groudnut fields. Brooks *et al*. (1988) found that treatment with 2% zinc phosphide rat cake (Smythe and Khan, 1980) followed with the baiting of 0.0375% coumatetralyl could eliminate rodents from experimental groundnut plots, but farmers cannot find formulated baits at village markets in Pakistan. With the availability of formulated baits at this level, the in-burrow baiting of rodents, will increase the productivity of the crop, and resultant income of the farming communities.

It is evident from the results of this study that with one to two applications of any formulated rodenticide baits effective rodent control in groundnut crop may not be achieved, whereas 4-5 applications of the rodenticide baits could result into economic yields of groundnut crop.

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