Rodent Damage and Control in Peanut Fields in India

V. R. Parshad*, C. S. Malhi, N. Ahmad and B. Gupta[1,2]

ABSTRACT

Studies were made on the identification, damage and chemical methods of control of rodent pests in irrigated and nonirrigated fields of peanut (*Arachis hypogaea* L.) at Ludhiana, India. Peanut fields were infested with *Bandicota bengalensis, Tatera indica, Rattus meltada* and *Mus* spp., except that *B. bengalensis* was absent in nonirrigated fields. These rodents reduced peanut yield by an average 3.86%, a loss of 190.18 rupees/ha ($15.12 US). Severe rodent damage was sporadic with a maximum of 18.97% reduction in peanut yield. Rodents inflicted more damage between 80 to 120 days after planting, i. e. during the pod fill stage of crop growth. A single treatment with poison bait at 80 to 90 days after planting with 2.4% zinc phosphide, 0.005% brodifacoum and 0.005% bromadiolone in cereal baits at the rate of 1 kg/ha resulted in 58.07%, 42.26% and 40.88% rodent control, respectively, in nonirrigated fields. In irrigated fields, 58.70% and 67.02% rodent control was achieved with zinc phosphide and brodifacoum baits respectively. Significantly higher rodent control was obtained with 2 treatments of either brodifacoum or bromadiolone than with a single treatment of any rodenticide. Wax blocks containing 0.005% brodifacoum were less effective than cereal baits containing the same rodenticide. Two applications at 10 day interval of either 0.005% brodifacoum or bromadiolone between 80-100 days after planting is suggested for rodent control in peanut fields.

Key Words: *Arachis hypogaea* L., brodifacoum, bromadiolone, damage, rodents, zinc phosphide.

Despite the fact that rodents produce considerable damage in peanut (*Arachis hypogaea* L.) fields (6), little research has been conducted on rodent management compared to the extensive studies on arthropod pests (7). In India, rodents damage branches of 3.6 to 9.3% of the peanut plants in Punjab (14) and 10.2 to 17.7% of the plants in Madhya Pradesh (2). An acute toxicant, zinc phosphide, is commonly used to control rodents is crop fields. Zinc phosphide has been reported to induce bait shyness which rapidly decreases its effectiveness (3). Recently, second generation single dose anticoagulant rodenticides, brodifacoum [3-(3-(4-bromobiphenyl-4-yl)-1,2,3,4-tetrahydro-1-naphthy 1)-4-hydroxy-coumarin] and bromadiolone [3-(3-(4-bromo(1,1-biphenyl)-4-yl)-3-hydroxy-1-phenylpropyl)-4-hydroxy-2H-1-benzopyran-2-one] have been shown to be highly effective against many rodents in crop fields in several ecological regions (5,10,12). However, the efficacy and acceptance of these rodenticides by rodents in peanut fields have not been investigated. The present studies were conducted to (1) identify rodent species in irrigated and nonirrigated peanut fields, (2) estimate the yield losses due to rodents, and (3) evaluate brodifacoum and bromadiolone for rodent control in peanut fields.

[1]Research by All India Coordinated Research Project on Rodent Control with financial support from the Indian Council of Agricultural Research, New Delhi.

[2]Zoologist (Rodents), Assistant Zoologist (Rodents) and Research Fellows (N.A. and B.G.) resp., Department of Zoology, Punjab Agricultural University, Ludhiana-141 004, India.

Materials and Methods

Research was conducted in both irrigated and nonirrigated (rainfed) peanut fields located around Ludhiana, India.

Trapping of rodents. Rodent pest species in peanut fields were identified by live-trapping rodents from non-experimental peanut fields over a 2-3 days period. Traps were arranged in a grid of 9 traps per site, 10 m between traps and 27 traps/ha. The locations of the grid varied with the dimensions of the field.

Estimation of rodent damage. Yield loss due to rodents was estimated in 20 randomly selected 72 m^2 (12 x 6 m)plots. In each plot, total plant density, number of rodent burrows, complete and partially damaged plants and number of damaged pods on the ground were recorded at 17, 39, 63, 79, 100 and 120 days after planting. During harvest, the number and weight of pods on 50 undamaged and 50 partially damaged plants were recorded. In addition, rodent burrows were excavated and hoarded pods were recovered and counted. Reduction in peanut yield due to rodents was calculated as follows:

$$\text{Per cent yield loss} = \frac{N_1 + N_2 + N_3 + N_4}{N} \times 100$$

Here, N is estimated potential yield of peanut (g/72 m^2 plot) as determined from the total plant density per plot and mean yield of undamaged plant; N_1 is yield loss due to 100 per cent damage to plants determined from the number of completely damaged plants multiplied by mean yield of undamaged plant; N_2 is yield loss due to partial damage to plants determined from the difference between the yields of undamaged and partially damaged plants; N_3 is weight of damaged pods collected on the ground, and N_4 is weight of pods hoarded by rodents in their burrows.

Efficacy of poison baits for rodent control. Field trails for rodent control were conducted in peanut with poison baits containing 0.005% brodifacoum and 0.005% bromadiolone. The baits were prepared from the 0.25% liquid formulation of brodifacoum and powder formulation of bromadiolone using a mixture of wheat flour, peanut oil, and sugar (96:2:2) as described previously (12). Zinc phosphide bait was prepared by mixing millet grains with 2.4% zinc phosphide and 1% peanut oil. Paraffin wax blocks (Klerat®) containing 0.005% brodifacoum were supplied by Imperial Chemical Ltd., England.

In a nonirrigated peanut field, 21 x 4 ha plots were assigned to 6 treatments and/an untreated control in a randomized complete block design with 3 replicates. The treatments consisted of single baiting with 0.005% brodifacoum, 0.005% bromadiolone, 0.005% brodifacoum wax blocks and 2.4% zinc phosphide baits and two baitings, at 10 day interval, with 0.005% brodifacoum and 0.005% bromadiolone baits and an untreated control (Table 1). All treatments were made between 80-100 days after planting. Poison baits were applied at rate of 1 kg/ha at 100 baiting points in a 10 m^2 grid. At each point, 10 g of bait was placed on a piece of paper. The baits were kept in the field for one day in case of zinc phosphide and three days in case of brodifacoum and bromadiolone. In irrigated fields, the rodents were treated with 0.005% brodifacoum and 2.4% zinc phosphide in the manner described above.

Relative effectiveness of treatments was evaluated by pre- and post-treatment track marking (TM), census baiting (CB) and/or trap census (TC) methods (12,13). The post-treatment census were done after 15 days of anticoagulant and 3 days of zinc phosphide treatments. With the TM method, white cards, 18 x 18 cm with 8 x 8 cm polyethylene sheet coated with a mixture of xerographic ink and peanut oil (1 : 1), were placed at 10 m distance from each other in rows of 10 each. In each plot, 4 rows of markers were set at 3 locations each. The following morning, all markers were examined and those showing track marks were considered positive for rodent activity. The census baiting was done by placing 10 g plain millet at 120 baiting points/plot arranged as previously described for the TM method. The number of baiting points showing consumption were recorded on the next morning. The TC was done with the method used for trapping rodents from non-experimental fields in the present study. To estimate the effect of treatments on damage reduction, the incidence of damaged pods on 5 x 1 m^2 ground was also recorded in each treatment and the untreated control of the nonirrigated area.

The effectiveness of the treatments expressed as per cent control or reduction in activity of rodents was calculated as below:

$$\text{Per cent control} = 100 - \frac{\text{post-treatment census data}}{\text{pre-treatment census data}} \times 100$$

The significance of treatment effects of all baits was tested by analysis of variance and Duncan's multiple-range test was used for significant differences between treatment means.

Results and Discussion

Rodent Species. Four rodent species, *Tatera indica* (Hardwicke), *Bandicota bengalensis* (Gray), *Rattus meltada* (Gray) and *Mus* spp., were found in irrigated and nonirrigated fields of peanut, with the exception that *B. bengalensis* was absent in nonirrigated fields. Based on 2 days of trapping with 27 traps/ha, 4.2 *T. indica*. 6.5 *B. bengalensis*, 4.2 *R. meltada* and 13.9 *Mus* spp. were trapped/100 traps/day in irrigated and 15.0 *T. indica*, 7.5 *R. meltada* and 17.5 *Mus* spp. were trapped/100 traps/day in nonirrigated fields, respectively. Apparently, *Mus* spp. occurred in higher proportion than any other rodent in peanut fields and *T. indica* was more frequent in nonirrigated conditions. Previously, *B. bengalensis* and *R. meltada* were reported from peanut fields in Central India (2). Other rodents which have been reported from peanut include *Tatera* spp. from East Africa (11) and *Mastomys natolensis* from Sudan (8).

Yield loss due to rodents. Estimation of mean damage by rodents in peanut revealed a complete damage to 0.85% of the plants and partial damage to 3.50% of the plants. Most of the damage occurred between 80 to 120 days after planting, i.e. during the pod fill stage of peanut development (Fig. 1). The partially damaged plants had 32.61% fewer pods which weighed 23.20% less than those of undamaged plants. In addition, 77.10 ± 10.23 damaged pods/ 72 m^2 were collected from the ground, and 160.0 ± 24.9 and 14.2 ± 3.93 pods/burrow were retrieved from the excavated burrows of *B. bengalensis* and *T. indica*, respectively. Calculations of the total yield loss due to complete and partial damage to plants and cutting and hoarding of pods by rodents showed that rodents reduce yield by 3.86%, a loss of 190.18 rupees/ha ($15.12 US). The distribution of rodent damage to peanut seemed to be sporadic rather than uniform as the extent of yield loss in one field was as much as 18.97%. Estimated losses in this study did not include losses that occur when plants are inverted and allowed to dry in the field. During this drying period, rodents remove pods from the plants and hoard them in their burrows such as reported in Senegal (6). Average losses to rodents was quite low, but sporadic, extensive damage in certain areas often prevented farmers from cultivating their peanuts. Similarly, peanut production has been abandoned in some south Pacific Islands due to losses to rodents (4).

Efficacy of poison baiting of rodents. Compared to some increase in rodents in untreated fields, the treated fields showed 26.14 to 72.37% reduction in rodents (Table 1). The incidence of rodent damage in treated fields also decreased. Differences among effects of different treatments in rodent control in peanut were significant. In nonirrigated fields, single baiting with zinc phosphide resulted in significantly higher rodent control than with the single baiting of brodifacoum or bromadiolone. Opposite results were obtained in irrigated fields. These differences in the performance of rodenticides in nonirrigated and irrigated fields of peanut may be related to the differences in rodent populations at these locations as observed in the present study.

Fig. 1. Incidence of rodent damage to peanut throughout the growing season (per cent plant damage is drawn as mean±S.E.)

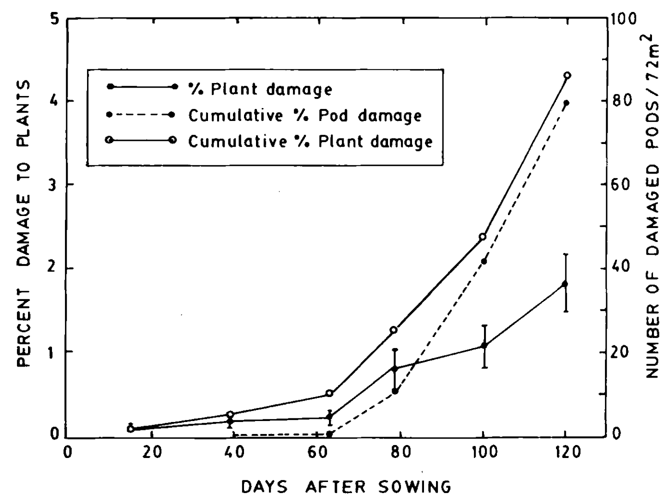

Table 1. Efficacy of rodenticidal treatments in irrigated and nonirrigated peanut fields in Ludhiana, India.

Treatment	No. of baitings	Per cent control*	Damaged pods/m^2 (mean±S.E.)
		Nonirrigated fields	
Brodifacoum	1	42.26[a]	1.2±0.72
Bromadiolone	1	40.88[a]	0.9±0.58
Brodifacoum wax blocks	1	26.14[b]	2.2±0.64
Zinc phosphide	1	58.07[c]	1.1±0.58
Brodifacoum	2	72.37[d]	0.9±0.51
Bromadiolone	2	67.25[d]	1.2±0.66
Untreated control	0	+18.77	6.8±2.13
		Irrigated fields	
Brodifacoum	1	67.02[d]	NR
Zinc phosphide	1	58.70[c]	NR
Untreated control	0	+12.38	NR

*, Values are means of two census methods and three replicates in each treatment. Means followed by the same letter are not significantly different at 5% level as determined by Duncan's multiple-range test.

+, indicates increase in rodents in untreated control fields and NR, not recorded.

Single treatment of zinc phosphide resulted in about 58% rodent control in both irrigated and nonirrigated fields. The residual population of rodents often develop shyness to zinc phosphide baits (3) and this prevented its use in repeat baitings. In the present study, repeat baiting of rodents at 10 days interval with brodifacoum and bromadiolane resulted in significantly higher control than with the single treatments in nonirrigated fields as well as with the single treatment of zinc phosphide. Similar results have been reported previously in other crops and field situations (5,9,10,12,13). The anticoagulats, brodifacoum and bromadiolone showed similar performance in repeat and single baitings and, thus, any of these may be used for the field control of rodents. The cereal bait of brodifacoum was more accepted and efficacious than its wax formulation. This might be related to the bait preference of the rodents which is affected by the availability of food from the peanut crop (1).

Economics of rodent control. The value of different inputs in the control of rodents was about 14.50 rupees/ha ($1.15 US) for zinc phosphide (including the cost of poison) and 6.00 rupees/ha ($0.48 US) for single baiting of brodifacoum or bromadiolone (excluding the cost of poisons as these are not yet commercially available in India). Considering the value of yield losses due to rodents and efficacy of treatments, it was apparent that even rodent damage of less than 1% would justify rodent control in peanut.

Literature Cited

1. Ahmad, N. and V. R. Parshad. 1985. Bait preferences of rodents in their natural habitat. Pro. Indian Acad. Sci. (Anim. Sci.). 94: 117-122.
2. Annonymous. 1985. Annual report of All India Coordinated Research Project on Rodent Control. Indian Council of Agricultural Research, New Delhi.
3. Barnett, S.A. and I. Prakash. 1975. Rodents of Economic Importance in India. 1-175. New Delhi and London, Arnold-Heinmann.
4. Brady, J.E. 1974. Experts for pest control to increase world's food. New York Times 28th October, 1974 (Cited in Sill, W.H. 1982. Plant Protection. p. 297, Iowa State University Press, Iowa).
5. Dubock, A.C. 1980. The development and practical use of the novel anticoagulant rodenticide brodifacoum. Plant Protect. Bull. (Taiwan). 22: 223-238
6. Fall, M.W., R.L. Bruggers and J.W. DeGrazio. 1983. Rodent and bird problems in agriculture and their management in developing countries. Paper presented to the Interafrican Physiosanitary Council Training Conference on Vertebrate Pests of West African Crops, September 19-23, 1983, Niamy, Niger.
7. Feakin, S.D. 1973. Pest Control in Groundnut, PANS Manual No.2, Centre for Overseas Pest Research, London.
8. Ishag, H.M., M.A. Ali and A.B. Ahmadi. 1980. Groundnut production and research problems in Sudan. p. 282-284. In proceedings of the International Workshop on Groundnuts. 13-17 October, 1980, ICRISAT Center, Patancheru, A.P., India.
9. Malhi, C.S., G. Chopra and V.R. Parshad. 1986. Rodent control in wheat crop. Indian J. Agric. Sci. 56: 609-611
10. Marsh,R. E., W.E. Howard and W.B. Jackson. 1980. Bromadiolone: A new toxicant for rodent control. Pest Control. 48: 22,24 & 26.
11. Mitchell, G. and A. Volvano. 1984. Annual report of vertebrate damage control research in agriculture. Denver Wildlife Research Center, U.S. Fish and Wildlife Service.
12. Parshad, V. R., N. Ahmad and G. Chopra. 1985. Laboratory and field evaluation of broadifacoum for rodent control. Int. Biodet. 21:107-112.
13. Parshad, V. R., N. Ahmad and G. Chopra. 1987. Deterioration of poultry farm environment by commensal rodents and their control. Int. Biodet. (In press).
14. Sood, M. L. and S. S. Guraya. 1976. *Rats and Their Control.* p. 30, Punjab Agricultural University Publication, Ludhiana, India.

Accepted February 21, 1987