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Control of Rodent Damage to Groundnuts in the Pothwar Plateau Region of Pakistan

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Abstract.- Efficacy of 0.005% flocoumafen, 0.0375% coumatetralyl and 2% zinc phosphide was evaluated for small rodents infesting groundnut fields in the Chakwal District of the Pothwar Plateau, Pakistan. The baiting duration was about 10 weeks, starting at the peg formation crop stage until two weeks before harvest. Treatment efficacy was assessed by live burrow counts before and after treatments and by the yield of nuts from treated and untreated reference plots. After three treatments, the reductions in rodent activity were: 70.2% (zinc phosphide), 90.4%, (flocoumafen), and 95.0% (coumatetralyl). The yield of groundnuts, obtained only from the flocoumafen- and coumatetralyl-treated plots, was substantially increased - 61.6% and 59.2%. Partial budget analyses, based on benefit /cost determinations for the rodent control treatments by anticoagulants showed a more than 20-fold economic return for both.

Key words: Groundnut crop, rodent damage, control, rodenticides, baits

INTRODUCTION

Groundnut (*Arachis hypogea*) is one of the major summer crops grown in the Pothwar Plateau, an uneven, rainfed landscape, in Pakistan. National production of this crop at the country level is 73,900 metric tonnes (GOP, 2007), of which about 70% is contributed by the three districts (Chakwal, Attock and Rawalpindi) of the Pothwar region (Ahmad, 1990). Average per hectare yield is about 1194 kg. This relatively low yield is usually attributed to many biological and environmental factors such as losses caused by diseases, insects, and rodent pests, low yielding varieties, and rainfall uncertainties. Five species of field rodents; *Bandicota bengalensis, Nesokia indica, Tatera indica, Golunda ellioti* and *Mus* spp. have been recorded from the crop fields of this area and except for *G. ellioti* the other species are considered to have pest status (Brooks *et al.*, 1988; Hussain *et al.*, 2003). On-farm constraints studies revealed that rodents severely damaged groundnuts in Pothwar and were perceived to be a limiting factor in achieving optimum production (Ali and Iqbal, 1984; Ali *et al*., 1984). These researchers also indicated that the spreading groundnut varieties were more susceptible to rodent damage than the erect ones. Ahmad (1991) reported that the majority of farmers (77%) in groundnut growing districts realized that vertebrate pests (principally rodents) were a problem, while 44% considered them a factor for limiting production. Islam (1987) estimated that vertebrate pests caused 17% yield reduction. Brooks *et al.* (1988) estimated 3.4% loss of the groundnut crop in Pothwar area due to rodents, with a resultant mean yield loss of 43 kg/ha.

Groundnuts are one of the most important subsistence crops in some arid and semi-arid countries but little information is available on the losses caused by rodents which can reach 100% locally (Meehan, 1984). Bindra and Sagar (1971) assessed loss in yield of groundnuts that ranged from 12-31 Kg/acre with an average of 20 Kg/acre. Prakash and Mathur (1988) reported rodent losses to the groundnut crop in India from 4 to 26%, while, according to Parshad *et al.* (1987), the yield loss of groundnuts to these pests was 3.86%. Low yields of groundnuts, because of rat damage, have also been reported from Philippines and Sudan (Baltonado and Bongolan, 1985; Ishaq *et al.*, 1980). In China, an enclosure study of groundnut damage by the rat-like hamster, *Cricetulus triton*, has revealed 14.8-19.6% damage (Zhang *et al.*, 1998).

Survey of literature offers scanty information

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on the management of the rodent pests infesting groundnut crop in Pakistan. Our study aimed to generate data on the field efficacy of two anticoagulant rodenticides (flocoumafen and coumatetralyl) and an acute rodenticide (zinc phosphide) for managing groundnut damage by rodents. Selection of bait materials for the rodenticides and their preparation and application were conducted in the simplest way possible, keeping the socio-economic conditions of the local farmers in focus and the constraints to adoption of the methodologies and practices by the extension agencies and farming communities.

MATERIALS AND METHODS

Experimental sites

The trials were conducted in the major groundnut growing area in the Chakwal District of Pakistan (32° 56′ N, 72° 54′ E), about 100 km in the south of Islamabad and Rawalpindi. The crop fields were selected at early growth stages and the treatments were initiated at the time of peg formation. This growth stage was the expected time for movement of rodents into the crop fields to begin, when farmers usually initiate rodent control measures (Hussain *et al*., 2003). During our site selection process, we emphasized finding both rodent infestation and easy accessibility to fields. The first site designated for the zinc phosphide treatment was 8.1 ha in size with a reference crop area of 5 ha. The second site, about 6 km distant, where the anticoagulant rodenticides flocoumafen and coumatetralyl were tested, had treatment areas of 9.1 ha and 8.5 ha, respectively. A common 5-ha reference plot was selected for both of these two treatments. The treatment blocks were 500-600 m apart, exceeding the maximum home range of the bandicoot rat (*B. bengalensis*), the major rodent pest species in the area (Fulk *et al.*, 1980).

Baits and treatment applications

Since the bandicoot rat has been reported a dominant rodent species in the study area (Fulk *et al.*, 1980; Brooks *et al*., 1988; Hussain *et al.*, 2003), the known food preference of this species was used for bait selection. Rice was reported among the favourite foods of the bandicoot rat, both in captivity and under field conditions (Kamal and Khan, 1977; Karim, 1994; Jalihal *et al*., 1980; Hussain and Prescott, 2006). Similarly vegetable oil improved palatability of baits for the bandicoot rat under both laboratory and field conditions (Marsh, 1988; Ahmad and Parshad, 1985).

Finished baits of zinc phosphide (2%), flocoumafen (0.005%) and coumatetralyl (0.0375%) were prepared (w/w) from broken rice (98%) and vegetable oil (2%), using an electric grain mixer at room temperature. For field use, the coumatetralyl formulation was packed in 50 g packets while the other two materials were placed in polythene bags in larger quantities - 2.5 kg/bag. At the start of each treatment fresh batches were prepared.

The baiting in groundnut fields was conducted from August through November (from peg stage to maturation of the crop). Three treatments were made at equal time intervals, with the final baiting at about 2 weeks before harvest. Zinc phosphide bait was applied by spot-baiting at the rate of 20 g/active rodent burrow, making a pile on either side of burrow openings. Bait piles were concealed by natural cover from surrounding plants to prevent consumption by non-target animals. Flocoumafen bait was similarly placed at the rate of 30 g/burrow. The 50 g coumatetralyl bait packets were individually placed inside active burrows.

Evaluation

Effectiveness of the rodenticide treatments was evaluated by determining reduction in live burrow activity and the difference in yields of groundnut pods in the treated and non-treated fields. Yield estimates were made in 3-4 randomly selected fields from all treatment and reference sites. In each field, a corner was randomly selected to start a diagonal transect line (corner to corner). On each line, four 2 x 2 m quadrats were placed at equal intervals on alternating sides of the line. From each quadrat the groundnut pods were dug and bagged. In the laboratory, materials were dried to 12% moisture content before making yield calculations. The yield data were obtained only from anticoagulant-treated fields and the related reference area; fields used for zinc phosphide treatment were flooded after heavy rains and yields could not be determined.

RESULTS AND DISCUSSION

The results of different rodenticidal treatments are summarized in Tables I, II and III. Post-treatment data taken at the maturity or harvesting stage showed that the burrow activity (active burrows/ha) was 100, 22 and 12 for the fields treated with zinc phosphide (2%), coumatetralyl (0.0375%) and flocoumafen (0.005%), respectively. In the reference fields a 9.5 fold increase in rodent activity was recorded over the period corresponding from pre-treatment period to the post-treatment. The relative percent reduction in burrow activity achieved was 70.2%, 90.4% and 95.0% (Table I), showing that the burrow-baiting of anticoagulant (coumatetralyl) was more effective than the spot-baiting of zinc phosphide and also leading the performance of flocoumafen by a close context. During these trials the treatments of zinc phosphide were effected, to some extent, by rains that might have become the cause of lower success of this rodenticide. The low success can also be attributed to the phenomenon of bait shyness in major field rodent species, *B. bengalensis* (Sridhara and Srihari, 1980) due to strong taste and smell of this compound, particularly when the rodenticide baiting is carried out without pre-baiting as was done in the present study. However the study proposes to avoid zinc phosphide application during wet weather. Necessary precaution should be adopted to prevent development of bait shyness by avoiding repeated application of zinc phosphide or conduct intermittent application with the anticoagulant rodenticide baits. Parshad *et al.* (1987) obtained 58.07% control of rats in both the irrigated and non-irrigated groundnut fields with zinc phosphide (2.4%) bait, the success less than the present study.

The results with the two anticoagulant baits are significant and comparable to studies conducted by other workers. Vyas *et al.* (1985) found 92.1 and 95.5% control successes after 3 and 5 days application of bromadiolone (0.005%) bait, respectively in summer crop of groundnut. However,

Table I. Rodent activity at various treatments in groundnut fields.

Treatment	Area (ha)	Total no. of active burrows (active burrows per ha.)				% age reduction in active burrows per ha.
		Pre-treatment	After 1st treatment	After 2nd treatment	After 3rd & post-treatment	
Zinc phosphide (2%)	8.1	243 (30.0)	233 (28.8)	320 (39.5)	812 (100.2)	70.2
Reference to the zinc phosphide treatment	5.0	96 (19.2)	249 (49.8)	645 (129)	1683 (336.6)	--
Flocoumafen (0.005%)	9.1	177 (19.5)	65 (7.1)	28 (3.1)	198 (21.8)	90.4
Coumatetralyl (0.0375%)	8.5	285 (33.5)	22 (2.6)	45 (5.3)	97 (11.4)	95.0
Reference to the anticoagulants treatments	5.0	200 (40.0)	357 (71.4)	638 (127.6	1138 (227.6)	--
Combined data of two reference (untreated) sites	10	296 (29.6)	606 (60.6)	1283 (128.3)	2821 (282.1)	853% or 9.5 fold increase

Table II. Bait usage in different treatments in groundnut fields.

Treatment	Area (ha)	1st treatment (kg/ha)	2nd treatment (kg/ha)	3rd treatment (kg/ha)	Total (kg/ha)
Zinc phosphide (2%)	8.1	0.900	0.864	1.186	2.950
Flocoumafen (0.005%)	9.1	0.583	0.214	0.092	0.889
Coumatetralyl (0.0375%)	8.5	1.853	0.072	0.104	2.029

Table III. Partial budget analysis on rodent control in groundnut crop using coumatetralyl (0.0375%) and flocoumafen (0.005%) baits.

No.	Items	Coumatetralyl	Flocoumafen
1	Avg. yield (kg/ha) @ 12% moisture content	1959 kg/ha*	1930 kg/ka*
2	Percent increase (over the untreated plots)	61.6 %	59.2 %
3	Economic yield (kg/ha)	747 kg/ha	718 kg/ha
4	Market price @ Rs. 1600/40 kg	Rs. 29880.00	Rs. 28720.00
5	Cost of bait used/ha	Rs. 250.00	Rs. 450.00
6	Labour cost of baits application/ha	Rs. 100.00	Rs. 100.00
7	Mechanical harvesting and threshing cost of the economic yield @ Rs. 1.20/kg	Rs. 896.00	Rs. 862.00
8	Total cost/ha	Rs. 1246.00	Rs. 1412.00
10	Net benefit/ha	Rs. 28634.00	Rs. 27308.00
11	Cost/benefit ratio	1:23	1:19.3

*Groundnuts yield of reference (untreated) plots = 1212 kg/ha

Parshad *et al.* (1987) got poor results with the usage of brodifacoum wax blocks (0.005%) and bromadiolone (0.005%). According to them wax blocks were less effective than cereal baits containing the same rodenticide. The results obtained in an experiment conducted at Bangalore (India) indicated that 85% success was achieved with flocoumafen treatments (AICRP, 1988), which is fairly comparable with the present study. Hussain and Prescott (2006), while studying the bait consumption pattern, obtained 85.4% reduction in burrow activity of *B. bengalensis* by using 0.025% warfarin rice grain bait in the groundnut crop of the Pothwar area.

Usage and consumption of different rodenticide baits indicated a steady trend with minor fluctuation during the third treatment (Table II). To a greater extent the trend was similar to that of Hussain and Prescott (2006). This showed that rodenticide baits are required in small quantities for affective management of rodent damage to groundnut crop.

The yield data was obtained from coumatetralyl and flocoumafen treated fields and two reference areas. The yield increase was estimated 61.6 and 59.2% for coumatetralyl and flocoumafen treatments, respectively (Table III). Average yield of nuts at 12% moisture content was 1959 kg/ha from the coumatetralyl treated fields while it was 1930 kg/ha in case of flocoumafen. The average yield from two reference (untreated) sites obtained was 1212 kg/ha. In an earlier preliminary study Khan *et al.* (1992) recorded an increase of 61.7% yield of groundnut production following control of field rats with anticoagulant baits. In India, maximum yield of nuts was recorded in bromadiolone (1500 kg/ha) treatments (AICRP, 1991). The yield gap of 920 kg/ha in the groundnut crop in Pakistan (Ali *et al.*, 1984) can be significantly abridged through rodent control efforts.

The outcome of this study has shown a good economic return *i.e.* over 20-fold, by control of rodent pests. The rodenticide baits are low cost interventions compared with the insecticides and fungicides. The present study indicates that the anticoagulant baits even as a single factor can significantly decrease rodent population and enhance yield.

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