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ABSTRACT: Control operations at 6-month intervals, continued for four years in crop fields, reduced the rodent population to 5.08 percent losses to agricultural production. After eight crop seasons, a significant reduction in rodent density was observed in treated areas when compared with that of the control areas ($P < 0.01$). Correlation between pre-treatment population index (y) and number of seasons (log of x) was found to be 0.91 ($P < 0.01$). A relationship was established between y and x : $y = 0.804.0-0.9621 \log x$. From this equation, it can be inferred that rodent population will reach zero level after treating crop fields continuously for6.85 or say 7.0 (seven) seasons. After control, the numbers of predominant rodents, Tatera indica, Meriones hurrianae and Rattus meltada. were significantly reduced and the residual population was composed of Mus booduga. Gerbillus spp., Rattus gleadowi. Golunda ellioti and Funambulus pennanti.

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INTRODUCTION

It has been observed that a single rodent control operation in crop fields does not yield lasting effect on minimizing the crop losses. Quantified data are wanting on the number of successive operations which should be undertaken to stabilizing the rodent population below a threshold level, on the reinfestation rate of rodent pests of which a number of species are found in a single crop field. Quantified information is also not available on the species which are obliterated in the initial operation and about those, the number of which build up subsequent to it. To answer these questions, a rodent control programme was undertaken in crop fields around a cluster of villages near Jodhpur and the results arc presented in this communication. It has been observed that to achieve a sustained riddance for rodent pests in the field, control operation should be repeated at 6-month intervals for 2 years, preferably prior to crop sowing. Similar attempts have been made with regard to perennial crop like coconut in S. India and Minicoy island (Advani 1986).

MATERIALS AND METHODS

A cropped area of about 2500 hectares around a cluster of villages near Jodhpur (26° 18'N-73°01 'E) was divided into three main areas: "maintenance area", in which rodent control operation was carried out every six months (corresponding to KHARIF, rain-fed crop - July to October; and RABI irrigated crop - October to March from 1978 to 1981. The second, "neglected area", was treated only once, prior to sowing of KHARIF crop during 1978 after which only rodent population census was conducted during subsequent seven seasons. In the third, "survey area", control operations were not undertaken at all but rodent censusing continued every six months. It served as control area for comparing the rodent infestation rate. Pre- and post-control census were conducted in each cropping season to evaluate control success in the first two areas using lines of snap traps which were laid in the grid manner. Trap indices (rodents/100 traps/24 hrs) were calculated by installing traplines of snap traps in crop fields, and using equation $T.i = M/(A \times T)$, where M is total number of animals trapped, T is number of nights during which traps were set and A is number of traps used in traplines (Barnctt and Prakash 1975). Trapping efforts (grid size x trap nights) remained almost same at each census. The trap nights varied from 2 to 4 days depending up climate of the region (as rains, dust storms etc.). However, trap index gave the comparable idea of rodent population level.

Control operations were carried out with the help of farming community. Prior to poison baiting, the active rodent burrows were prebaited for two days with simple bait material. Ninety-five parts of locally grown and available millet, bajra (Pennisetum tvphoides). 3 parts of edible oil and 2 parts zinc phosphide were used in preparing poison baits for mass distribution and placement in the burrows in crop field, at the rate of 6 g per active burrow opening.

RESULTS AND DISCUSSION

The infestation at the time of initiating the field experiment was 9.25, 6.5, and 5.2 rodents/100 traps/24 hrs in the maintenance (6-month control operation), neglected (control once only) and survey (no control) areas respectively. In the survey area, the population of rodents show (Fig. 1) an increasing trend. By 1981 end, the rodent infestation rate (r.i.r., rodents per 100 traps/24 hrs) increased from 5.2 to 7.15. After the initial control operation, r.i.r. declined to 0.55 and 0.70 in the maintenance and neglected areas, respectively. Thereafter, in this latter area, in which no further

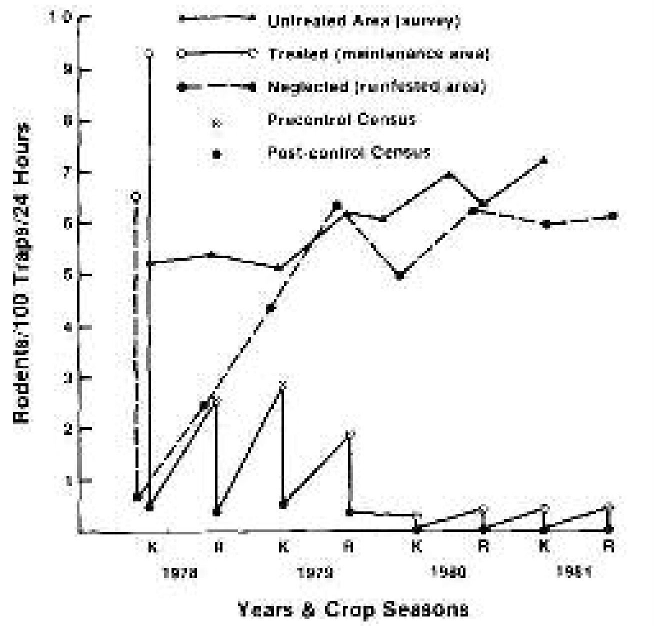

Fig. 1. Rodent population levels (Trap indices) in maintenance (treatment) neglected and Control' crop fields during different crop seasons (1978-1981).

control operation was undertaken, r.i.r. built up almost to the original level within 11/2 years (Fig. 1), whereafter, this level remained mildly fluctuating till the Rabi crop census during 1981.

In the maintenance area, wherein rodent control was repeated every six months, the rodent population increased 5 times after the first operation, r.i.r. increasing from 0.55 to 2.61; and after the second operation 9 times, r.i.r. increasing from 0.30 to 2.92 (Fig. 1). In the subsequent operation, however, the reinfestation was only 3 times (0.58 to 1.84). Later on, the population rate did not increase above 0.55 rodents/100 traps/24 hours. It is also observed that the control success ranged from 80 to 94 percent when the population was high and it was 100 per cent at a low population level. These results clearly indicate that cleaning of field rodents can be achieved with greater efficiency when their population density is low.

In a similar study at Devonshire (England) on impact of control operations on rodent populations in villages, Barnett et al. (1951) also could not get complete clearance of a whole village. Lasting reduction in rat populations was achieved by comprehensive double or triple operations. After such treatments, the rat populations took more than a year to recover as against 1 1/2 years in case of present studies in neglected villages (Fig. 1).

Monitoring of r.i.r. in the three areas with different treatments, has yielded for the first time for south Asian rodent populations, quantified data about: a) after a single day control operation, the rodent population can be reduced by 94.05 per cent of the initial level, b) after the operation, the r.i.r. increases five times within six months (Fig. 1), c) if it is not brought down by repeat operations, it keeps on rising, attaining the initial level within 1 1/2 years, d) after 4 six-month control treatments, the r.i.r. is unable to build up and remains almost at a constant low level indicating operations must be continued for two years at an half yearly interval.

After the control operations, the predominant species like M- hurrianae and T. indica remained in the fields in low numbers but Rattus meltada pallidior population was totally obliterated and did not appear in trap lines in subsequent census in the maintenance area (Table 1). Whereas, Tatera indica disappeared after fourth control operation, Gerbillus gleadowi. a psammophilic rodent, and the little field mouse, Mus booduga. and others were trapped in low numbers. The species encountered after the last operation were M- hurrianae and Gerbillus nanus indus. This change over in a multiple species composition of field rodents is important from the point of view of sustaining their low level to minimize the crop losses. No change is, however, observed in species composition in the survey and neglected areas (Table 2 and 3).

Davis (1953) presented some interesting data on the rate of increase of rat population after artificial reduction in Baltimore. From 26 to 95% reduction imposed upon these populations, in nine out of 29 blocks, the rat populations returned to or even exceeded the pre-control populations levels within 3 to 8 months. In seven blocks, these populations attained their former level within six months. For Norway rats (Rattus norvegicus) populations (Southwick 1966) intensive control operations exterminated rats in May 1943, but after two years (in 1945), rats increased rapidly more than the precontrol level, later declined and eventually stabilized at approximately the original population. However, the field populations of desert rodents behave slightly in a different fashion, as indicated above.

When analyzed statistically, after 8 crop seasons of four years, a correlation was established between pretreatment population index (y) and number of seasons (log of x), which was found to be 0.91 ($P < 0.01$). A relationship was established between y and x as $y=0.804-0.9621 \log x$. Owing to this relationship, theoretically it is inferred that the density of rodent population would reach zero level in the maintenance fields, after treating continuously for 6.85 times or broadly after seven crop seasons. Practically, however, it is observed that after four 6-month control operations the rodent infestation fluctuated between 0.2 to 0.55 rodents/100 traps/ 24 hours.

The assessment of rodent damage to different crops like twelve vegetables (Advani & Mathur 1982) and wheat (Advani et al. 1982) revealed an almost parallel trend between reduction in rodent population and resultant reduction in damage by rodents in treated areas. On an average 90.2 per cent of rodent damage reduced due to continuous control operations in vegetables, wheat, millet and oil seed crops in Rajasthan.

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Table 1. Variations in rodent infestation patterns in response to regular control operations.

Species	1978 K[1] Pre[3]	1978 K[1] Post[4]	1978 R[2] Pre	1978 R[2] Post	1979 K Pre	1979 K Post	1979 R Pre	1979 R Post	1980 K Pre	1980 K Post	1980 R Pre	1980 R Post	1981 K Pre	1981 K Post	1981 R Pre	1981 R Post
F. pennanti	-	-	-	-	-	-	1* (16.6)**	-	-	-	1 (50.0)	-	-	-	-	-
R.m. pallidior	1* (3.6)**	-	3 (33.3)	1 (25.0)	2 (12.5)	-	-	-	-	-	-	-	-	-	-	-
R. gleadowi	-	-	-	-	-	-	1 (16.6)	-	-	-	-	-	-	-	-	-
G. ellioti	-	-	-	-	1 (6.2)	-	-	-	-	-	-	-	1 (50.0)	-	-	-
M. booduga	1 (3.6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. indica	13 (46.7)	-	1 (11.1)	1 (25.0)	4 (25.0)	1 (50.0)	2 (33.3)	-	1 (100.0)	-	1 (50.0)	-	-	-	-	-
M. hurriane	13 (46.7)	1 (33.3)	4 (55.5)	2 (50.0)	9 (56.9)	1 (50.0)	2 (33.3)	-	-	-	-	-	-	-	1 (50.0)	-
G. gleadowi	-	1 (33.3)	-	-	-	-	-	1 (100.0)	-	-	-	-	-	-	-	-
G. nanus nanus	-	1 (33.3)	-	-	-	-	-	-	-	-	-	-	-	-	1 (50.0)	-

[1]Kharif (Summer) crop
[2]Rabi (Winter) crop
[3]Pre control rodent population
[4]Post control rodent population
*Relative numbers of rodents captured in one season
**Relative percent abundance of rodents in one season

Table 2. Variations in rodent populations in absence of control operation.

Species	% Occurrence 1978 K	1978 R	1979 K	1979 R	1980 K	1980 R	1981 K	1981 R
F. pennanti	-	1* (5.1)**	-	2 (10.5)	-	1 (9.1)	-	2 (11.?)
R.m.pallidior	2* (12.5)	3 (15.8)	2 (12.5)	3 (15.8)	1 (6.6)	3 (27.2)	2 (13.2)	3 (17.6)
M. booduga	1 (6.25)	-	-	1 (5.2)	1 (6.6)	-	1 (16.6)	1 (5.9)
T.i. indica	4 (25.0)	7 (37.8)	5 (31.2)	6 (31.5)	5 (33.3)	4 (36.3)	5 (33.3)	6 (35.2)
M. hurrianae	9 (56.2)	8 (42.1)	9 (56.2)	7 (36.8)	8 (53.3)	3 (27.2)	7 (46.6)	5 (29.4)

*Relative numbers of rodents captured
**Relative percent occurrence of rodents

Table 3. Variations in rodent populations in response to one initial control.

	1978			1979		1980		1981	
	K		R	K	R	K	R	K	R
Species	Pre	Post							
F. pennanti	-	-	-	-	1 (7.1)	-	-	-	-
R.m.pallidior	3* (23.1)**	-	-	1 (10.0)	2 (14.3)	2 (20.0)	2 (13.3)	1 (14.3)	1 (16.6)
R. rufescens	-	-	1 (14.2)	-	-	-	-	-	-
G. ellioti	-	-	1 (14.2)	1 (10.0)	1 (7.1)	-	-	-	-
M. booduga	-	-	-	1 (10.0)	-	1 (10.0)	-	-	-
T. indica	6 (46.1)	1 (100)	3 (42.8)	3 (30.0)	6 (42.8)	3 (30.0)	7 (46.4)	2 (28.6)	3 (50.0)
M. hurrianae	4 (30.7)	-	2 (28.5)	4 (40.0)	4 (28.6)	4 (40.0)	5 (33.3)	4 (57.1)	2 (33.3)
G. gleadowi	-	-	-	-	-	-	1 (6.6)	-	-

*Relative numbers of rodents in seasons

**Relative percent occurrence of rodents

community for cooperating during rodent control campaigns organized on mass scale. Thanks are due to Ms. Paula Savarese, Work Process for typing this manuscript and Mr. E. Randy Dupree, Asst. Commissioner, NYC Bureau for Pest Control for encouragement.

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