Proc. Indian natn. Sci. Acad. **B57** No. 6 pp. 391-396 (1991)

Rodent Damage and Control in Pecan Orchards

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(Received on 28 June 1991; Accepted on 29 July 1991)

Bandicota bengalensis, Mus musculus and *M. booduga* were the major species (comprising 41.01, 21.87 and 14.06% of rodent population respectively) while *Golunda ellioti, Rattus meltada, R. rattus* and *M. platythrix* constituted only the minor components of rodent population in pecan. Of these *R. rattus* and *M. musculus* were commensal whereas the rest were exclusively field murids. Their burrows had a specific distribution pattern. *B. bengalensis* had 58.18% of its burrows inside the field, the majority of these being within 1.5 m radius of the pecan plants. Burrows of mice were located on the bunds and in the peripheral region of the plots whereas the burrows of other rats were primarily on the bunds. These burrows were away from the pecan plants. *B. bengalensis* was primarily responsible for damage, killing 17.42% plants. Burrow baiting with rodenticides by using 2.5% zinc phosphide followed by 0.005% bromadiolone after one month, significantly controlled rodents (93.1% success).

Key Words: Rodents, Pecan, Trap index, Damage, Control, Burrow baiting, Fumigation

Introduction

Himachal Pradesh figures prominently on the horticultural map of India, producing many temperate, tropical and sub-tropical fruits. The cultivation of nuts, in spite of their high food value, has not received due attention in Himachal Pradesh which, nevertheless, produces around 2800 tonnes of nut fruits annually. Pecan, *Carya illinoensis,* the favourite nut of Americans, has caught the attention of horticultural scientists and farmers lately due to its superiority over walnut in terms of yield and selling price, and therefore is being projected as the future nut cash crop for farmers. Rodents are the major mammalian pests and have been recorded to infest the orchards in Himachal Pradesh (Sheikher & Jain 1990). The present work has been undertaken to assess the extent and mode of damage by rodents in pecan plantations and to work out their control/ management strategies.

Materials and Methods

The work was carried out at Nauni and Kandaghat (Himachal Pradesh).

Population studies: The rodents were live-trapped for 3 days every month (after 2 days prebaiting) for one year to assess their population density and species composition on the basis of the trap index (i.e. the number of rodents trapped/100 traps/day) as follows:

$$\text{Trap Index} = \frac{\text{No. of Rodents trapped}}{\text{No. of traps laid} \times \text{No. of trap days}} \times 100$$

Trapping was preceded by live-burrow census every month, and the burrows were broadly classified as follows:

i) with large surface openings (> 5 cm diameter) having mound or heap of loose soil,

ii) with large uncovered surface openings (> 5 cm diameter), and

iii) with small uncovered surface openings (< 3 cm diameter).

Cagegory "i" belonged to *Bandicota bengalensis*, while "ii" belonged to other rat species (*Rattus meltada*, *R. rattus* and *Golunda ellioti*) and "iii" belonged to mice species (*Mus musculus*, *Mus booduga* and *M. platythrix*).

Damage estimation: The pecan plants were observed for the nature of rodent damage. Healthy and damaged plants were counted vis-a-vis their age.

Control: The orchard was treated in 1989 and 1990 in pulse treatment as below:

i) The orchard was treated through surface baiting with 2.5% zinc phosphide in April, 1989 after prebaiting. The bait was placed in a grid; bait to bait distance being 10 m. After one month the live burrows were fumigated with aluminium phosphide.

ii) In April, 1990, the orchard was treated through burrow baiting with 2.5% zinc phosphide by placing poison bait inside the burrow. After one month, the live burrows were treated with 0.005% bromadiolone bait.

Each application of rodenticide/fumigant was preceded by pretreatment census and followed by post-treatment census of live-burrows. The success was calculated on the basis of reduction in the count of live-burrows as follows:

$$\% \text{ Success} = \frac{a - b}{a} \times 100$$

a and b represent number of live burrows at pre- and post-treatment census respectively.

Results and Discussion

Seven species of rodents, all belonging to family Muridae, were recorded from pecan orchards; their total annual trap indices (table 1) being *Bandicota bengalensis* (38.85) > *Mus musculus* (20.72) > *M. booduga* (13.32) > *Golunda ellioti* (6.29) > *Rattus rattus* (5.92) > *R. meltada* and *M. platythrix* (4.81 each).

Table 1 *Trap Index in pecan orchard during* 1988-89

Period	Rats					Mice				Total Rodents
	B.b.	G.e.	R.m.	R.r.	Total	M.m	M.b	M.p.	Total	
May	3.70	0.74	0.74	0.74	5.92	2.22	1.85	0.37	4.44	10.36
June	3.33	1.11	0	0.74	5.18	1.85	1.11	0.74	3.70	8.88
July	3.70	0.37	0	0.37	4.44	1.85	1.11	0	2.96	7.41
August	4.44	0.74	0.37	1.11	6.66	2.22	1.48	0.74	4.44	11.10
September	4.07	0.37	0.74	0.74	5.92	2.59	1.48	0.37	4.44	10.36
October	4.44	0.74	0.74	0.37	6.29	2.22	1.85	0.37	4.44	10.73
November	3.33	0	0	0	3.33	1.11	0.74	0	1.85	5.18
December	1.11	0	0	0	1.11	0.74	0.37	0	1.11	2.22
January	1.48	0.37	0.37	0.37	2.59	0.74	0.37	0.37	1.48	4.07
February	1.85	0.37	0.37	0.37	2.96	1.11	0.37	0.37	1.85	4.81
March	2.96	0.74	0.74	0.74	5.18	1.85	1.11	0.74	3.70	8.88
April	4.44	0.74	0.74	0.37	6.29	2.22	1.48	0.74	4.44	10.73
Total	38.85	6.29	4.81	5.92	55.87	20.72	13.32	4.81	38.85	94.74
Per cent composition	41.01	6.64	5.08	6.25	58.98	21.87	14.06	5.08	41.01	

B.b = *Bandicota bengalensis*; G.e = *Golunda ellioti*; M.b = *Mus booduga*; M.m = *M. musculus*; M.p = *M. platythrix*; R.m = *Rattus meltada*; R.r = *R. rattus*

B. bengalensis accounted for 41.01% of rodent population and it along with *M. musculus* and *M. booduga* (constituting 21.87 and 14.06% of population respectively) formed the major rodent species in pecan, the obervation being based upon trap indices (table 1). Other rodent species constituted only minor component of rodent population. The data also revealed that the exclusively field species accounted for 71.87% of rodent population comprising 52.73% field rats (*B. bengalensis, G. ellioti* and *R. meltada*) and 19.14% field mice (*M. booduga* and *M. platythrix*), while commensal forms which inhabited both fields and residential premises formed the rest of rodent population with *M. musculus* and *R. rattus* contributing 21.87 and 6.25% respectively.

The rodents showed specific territorial behaviour of their burrowing activity (table 2). The per cent prevalence of live-burrows of various rodents was mice (43.88) > lesser bandicoot rat (37.55) > other rat species (18.57).

B. bengalensis had its burrows all over the study area; 41.82% of these on the bunds and 58.18% in the field. Of the burrows in the field, a majority (65.28%) were located within a radius of 1.5 m around pecan trees (table 3) while the rest were more or less evenly distributed in the orchard away from trees. The live-burrows of mice were located mostly on the bunds (61.24%) and the rest were generally in the peripheral zone of the sub-plots. The burrows of other rats (i.e. *G. ellioti, R. meltada* and *R. rattus*) were also present mostly (70.24%) on the bunds and the rest (29.76%) were in the field (table 2). Only a few of these burrows in the field (18.03%), were at the base of the pecan trees (table 3). However, the burrows of other rats were commonly present at the base of shrubs both in the field and on the bunds.

Table 2 *Live-burrows of rodents in pecan orchard during* 1988-89

Period	Burrows of *B. bengalensis*			Burrows of other rat species			Burrows of mice			Total No. of burrows
	Bunds	Field	Total	Bunds	Field	Total	Bunds	Field	Total	
May	8.0	11.0	19.0	6.0	2.0	8.0	14.0	7.0	27.0	48.0
June	7.5	9.5	17.0	6.5	2.0	8.5	14.5	7.5	22.0	47.5
July	6.0	11.5	17.5	5.5	2.0	7.5	11.5	7.0	18.5	43.5
August	6.5	12.0	18.5	6.5	2.5	9.0	13.0	8.0	21.0	48.5
September	6.5	11.5	18.0	7.5	3.0	10.5	13.0	9.0	22.0	50.5
October	8.0	12.5	20.5	7.0	4.0	11.0	13.5	9.5	23.0	54.5
November	6.0	6.5	12.5	3.5	2.5	6.0	10.0	7.0	17.5	36.0
December	4.5	4.0	8.5	3.0	1.5	4.5	7.5	4.0	11.5	24.5
January	5.0	4.0	9.0	4.0	2.0	6.0	7.5	4.5	12.0	27.0
February	6.0	8.0	14.0	5.0	2.0	7.0	8.5	6.5	15.0	36.0
March	7.5	10.0	17.5	5.0	2.5	7.5	10.5	8.0	18.5	43.5
April	8.0	10.0	18.0	6.5	2.0	8.5	12.0	8.0	20.0	46.5
Average ± SD	6.62 ± 1.14	9.21 ± 2.84	15.83 ± 3.77	5.5 ± 1.37	2.33 ± 0.62	7.83 ± 1.78	11.33 ± 2.36	7.17 ± 1.55	18.5 ± 3.7	42.16 ± 8.97
Percentage of total burrows	15.71	21.84	37.55	13.04	5.53	18.57	26.87	17.01	43.88	
Percentage of burrows of individual type	41.82	58.18		70.24	29.76		61.24	38.76		

Though the live-burrows of mice were more in the orchard than those of bandicoot rats (table 2), yet the total trap indices of the two were observed to be equal (table 1). This may be due to the specific distribution of their burrows and home range. The burrows of mice were localised on the bunds and in the peripheral zone. Therefore they may have possibly escaped the trap line towards the centre of the fields, and hence relatively their low trap index as compared to that of *B. bengalensis*.

Damage: The rodents damaged only the root system of the pecans. Though rodents are on record to debark and to girdle the stem and shoots (Udagawa 1968, Kuo & Liao 1986, Malhi & Sheikher 1989) and damage fruits significantly in a variety of trees (Fiedler et al. 1982, Shamsuddin & Koya 1983), no such damage was observed during present studies.

The lesser bendicoot rat, *B. bengalensis*, burrowed at the base of the pecan (figure 1) and attacked the trees/plants from underground by gnawing and cutting the fine branches of roots as well as by girdling and completely destroying the main tap root (figure 2). The trees as a result deteriorated and ultimately fell dead (figure 3). It was recorded that the trees which had a rodent burrow system within a radius of 1.5 m (figure 1) were prone to fatal damage. Rodents killed 17.42% plants during 1988-89 in the orchards where no rat control operation was followed (table 4). It appeared that *B. bengalensis* was primarily responsible for damage since only this species had extensive burrows at the base of the trees. Fossorial rodents damage root system of a tree during their burrowing activity. In addition, the roots may also form a part of their food (Prakash 1981, Fiedler 1987, Malhi & Sheikher 1989). Further it was observed that the trees which were plus 20 years of age, could withstand the damage probably due to its large size and more elaborated and strengthened root system.

Though no records of rodent damage in pecan could be traced in literature, the rodents have been reported to cause very high damage to tree crops such as coconut, cocoa, banana, rubber, etc. (Fiedler 1987, Elias & Fall 1988, Hoque & Fiedler 1988, Malhi & Sheikher 1989).

Control: In the heavily infested orchard, two pulse treatments were given. In April 1989, the field was treated with 2.5% zinc phosphide through surface baiting which resulted in 29.27% success.

Table 3 *Distribution of live burrows in the fields*

Species	*Burrows*		
	Total number (average of one year)	Within a radius of 1.5 m (%)	Outside the radius of 1.5 m (%)
B. bengalensis	9.21	65.28	34.72
Other rat species	2.33	18.03	81.97
Mice	7.17	0	100

Table 4 *Damage in pecan*

Sampling period	Number of healthy plants (a)	Number of completely damaged/killed plants (b)	Number of plants likely to be killed (c)	Total number of plants (a+b+c)	Per cent damage $\left[\frac{b}{a+b+c} \times 100\right]$
1988-89	99	23	10	132	17.42
1989-90*	88	6	5	99	6.06
1990-91**	184	3	3	190	1.62

*Census after treating the field through surface baiting with 2.5% zinc phosphide followed by fumigation with aluminium phosphide tablets (April-May, 1989)

**Census after treating the field through burrow baiting with 2.5% zinc phosphide followed by 0.005% bromadiolone (April-May, 1990)

It was followed by fumigation with aluminium phosphide tablets after one month of zinc phosphide treatment. Fumigation achieved 66.67% reduction in live-burrows. This twin (pulse) treatment produced over-all 75.61% success (table 5).

Second pulse treatment was employed the following year. The live-burrows were baited with 2.5% zinc phosphide causing 62.07% reduction in live burrow count. After one month, the live-burrows (still remaining) were baited with 0.005% bromadiolone which caused 84.61% success. This pulse treatment achieved 93.1% overall success (table 5).

A survey of literature revealed that no systematic work on rodents as pests of pecan has been done. However, various authors have reported extensive rodenticides for their effective control (Shamsuddin & Koya 1983, Hoque & Fiedler 1988, Malhi & Sheikher 1989). For controlling rodents in coconut groves, crown baiting has been advocated as fruits are damaged the most. However, in pecan only roots are damaged and therefore burrow baiting is recommended; surface baiting has not proved effective during the course of present studies.

Since aluminium phosphide is a restricted fumigant and farmer cannot use it in absence of expert supervision, the other rodenticide pulse treatment (i.e. burrow baiting with zinc phosphide followed by bromadiolone) can safely and hence recommended.

Acknowledgement

The authors are grateful to ICAR, New Delhi for financial aid and to Dr O.P. Bhalla, Professor and Head, Department of Entomology and Apiculture, Dr Y.S. Parmar University of Horticulture and Forestry, Solan, for the laboratory and other facilities.

— **Figure 1** Burrow openings (arrow) of *B. bengalensis* at the base of the tree

— **Figure 2** Girdled and chiselled (completely cut) tap roots of two trees

— **Figure 3** Pecan tree felled by rodents

Table 5 *Efficacy of control operation in Pecan*

S.No.	Treatment	Live burrow count		Per cent success of treatment	Per cent success of pulse treatment
		Pre-treatment census (a)	Post-treatment census (b)		
1	Surface baiting with 2.5% zinc phosphide	41	29	29.27	
2	Fumigation with aluminium phosphide	30	10	66.67	75.61
3	Burrow baiting with 2.5% zinc phosphide	29	11	62.07	
4	Burrow baiting with 0.005% bromadiolone	13	2	84.61	93.1

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