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Damage by *Bandicota bengalensis* to growing wheat in Bangladesh and methods of control

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Wheat is an increasingly important dry-season grain crop in Bangladesh. Rat damage, caused primarily by *Bandicota bengalensis*, to the wheat crop in 1979 was estimated from surveys to amount to 12.1 %, or a loss of 77 000 tons. Damage assessments were based upon random selection of areas, villages and fields to be surveyed. Quantitative estimates were made from actual counts of cut and uncut wheat stems in quadrats located on transects along field diagonals. Damage before the booting stage of maturity remained less than 1 % but increased rapidly from 2 to 12 % between 60 and 120 days after sowing. Control methods were developed for use by individual farmers. These rely on placing 5 to 10 g of zinc phosphide bait cakes into each rat burrow opening in fields. Farmers using these baits reduced damage by 72 % over those farmers that did nothing or used locally-available rodenticides. Training of extension workers and plant protection inspectors in methods of rodent damage assessment and control is underway. Large-scale damage assessments and damage control using zinc phosphide baits are planned for the next seasons.

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1. Introduction

Wheat is becoming an increasingly important grain crop in Bangladesh. Along with the increase in area planted to wheat and its rise in production has come an increase in rodent damage to the growing crop. Prior to 1979 no estimate was made of losses to the wheat crop caused by rodents. Damage assessments carried out in four wheat-producing districts in 1979 gave an estimated loss of 12.1 % of the total crop, amounting to 77 000 tons worth U.S. $ 13 million (Poché et al. 1982).

Rat damage to growing wheat is caused primarily by the lesser bandicoot rat, *Bandicota bengalensis*, which occurs throughout the wheat-producing areas of Bangladesh (Poché et al. 1982). Studies of the ecology of *B. bengalensis* in wheat fields in Bangladesh were made in 1979, 1980 and 1982, and during 1981 a large-scale demonstration of farmer-use of pre-packaged rodenticide baits to reduce rat damage to maturing wheat was carried out. The results of these studies are reported here.

2. Method and materials

Wheat fields were selected for damage assessment using random sampling procedures. In 1979, districts, thanas and villages were numbered on maps and drawn by lots. At each chosen village, 8 fields were selected along 4 transect lines at distances of 100 and 200 m from the village center. In 1982, fields were selected from preset automobile routes in certain thanas, stopping every 2 km and taking the 2 fields nearest the road on each side and 2 fields 100 m distance from the stopping point.

In each field, 2 rows of 5 quadrats each, measuring 50 by 100 cm, were laid along the length of the field. Each transect row was located one-third of the field width in from the edge (Poché et al. 1982). In 1981 and 1982, five 50 by 100 cm plots were taken on a transect along the field diagonal. All wheat stems, cut and uncut, were counted within the sampled quadrat and the stage of crop maturity noted. In assessing farmer-use of rodenticides, the farmer was interviewed after the damage assessment to determine if he used the pre-packaged bait, used other materials or did nothing (Fiedler et al. 1981).

The effect of damage on yield was evaluated in 20 fields (Poché et al. 1982) by cutting all panicles on 5 × 1 m² quadrats spaced equidistant on the field diagonal after the number of cut and uncut stems was noted. Panicles were dried, threshed by hand and weighed to the nearest g. The observed yield (Yo) and potential yield (Yp) were compared for each field. Potential yield was calculated as Yp = Yo N/n, where Yo was the weight of grains harvested, n was the number of undamaged panicles and N was the total number of damaged and undamaged panicles (Gomez 1972).

3. Results

Rat damage to wheat in 1979 was low during the tillering stage (7 to 60 d); the average percentage of cut stems for all fields remaining under 1 % until the crops were 60 days after sowing (Poché et al. 1982). At the booting stage (60 to 75 d) and up to harvest at 120 d, rat damage increased from 2 to 12 %. Dacca District

had the highest damage and Jessore the lowest (Table 1). Damage has been shown to vary from season to season (Poché et al. 1982, Posamentier & Alam 1980, Fiedler et al. 1981), mostly depending upon the distribution and abundance of rainfall during the growing season. The low damage levels recorded in 1980 were thought due to heavy rains in the spring that flooded many fields, forcing rats out of their burrows (Poché et al. 1982). The effect of irrigation in reducing rat damage or abundance in wheat fields has been reported by Poché et al. (1982) and noted by Brooks et al. (1982) as given in Table 2. Rats begin cutting and storing wheat panicles from the booting stage on. Prior to that they do some cutting of wheat leaves and stems, some for food and some for nesting materials. Stems are felled by cutting their bases from 4 to 15 cm above ground and the base of the panicle is cut from the stem and stored underground. Damage is most severe in the immediate proximity of the burrow openings, cut stems decreasing by 50 % beyond 2.5 m distance and dropping sharply beyond 6 m (Poché et al. 1982). Damage is highest between entrances to the same burrow system. It is apparent that *Bandicota* forages in close proximity to its burrow openings.

Table 1. Rodent damage to mature wheat in several districts in Bangladesh: 1979 data from Poché et al (1982), 1980 from Posamentier & Alam (1980) and 1981 from Fiedler et al. (1981).

Year	No. of fields	Percent damage			
		Dacca	Comilla	Pabna	Jessore
1979	119	14.0	13.0	12.5	7.0
1980	355	5.0	1.5	5.0	1.3
1981	169	9.1	5.7	—	—

Table 2. Rat infestation in irrigated and non-irrigated (rainfed) wheat fields in Bangladesh, 1982 (Brooks et al. 1982).

Type of field	No. rat-infested	No. not rat-infested	Total
Irrigated	22	34	56
Non-irrigated	138	43	181
Total	160	77	237

Table 3. Rodent damage to mature wheat in several districts in Bangladesh in 1982 (Brooks et al. 1982).

District	No. of fields	No. of cut stems	Total stems examined	Percent damage
Dinajpur	34	582	15 266	3.8
Rangpur	12	179	4 101	4.4
Rajshahi	30	456	10 943	4.3
Tangail	76	2 042	30 480	6.7
Dacca	55	4 095	25 504	16.1
Comilla	30	1 030	13 430	7.7
Totals	237	8 388	99 724	8.4

Table 4. Observed rat damage to mature wheat in fields in Gazaria Thana, farmer-treated with pre-packaged zinc phosphide baits, with other rodenticides or with no treatment (Fiedler et al. 1981).

Treatment	No. of fields	Cut stems	Stems counted	Percent damage
Zinc phosphide	20	334	12 752	2.6
Other rodenticides	8	432	4 820	9.0
No poison	80	4 480	48 523	9.2

Rat damage to mature wheat in 1982 averaged 8.4 % in 6 districts sampled in Bangladesh (Table 3). Damage was lightest in the northwestern districts of Dinajpur, Rangpur and Rajshahi and heaviest in Dacca in low-lying soils that are flooded during the monsoon season. The 1982 estimated harvest of wheat in Bangladesh was 800 000 tons. The loss to rat damage comprised 73 000 tons valued at U.S. $ 15.7 million (Brooks et al. 1982).

The effect of damage on yield showed that at the tillering stage, stem cutting had little impact on yield because of compensatory growth of the wheat plant (Haque et al. 1980). From booting on, however, the effect of stem cutting on decreased yield becomes more profound as crop maturity approaches. There was found to be a strong relationship ($r = 0.978$) between rat-damaged stems and yield loss, expressed by the formula $Y = 13.12 x - 17.38$, where Y is the loss in g of wheat/m^2 and x is the percent of cut stems/m^2 (Poché et al. 1982).

A demonstration of reduction in rodent damage to wheat was carried out in one thana by the Vertebrate Pest Section (Fiedler et al. 1981). Pre-packaged zinc phosphide bait cakes (2 % a.i.), produced at the Vertebrate Pest Laboratory, were sold to wheat farmers at cost at the thana central market. Farmers were advised to apply baits into the burrow openings from the booting stage of crop maturity on, or whenever the damage level in fields became noticeable. A 100 g bait package was usually sufficient to treat an average field of less than 0.1 ha. Random surveys of wheat fields just before harvest were made and it was determined if the farmer had used the pre-packaged bait, had used other locally-available rodenticides or had done no control. Results of these findings are given in Table 4. Twenty farmers (18.5 %) had used the zinc phosphide bait in their fields. Their level of damage was only 28 % of that of farmers using other rodenticides or doing nothing. This reduction in damage was achieved with very little supervision of the farmer. The simple instructions given at the time of bait sale was our only contact. The rest was achieved by the farmers on their own (Fiedler et al. 1981).

The cost/benefit analysis of this trial was made. It cost the farmers about U.S. $ 0.75 to treat 1 ha with zinc phosphide bait. The benefit gained was a saving of 72 % of the average of 9.1 % loss of wheat, which in 1981 would have amounted to 130 kg extra wheat/ha, worth U.S. $ 22.75. The cost/benefit ratio is 1 to 30.

4. Discussion

Coordinated research on rodent damage to wheat and development of methods of control is being done by the Vertebrate Pest Section based at the Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh. Annual surveys of damage to the wheat crop is carried out independently both by the Vertebrate Pest Section and by the Bangladesh-German Plant Protection programme based in Dacca. Training of extension and plant protection personnel throughout the country has been done by the Bangladesh-German programme, while workshops for agricultural scientists and extension and research personnel have been held by the Vertebrate Pest Section. Attempts are being joined by both programmes to institute a vertebrate pest control curriculum at the Mymensingh Agricultural University at Mymensingh. This action is being coordinated by the Bangladesh Agricultural Research Council at Dacca.

Much remains to be done before real countrywide reduction of rat damage to wheat can be accomplished. Large-scale formulation of zinc phosphide bait cakes should be undertaken by private enterprise and a country-wide distribution network be established in all wheat-producing districts. Farmers are eager to purchase effective baits at nominal costs and they know how to use them. Another pressing problem is to establish a predictive model of years in which damage to wheat will be abnormally high. Generally this can be expected to occur in drier than normal wheat-growing seasons. Along with this is the need to further refine our methods of assessing rodent damage to wheat crops.

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