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COMPARATIVE EVALUATION OF TWO ANTICOAGULANT AND TWO ACUTE RODENTICIDES IN SUGARCANE FIELDS

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ABSTRACT

Field study was conducted to evaluate the effectiveness of formulated baits of 0.005% brodifacoum, 0.0375% coumatetralyl, 0.005% bromethalin and 2% zinc phosphide against field rats inhabiting sugarcane crop. The efficacy was calculated on the criterion of reduction in rodent activity, damaged canes and yield of harvested canes. After five applications of baits, the rodent activity reduced to 90-96% except for zinc phosphide treatment where in it reduced to 76.04%. The counts of damaged canes on treated plots varied from 1.1-2.5%, while on non-treated plots, the damage ranged 13.0-29.9%. Yield of cane significantly increased (26.64-32.92%) on three treated sites except on zinc phosphide site where cane yield increased by 9.89%. It is estimated that one percent rat damage to canes is equal to 0.42% loss in sugar recovery. This study indicated that rodent control in sugarcane is economical and returns on costs ranged 27 to 50-folds.

INTRODUCTION

Sugarcane (*Saccharum officinarum*) crop is an important industrial and cash crop in Pakistan. It serves as a major raw material for production of white sugar and gur. Sugarcane tops and molasses are valued as livestock fodder while bagase is used as fuel and as an input to the paper and chipboard industry and press mud used as a source of organic matter and plant nutrient. Its share in value added in agriculture and GDP are 3.6 and 0.8 percent, respectively (GOP, 2006). Pakistan occupies an important position in cane producing countries of the world. It ranks 5th in cane area and 15th in sugar production (FAO, 2003). However, there is further need to improve the productivity through better crop management including rodent control.

Sugarcane is highly vulnerable to damage by field rats. It being a long duration crop provides an excellent protective cover to burrowing, nibbling, feeding and breeding activities of rodents almost throughout the year. The problem of rodent pests is further aggravated in the areas where small land holdings are surrounded by other short duration crops. In such situations the sugarcane crop is periodically threatened by the waves of rodent migration from the surrounding fields as a result of frequent disturbances during ploughing, irrigation, harvesting and other agronomic practices. As a result of this agro-ecological situation, sugarcane suffers heavy damage due to rodent attack.

A complex of species of field rats inhabit sugarcane crop. The major species causing damage are: *Bandicota bengalensis, Nesokia indica, Millardia meltada and Mus* spp. (Hussain *et al*., 1975; Smiet *et al*., 1978, 1980; Khan, 1982). Hussain *et al.* (1975) found that *M. musculus* could attain high abundance in sugarcane crop over a period of 11 months while Beg *et al.* (1980) described that the first three species remained in sugarcane fields from six to nine months and from there migrate to wheat fields. A comprehensive study by Smiet *et al.* (1980) in sugarcane fields in lower Sindh (Thatta district) indicated that *M. meltada* was the most abundant species and could maintain stable resident population throughout the year like *N. indica.* They also found that *B. bengalensis* ate cane tissues more frequently than *M. meltada.* This also suggested that sugarcane serves as a source of rodent infestation to other crops (rice and wheat).

Damage by rodents to the canes affects their weight and sugar contents. Sugar content is reduced by the general debilitating effect of the rodent injury, by fermentation of the juice and by increased susceptibility of a variety of diseases such as red rot, *Physalospora* spp. (Collado and Ruano, 1962; Bates, 1969). Such secondary effects may be more serious than the direct losses due to consumption of canes by rats (Hood *et al.*, 1970).

Economic losses due to rodent damage to sugarcane in Pakistan have not been well documented based on scientific sampling methods. Beg *et al.* (1979) reported 11% damage to canes in three districts of central Punjab. It was estimated that rat depredations might have resulted in 4-15% loss in sugarcane production. Fulk *et al.* (1980) estimated 7.2 and 4.4% damaged canes in four districts of Punjab and Sindh during 1978 and 1979, respectively. They calculated that rodents reduced sugar production by an average of 10.7% in 1978 and 7.7% in 1979). Mishkat *et al.* (2006) estimated 10.77% reduction in sugar recovery because of rat damage in sugarcane growing areas of Mandi Bahauddin, Phalia, Balwal and Khushab. Based on food habits of rodents in sugarcane fields,

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Smiet *et al.* (1980) estimated 24% damage to canes in Thatta district of lower Sindh. Khan (1990) calculated economic loss of Rs. 140.6 m annually based on 1986-87 production and support prices.

This study was designed to determine the field efficacy of 0.005% brodifacoum wax blocks (Klerat), the usage of which has been suggested/recommended by many workers in cane fields. Little work has been conducted in cane fields with single feed anticoagulant brodifacoum. However, in some field situations as well as in the laboratory, brodifacoum has been shown to be highly effective against most of the world's major rodent pests of sugarcane including *Rattus* spp., *Sigmodon hispidus, B. bengalensis, Holochilus brasiliensis, Tatera indica, Arvicanthis niloticus and Peromyscus* spp. (Brooks, *et al.*, 1979; Lund, 1981; Greaves and Rehman, 1977).

MATERIALS AND METHODS

Experimental sites

The trial sites of varying sizes (8-12 ha) were selected in cane growing areas of Thatta Sugar Mills, 125-150 km south-east of Karachi and were located in sub-division of Sujawal. The criteria for the selection of sites was based on the approximately uniform development period of the crop and same variety of cane. On all sites BL-4 variety was cultivated.

Baiting, Bait Usage and Monitoring Rodent Activity

Baiting was initiated in the first week of June and terminated by the end of October, 2 weeks before harvest. All together five applications were made. The quantity of bait used for each application was recorded for cost analysis of treatments. The baiting was conducted along the bunds and on two transects lines, equally spaced, inside the fields. On each bait point, spaced by 10 m, 1 pile of 100 g of coumatetralyl (0.0375%) bait made up from broken rice, 25 g rat-cake bait (Smythe and Khan, 1980) of zinc phosphide (2%) and bromethalin (0.005%) and one 20 g wax block of 0.005% brodifacoum (Klerat) were placed. Before and after (2 weeks) each application rodent activity was monitored along the bunds and inside the fields by placing tracking tiles at intervals of 20 m (Lord *et al*. 1970). Based on positive tiles rodent activity index was calculated. For rodent activity and cane yield assessment 20-50% of the treated area was sampled. The costs of bait used were calculated at market prices prevalent at the time of trials. The efficacy of the four rodenticide baits was calculated on the criterion of reduction in rodent activity, yield of harvested canes and counts of damaged canes.

RESULTS AND DISCUSSION

The results of field trials are summarised in Table I, II, III. These trials were aimed at to evaluate the comparative effectiveness of wax blocks of 0.005% brodifacoum (Klerat), 0.0375% coumatetralyl (Racurnin), 2% zinc phosphide and 0.005% bromethalin (Vengence) against *B. bengalensis, M. meltada, N. indica and Mus* spp. which are common rodent pests infesting sugarcane fields in lower Sindh (Smiet *et al*., 1980).

The rodent activity significantly reduced (90-96%) after five applications of all the rodenticide baits except for zinc phosphide treatment where it reduced to 76.04%. The pattern of rodent activity reduction after bait applications was similar in all cases except for bromethalin. This may be due to delayed mortality, a characteristic of it, or initial extended exploration period. The pattern of bait usage (Fig. 1) also confirm the steady reduction in rodent activity except for brodifacoum where it fluctuated between August and September. Redhead (1968) reported the usage of different first generation anticoagulants against *R. conatus* in Queenlands sugarcane fields. The percent mortality obtained with warfarin (0.025%), racumin (0.025%) and chlorophacinone (0.005%) was 70, 90 and 90%, respectively and are in agreement with the results of the present study.

Wang (1981) evaluated the efficacy of brodifacoum at different concentrations in the laboratory against *B. nemorivaga, R. losea, R. norvegicus, R. rattus* and *M. formosanus,* rodent pests commonly found in sugarcane fields in Taiwan. He obtained 86-96% control of rats with the usage of 1-2 kg/ha of the bait, which was less than half of warfarin baits generally used in Taiwan. Parshad *et al.* (1987) evaluated the effect of multiple poison baiting of rodents with brodifacoum (0.005%) and zinc phosphide (2.4%) in different fields of sugarcane. The results showed significant difference in their performance within and between fields. The rodent control success achieved ranged from 23-45.6% in the months of August and September and 68.1-93.4% in October to December. Overall reduction in post-treatment activity of rodents was 47.2 and 96.1% in different fields treated with zinc phosphide and brodifacoum, respectively. The results are comparative to brodifacoum wax blocks treatments in this study. Similar results have been reported by Wagle (1987) while using bromadiolone in sugarcane fields in Uttar Pradesh (India). Trials conducted in Indian Punjab with two baitings with 0.005% flocoumafen, a similar compound to brodifacoum, brought about 85.57% control of rodents in cane fields (Srivastava, 1992).

For application of formulated bait of rodenticides in sugarcane fields, the relationship between the size of bait points and the spacing between points on the ground may be crucial for effective and economical control (Teshima, 1976). With good cover and plentiful food, the movement range of the rodents may be very limited as in matured cereal crops. Baiting must, therefore, be frequent, but very small bait points may decrease the chance of a rodent to obtain a lethal dose. In practice, bait size and the density of bait points may be dictated by other factors and the rate of application, therefore, be adjusted to obtain the required level of control.

The bait usage ha^{-1} of the two anticoagulant rodenticides varied between the treatments, and on the average the quantity applied was 1.57 kg /ha and 4 kg /ha of brodifacoum and coumatetralyl, respectively. Parshad *et al.* (1987) used 1 kg /ha of brodifacoum which resulted 22.4 to 45.6% reduction in rodents in the months of August and September and 68.1 to 78.9% in November and December. Brodifacoum wax blocks in this study were highly accepted by the rodents than the coumatetralyl bait, being getting mouldy and less palatable. Bait intake data for the first two applications (June-July) indicated that 94.11 and 63.15% bait points of brodifacoum and coumatetralyl were consumed, respectively.

A general assessment of damaged canes was made 15 days before harvest. Three to four fields were randomly selected from the experimental sites. The counts of damaged canes on treated plots varied from 1.1 – 2.5%, while on non-treated plots, this ranged from 13- 29.94%. Yield data taken from randomly selected fields indicated significant increase (26.64 – 32.92%) on all sites except on zinc phosphide site (Table II) where 9.89% increase was recorded. Chemist of Thatta Sugar Mills estimated that 29.94% cane damage was equal to 12.47% loss in sugar recovery.

Economic returns on the costs of control measures were highly significant, benefits ranged from 27 to 50 folds (Table III). This strongly suggest the need to adopt rodent control measures in sugarcane crop for higher yields and to obtain additional profits. Cost-benefit ratio of about 1:20 has been reported for rodent control in sugarcane (Hampson, 1982). Theoretical calculations suggest that a yield increase less than 0.5% can justify rodent control (Hampson, 1982). Cost-benefit ratio of multiple baiting in different combinations twice annually have been recorded from 1:8 to 1:25 (Ahmad and Parshad, 1991 a,b).

A number of examples of the costs and benefits of rodenticide applications in sugarcane have been published. In Egypt, a study showed that rodent control costing £ 4300 gave a return of £ 86,000, a ratio of 1: 20 (Hopf *et al.*, 1976). The same report states that in Australia an investment of £4000 gave a return of £ 27,000 (1 : 6.75), whilst Hitchcock (1973) concluded that a reduction in damage by 3% in Australia would result in an economic gain. Rodent control in Jamican sugarcane has been reported to give a cost/benefit ratio of approximately 1: 5 (Frank, 1970). In Pakistan, zinc phosphide has been estimated to give a 1:36 return, whilst a more expensive coumatetralyl treatments gave a return of 1:11 (Khan, 1977). Trials and practical use suggest that substantially larger gains in yield may be obtained by the correct use of rodenticide baits, and even at very low levels of damage their application must generally be beneficial.

CONCLUSION AND RECOMMENDATIONS

Five monthly applications of baits of all the four rodenticides significantly reduced rodent populations in cane fields. On the average harvested cane yields increased by 23.15%. It is estimated that one percent rat damage to cane is equal to 0.42% loss in sugar recovery. This study also showed that rodent control in sugarcane is highly economical, and returns on costs were 27 to 50-folds. Multiple baiting (5-6) with anticoagulant is recommended for effective rodent control in cane fields. The second strategy could be one baiting with 2% zinc phosphide followed by 2-3 baitings with anticoagulants. For more effective rodent control pre-baiting is advisable when using zinc phosphide bait.

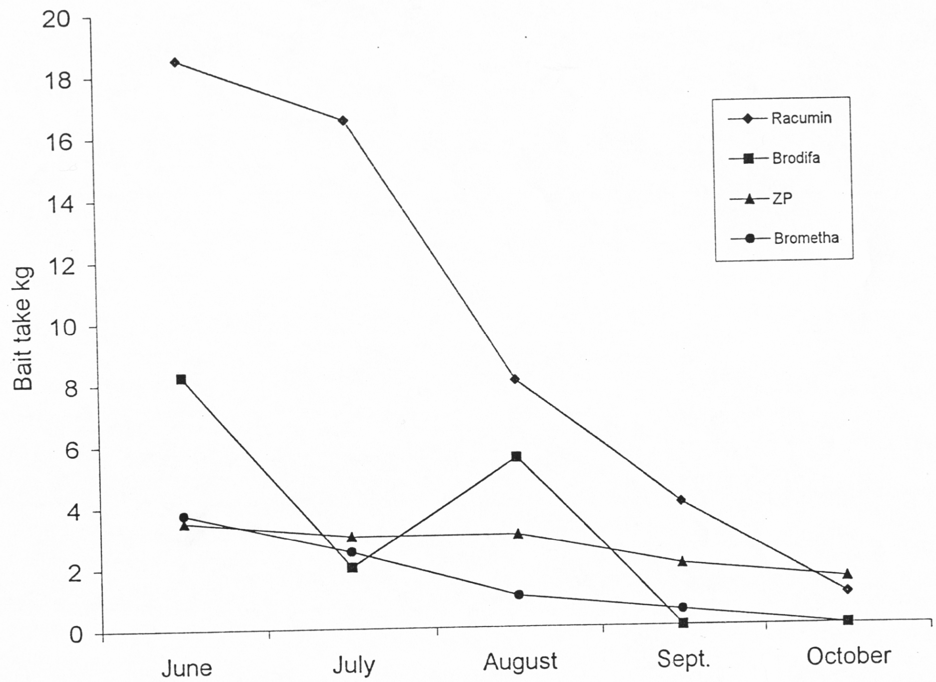

Fig. 1. Pattern of bait usage of different rodenticides in cane fields

Table I. ***The effect of different rodenticide baits on rodent activity in sugarcane fields measured by tracking tiles***

Treatments	Size of area (ha) index	Pre-treatment (%) index	Post-treatment (%)	% Reduction
Brodifacoum 0.005 % wax blocks	10(5)*	50.00	2.00	96.00
Coumatetralyl 0.0375 %	12(6)	60.00	5.26	90.00
Control	**10(5)**	**52.63**	**65.00**	**-**
Bromethalin 0.005%	11(5)	57.89	4.26	92.64
Zinc phosphide 2%	8 (3)	55.57	13.31	76.04
Control	**12(6)**	**66.67**	**75.5**	**-**

* In parentheses is the size of sampled area for measuring the rodent activity

Table II. ***Mean yields of harvested cane from the experimental sites***

Treatments	Area sampled (ha) Treated	Mean Yield tonnes/ha Control	% increase	Yield ratio

Brodifacoum 0.005% wax blocks	4.04	81.29	57.29	29.62	1:42
Coumatetralyl 0.0375 %	2.0	78.10	57.29	26.64	1:36
Bromethalin 0.005%	2.75	79.18	53.11	39.92	1:49
Zinc phosphide 2%	2.83	53.57	48.27	9.89	1:11

Table III. ***Bait usage, costs and returns for increased yields in sugarcane crop***

Treatments	Bait used (Kg/ha)	Cost of bait (Pak. Rs/ha)	Return* (Pak. Rs/ha)	Cost/Return ratio
Brodifacoum 0.005 % wax blocks	1.57	203.00	5614.00	1:27.6
Coumatetralyl 0.0375 %	4.0	93.00	4865.00	1:52.3
Bromethalin 0.005%	0.7	FOB		cost at Karachi not known
Zinc phosphide 2%	1.88	30.00	1239.00	1:41.3

* Exclusive of labour charges. Baiting was done by the author and his team.

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