

DEVELOPMENT OF VERTEBRATE PEST MANAGEMENT MODELS FOR SUGARCANE CROP

Syeda Azra Tariq, Amjad Pervez, Syed Muzaffar Ahmed and Hina Zafar
Vertebrate Pest Control Institute, Southern-Zone Agricultural Research Centre,
Pakistan Agricultural Research Council, Karachi University Campus, Karachi-75270
Email: sazratariq@yahoo.com

ABSTRACT

Sugarcane crop is heavily damaged by a complex of rodent species and wild boar. The damaged sugarcane becomes infested with microorganisms and other physiological stresses, resulting in reduction of weight and sugar recovery. In this regard a study was carried out to know the damage caused by rodents to four varieties of sugar cane grown at Thatta. In these studies maximum damage by rodents was observed to BL-4 ($10.29 \pm 0.44\%$) variety followed by BL-129 (10.23 ± 0.35) and Thatta-10 ($7.31 \pm 0.22\%$) in the month of November. To manage the vertebrate pests Integrated Pest Management approach was tested and the pest management model is designed for its adoption by the sugarcane growers after research and practical studies. In these studies egg mixed brodifacoum bait proved the most promising one in achieving ($92.55 \pm 0.55\%$) rat reduction followed by bromdiolone ($89.87 \pm 0.6\%$) and Zinc Phosphide bait ($84.10 \pm 1.00\%$). Paraffinized Zinc Phosphide Capsular Technology used to kill wild boar population proved very successful by reducing the activity upto 98.11 Percent on the fifth day. The proposed model is a combination of mechanical, chemical and habitat manipulation approaches, which will help to enhance the crop yield through minimizing pest infestation.

INTRODUCTION

Sugarcane (*Saccharum officinarum*) is a major, widespread cash crop of Pakistan. It is a high value crop for making sugar, sugar-related products, chipboard, paper etc. The crop accounts for 3.6% value added share in agriculture and 0.7% share in GDP of the country (Pakistan Economic Survey 2017-18). It provides raw material to approximately 77 sugar factories besides indigenous "brown sugar" cottage industry (A. P. Com, 2003). Sugar industry is the second largest industry after

textile and plays an important role in economy of the country (Memon, 2002). It must spearhead the research and development efforts so as to meet its raw material requirements (Hussain *et. al.* 2006). Sugarcane is a profitable crop for growers as long as growing problems do not overtake the fields. One of the major problems is invasion of the vertebrate pests. Sugarcane crop is heavily damaged by a complex of rodent species including *Bandicota bengalensis*, *Nesokia indica*, *Millardia*

meltada and *Mus booduga* and wild boar, *Sus scrofa*. Sugarcane is a long duration crop and thus provides an ideal condition for a complex of rodent population to subsist and cause extensive damage through eating into internodes and roots. This damage becomes more prominent in lodged sugarcane. Rat damaged sugarcane becomes infested with various microorganisms and other physical stresses resulting in reduction of its weight and sugar recovery. Hampson (1984), recorded 3.7% (range 3-4%) mean sugar loss for every 10%

damage of sugarcane. In a rat damage survey by Fulk *et. al* (1980) at Fauji Sugar Mill, Khoski, Badin, 10.7% loss to sugar production was recorded. In a rodent control program conducted in sugarcane growing areas of Army Welfare Sugar Mills, Badin district, 2% Zinc Phosphide baiting decreased 74% rodent population (Khan and Munir, 2006).

After extensive surveys conducted in Punjab and Sindh provinces, a complex of five rodent pest species and wild boar have been recorded to invade and inflict severe damage to sugarcane crop. These rat pest species are: lesser bandicoot rat, *Bandicota bengalensis*; soft-furred field rat, *Millardia melitana*; short-tailed mole rat, *Nesokia indica*; Indian gerbil, *Tatera indica* and field mouse, *Mus booduga*. Wild boar, *Sus scrofa*, causing enormous damage in Punjab and Sindh provinces and is considered a major pest of sugarcane. Rats and wild boar have been reported to collectively causing an annual loss of 457.5 million rupees approximately. In view of severity of the problem and to obtain high sugar yield, many scientists of Vertebrate Pest Control Institute conducted in-depth laboratory and field trials related to rodent and wild boar management through traditional and poison baiting (Smythe, 1977; Fulk *et. al.*, 1978 & 1980; Smiet *et. al.*, 1979 & 1980; Beg & Khan,

1982; Shafi & Khan, 1983; Brooks *et. al.*, 1989; Shafi & Khokhar, 1989; Khan, 1991; Khokhar *et. al.*, 1995; Khokhar & Rizvi, 1995, 1998 & 1999; Pervez *et. al.*, 1999 & 2005; Roberts, 1997; Rizvi, 2004; Pervez *et. al.*, 2016; Tariq *et. al.*, 2016 & 2017).

An Integrated Pest Management approach was practiced to manage rodents and wild boar damage. The package successfully developed after a series of trials and is now ready for adoption by the end-users.

MATERIAL AND METHODS

The experiments were carried out at National Sugar Crop Research Center (NSCRC) experimental farms and farmer's fields at Makli, Thatta. The IPM based rat control trials were conducted on three sugarcane varieties, i.e., Thatta-10, BL-4 and BF-129 (Gulabi).

Rat management approaches were based on:

1. Mechanical

Snap traps
Gopher Kill traps
Live traps

2. Chemical

Use of Zinc Phosphide bait
Use of brodifacoum bait

Use of Aluminum Phosphide tablets

3. Habitat Modification

Removal of weeds
Sanitation of bunds

4. Wild boar Capsular Technique

For wild boar control poison baiting through embedding Zinc Phosphide capsule in wheat flour dough was applied with strict vigilance to avoid any mishap of eating by non-target species.

RESULTS

Results of the studies are depicted in Tables-8. Table-1 shows overall percentage of sugarcane damaged by different rodent species on three sugarcane varieties during July, September and November 2007. BL-4 variety was recorded the worst attacked by rats followed by BF-129 variety. Whereas, Thatta-10 was least damaged by rats. The damage variation among the three varieties was highly significant in the month of July whereas significant in the months of September and December (Table-2). Rodent control trials were conducted at various growth stages of crop on three different varieties, viz Thatta-10, BL-4 and BF-129. The results of additive poison baiting [using mixture of wheat flour and broken rice as bait base, egg 3% and Brodifacoum rodenticides (0.005%)] proved very promising bait for successful control of rodent pest population. This bait

package, named as **PARC Rat Bait**, has already been tested in sugarcane crop resulting 92.63% reduction in pest population (Table-3). As per results reduction in rodent activity was highly significant after poison baiting (Table-4). Besides, rats on *bunds* can be controlled through fumigation by Aluminum Phosphide tablets commonly known as Detia tablets.

For wild boar control, Zinc Phosphide capsule embedded in wheat flour dough and coated with milk powder have proved very successful in eradication of their population. The trails were carried out in sugarcane fields in four district of Punjab (Table-5). The trials were very successful and the bait intake and reduction in activity was reduced from 92.67 to 98.11 Percent on the fifth day (Table-6), complete results are shown in Tables 5 & 6. Wild boar control trails using capsular baiting technique in sugarcane field trails proved very successful by declining pig activity. In Table -7 mean reduction in intake/activity of the bait by wild boar in all the areas of the four districts is depicted. The results were highly significant for all the areas and district in regard of reduction in wild boar activity (Table-8) accordance.

DISCUSSION

Rodents are one of the major problems directly concerning

to the production, storage and processing of the agricultural crops a accordance nd their eventual utilizations by man and his livestock as food (Sarwar *et al.*, 2011; Sarwar,2015 a; Sarwar, 2015 b). Sugarcane is highly vulnerable to attack by a complex of rodent pest species due to its long duration thus providing an excellent protective cover for rats to feed and thrive almost throughout the year (Smiet *et al.*, 1978 & 1980; Khan and Munir, 2 accordance 006). The results of the treatments of three rodenticidal bait formulations clearly indicated the success of PARC Rat Bait in red accordance uction of rodent population and decline in sugarcane damage. Observations on the damage survey conducted during 2007 in Thatta District shows that BL-4 was heavily attacked variety due to its softness compared to Thatta-10 and BF -129. It is worth mentioning that BL-4 is the most grown sugarcane variety in lower Sindh (Smiet *et al.* 1980). Results of the experiments of rodent control using acute Zinc Phosphide bait with egg and second generation anticoagulant baits of brodifacoum and bromadiolone rodenticides (0.005% each) mixed with egg were applied in pellet form. In these studies egg

mixed brodifacoum bait proved the most promising one in achieving (92.55±0.55%) rat reduction followed by bromdiolone (89.87±0.6%) and Zinc Phosphide bait (84.10±1.00%). These findings are in line with the trials conducted in paddy and wheat by Pervez *et. al.* 1999 & 2005. Similar poison baiting trails conducted for sugarcane in India and Elsevier by Hampson (1984) have clearly shown the complete control of rodent pests and reduction in damage to crop. Performance of bait offered is affected by a number of ecological factors in field situation, such as rodent species composition, post-control re-infestation, stage of crop development, climatic factors, crop harvesting time and intercropping heterogeneity (Parshad *et. al.*, 1986). By considering all these factors, the rodent and wild boar management package is developed for these pests.

Paraffinized Zinc Phosphide Capsular Technology was used to kill wild boar population successfully. In the Punjab, 80.4% to 100.0% reduction in pig activity was noted through application of the capsular technique (Khokhar & Rizvi, 1998) these previous studies are in accordance with these findings. The damage studies were conducted in early maturity stage of crop when less dense cover was

available for pigs. Wild boar is also known to cause colossal losses to wheat, maize, vegetables, cotton and fruit crops (Khokhar and Rizvi, 1998) and by using this

poison capsular technology the pest may be managed.

Table-1 Damage by Rats to Different Sugarcane Varieties at District Thatta

Varieties	Month wise Percent Damage (Mean±SE)		
	July	September	November
Thatta-10	5.85± 0.15	6.73±0.37	7.31±0.22
BL-4	9.34± 0.28	9.13±0.57	10.29±0.44
BF-129	6.08± 0.09	9.97±0.25	10.23±0.35
LSD ^{0.05}	0.61182	1.253	1.1144

Table-2 ANOVA for Damage by Rats to Different Sugarcane Varieties

Months		Sum of Squares	df	Mean Square	F	Sig.
Percent damage (July)	Between Groups	30.47625	2	15.238125	104.2953	5.9527E-07
	Within Groups	1.31495	9	0.146105556		
Percent damage (September)	Between Groups	23.31291667	2	11.65645833	24.01207	0.00024651
	Within Groups	4.368975	9	0.485441667		
Percent damage (November)	Between Groups	21.11291666	2	9.655833113	22.01207	0.00234521
	Within Groups	4.368975	9	0.485441667		

Table-3 Reduction in Rodent Population in Sugarcane Crop after Three Different Bait Formulations

Treatment	Pre-Treatment Activity	Post-Treatment Activity	Reduction in Rodent Activity (%)
Brodifacoum* (0.005%) with egg additive	94.25±1.55	7.00±0.41	92.55±0.55
Bromadiolone (0.005%) with egg additive	83.75±2.75	8.50±0.65	89.87±0.6
Zinc Phosphide (2.00%) with egg additive	79±3.58	12.5±0.65	84.10±1.00

* PARC Rat Bait.

Table-4 ANOVA for Reduction in Rodent Population in Sugarcane Crop after Three Different Bait Formulations

Bait Formulations		Sum of Squares	df	Mean Square	F	Sig.
Pretreatment activity	Between Groups	487.1666	2	243.5833	8.0155	0.0100
	Within Groups	273.5	9	30.3888		
	Total	760.6666	11			
Post treatment activity	Between Groups	64.6666	2	32.3333	24.25	0.0002
	Within Groups	12	9	1.3333		
	Total	76.6666	11			
Reduction in activity	Between Groups	149.2446	2	74.6223	32.9311	7.2428
	Within Groups	20.394075	9	2.266008333		
	Total	169.6386917	11			

Table-5 Bait Intake of Wild Boar in Sugarcane Fields of the Punjab

Area	Day-1*	Day-2*	Day-3*	Day-4*	Day-5*
Sheikhupura District					
Langowal	55/10	76/42	100/46	46/31	45/1
Gatiawala	105/95	131/130	151/145	145/101	145/5
Sultanpura	97/75	110/70	123/101	101/59	101/8
Sialkot District					
Dally Wali	125/100	408/265	391/300	300/263	300/19
Ghazipur	85/80	205/190	346/240	240/201	240/7
Gurukhair	101/100	400/300	450/345	345/250	345/19
Faisalabad District					
RB-121	51/25	53/28	58/31	31/11	31/2
Sahuwala	149/180	200/83	206/94	206/131	206/7
Motaili	139/120	201/143	249/181	181/93	181/0
Gujrat District					
Hill Minhasa	50/50	190/120	153/105	133/91	138/3
Tool Chapala	195/152	209/140	208/150	150/115	150/11
Simbly Rai	153/105	169/151	191/159	159/75	159/3

* Number of dough balls placed/Number of dough balls eaten.

Table-6 Reduction in bait intake/ Activity up to five days

Days	Reduction in bait intake/ activity (%)											
	Sheikhupura District			Sialkot District			Faisalabad District			Gujrat District		
	Langowal	Gatiawala	Sultanpura	Dally Wali	Ghazipur	Gurukhair	RB-121	Sahuwala	Motaili	Hill Minhasa	Tool Chapala	Simbly Rai
1	81.81	9.52	22.68	5.8820	5.88	0.99	50.98	17.22	13.67	0	22.05	31.37
2	44.74	0.76	36.36	35.05	7.32	25	47.16	58.5	28.86	36.84	33.01	10.65
3	54.00	3.97	17.89	23.27	30.84	23.33	46.55	54.37	27.31	31.37	27.88	16.75
4	32.61	30.34	41.58	12.33	16.25	27.54	64.52	36.41	48.62	31.58	23.33	52.83
5	97.78	96.55	92.08	93.67	97.08	94.49	93.55	96.6	100	97.83	92.67	98.11

Table-7 Mean bait intake by wild boar up to five days

District	Area	Mean of five days intake	Std.Deviation	Std. Error
Sheikhupura	Langowal	62.19	26.91	13.46
	Gatiawala	28.23	39.89	19.95
	Sultanpura	42.12	29.56	16.73
	Dally Wali	36.87	32.79	16.40
Sialkot	Ghazipur	31.47	37.10	18.10
	Gurukhair	34.27	35.31	17.65
	RB-121	60.55	19.82	9.91
Faisalabad	Sahuwala	52.62	29.53	14.76
	Motaili	43.69	33.85	16.93
Gujrat	Hill Minhasa	39.524	35.70	17.85
	Tool Chapala	39.788	29.87	14.94
	Simbly Rai	41.942	35.35	17.68

Table-8 ANOVA for reduction in activity by wild boar in four districts

Source	Sum Squares	of df	Mean Square	F	Sig.
Areas	2572.588	3	857.5294	0.805031	0.497268
Districts	1535.748	2	767.874	0.720865	0.491521
Area * District	2181.016	6	363.5027	0.341249	0.91151

RECOMMENDATIONS

- **PARC Rat Bait** has proved very successful in control of a complex of rodent pest population in sugarcane crop and recommended to sugarcane growers for safe, economical and easy rodent control.
- **Zinc Phosphide Capsular Technique** is recommended for wild boar control. It was found very effective when applied through flour dough balls coated with milk powder.
- Farmers' participation through arranging farmer's field days, on field demonstrations and multidisciplinary approaches are recommended to knock down rats and wild boar pest population, thus to enhance the crop yield.
- To achieve long term benefits of rodent and wild boar pest problems, participation of all stake holders of the area is essential including growers, mill management and R & D personnel.

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