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Rodent menace, their management and role of possible new rodenticide formulations to combat resistance

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Abstract
Rodents have caused havoc with human's economy as they destroy all food items in field, godown, storage house, poultry farm and premises. Due to its closeness to man habitation, it spreads number of diseases like plague etc. Rodents are estimated to cause around 5-15% damages, losses to cereals and other areas. Rodenticide is one of the important ways of controlling rodent damage. However, limitations with present rodenticides are accidental or secondary poisoning, risk to non-target organisms and probable development of resistances. Under such circumstances, there is need for awareness generation among the farm growers and manufacturers, who are involved in using and developing these rodenticide technologies. Possible new innovative rodenticide formulations like spreading oil, encapsulated bait etc may be successful to combat rodent resistance.

Keywords: Rodent, habitations, rodenticide, resistance, formulation

1. Introduction
Rodents are damaging different crops/commodities by eating them and indirect loss by spoilage, during on-farm and off-farm periods. A yearly loss of grains due to rats is measured about 5-15% total production [1]. In our country, rodents are major pests in farm lands and residents, both in villages and towns. Those cause heavy losses to crops during pre and post harvest, destroy infrastructures and are sources of problematic diseases [2]. Rats create primary damage to no. of crops by gnawing and eating and indirect loss by spoilage, during on-farm and off-farm periods [3]. Due to its closeness to man habitations, it is indulged in spreading no of diseases, like plague and play as reservoir of organisms that cause serious diseases in men and animals [4]. Knowledge of characters, range of losses and vulnerable time for rat attack in different crops and conditions is critical for good planning of controlling methods. Procedures utilized for control of rodents like trapping, harborage alteration, and use of repellent/attractant/pathogens, that cause deaths or repellency have never given proper performances [5].
With the start of 1st and 2nd generation anti-coagulant rodenticide, rat management methods have changed completely. However, rodenticides which are common in use have their selves' disadvantages like bait shyness, lack of target orientation and resistance generation [6]. Overcoming the rodenticide resistance and shyness is important for good rodent management, so there is an urge to develop rodenticides in such way that they can have sufficient rodenticidal properties, less or no resistance, friendly against non-target organisms and cheaper. It is also found that the choice for rodenticides or their formulations is eventually absent in our country. Under such an eventuality, there is need for awareness generation on relevant areas of existing rodenticides among the farmers & manufacturers, who are involved in using these technologies as well as those developing the technology. Effort also is needed to develop safer and effective rodenticide formulations. The main objective of present paper is to review in details the extent of rodent menace, their management, drawbacks of conventional formulations with special emphasis on possible new innovations in rodenticide formulation technologies to combat rodenticide resistance.

2. Rodents and their distribution in crop fields

Order Rodentia covers about 40% of mammals, including more than 2000 species in 34families that comprise of 389 genera around the globe. In India, 4 families, 43 genera and 104 species represent rats. Out of that around 14 species cause economic losses. Group is familiar with this kind of name for gnawing teeth (*Rodere* = to gnaw; *dent* = teeth), which help them go to blocked areas and packing materials and food resources [7].

3. Rodent problems

3.1 Agriculture

Standing crops are susceptible to rat damage mainly. However, the types, range of losses differ in various agricultural crops and regions. Chronic and acute attacks damage cereal yield economically in India. Chronic damages frequently remain un-noticed which are significantly more important [8]. In India total grain losses were about 25% and 25-30% during pre and post-harvest (around US$ 5 billion) yearly. Analysis of literature on pre-harvest losses estimates 5-15% losses to cereal crops like rice, wheat etc. Incidence of medium to high damage to lentil, arhar, moong, soybean and Bengal gram are common due to heavy protein content. Rodents, usually attack plantation crops such as coconut, cocoa, cardamom, oil palm etc [9].

3.2 Public health

Rodents transmit no of diseases to human beings and animals also. Rodents act as vectors for disease causing pathogens or arthropods. Rodents transmit bacterial, viral, protozoan etc diseases [10]. Leptospirosis is caused by *Leptospira interrogans*, which are parasitic in rodents. Definite incidents of plague occurrence in India exist from 1896 onwards with rodents as vectors/reservoirs. Rodents are main source of *Yersinia pestis*, for plague disease by oriental flea, *Xenopsylla cheopis.*

4. Integrated rodent management (IRM)

Integrated pest management (IPM) is related environment and population dynamics of pests, uses all appropriate techniques and processes in a comfortable manner and maintains pest populations at below the economic injury level (EIL). Rodent management is a problem of applied ecology and control measures should be based on proper understanding of ecological factors into control policy [11].

5. Monitoring rodent incidence

There is a need of monitoring the condition in different ecosystems through losses or extend of infestation. It is suggested that efforts for regular monitoring in agricultural fields on the number of fresh/active burrows/hectare [12]. Management decision may be taken based on the monitoring. It is not only possible to tell if rodents are around by looking at droppings but also to tell which species is present

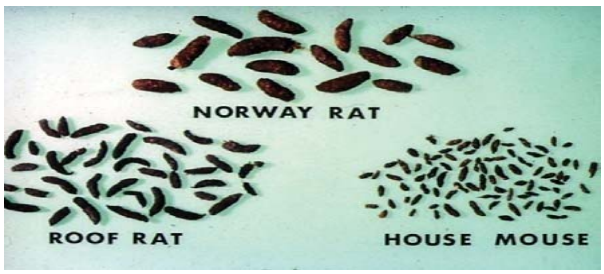

Fig 1: Different types of dropping of various rodent species

6. Rodent management measures

Different methods are present in managing rodents. However, each method has its own demerits. Procedures and demerits are discussed below

6.1 Role of predators

Snakes and owls have been the natural predators for field rodents. It was noticed that during day insectivorous birds (Black drango, King fisher etc.) perched on these rodents and shown significant consumption [13].

6.2 Physical methods

Trap Barrier System (TBS) is being used in various countries. Looking at fencing cost and land holdings, it may not be suitable in India, although the preliminary studies found significant results. However, in North-eastern states of India this system can be utilised in jhum cultivation.

6.3 Ultrasound devices

Hearing sense among the rodents is above 20 kHz which is well into ultrasonic range. Ultrasound devices are being tried as deterrent to rodent immigration. However no proven record was found them as effective against rodents.

6.4 Chemical repellents

Although pheromones showing to be encouraging, lots of scientific works are required to identify, isolate and bring out the pheromones for wide popularity purpose. Recently, a castor based repellent – Ecodon, exhibited significant repellent action on *B. Bengalensis* in rice fields, when broadcasted as granules or sprayed on fences of rice fields. Rice tiller damage is less than 5% in treated fields, while untreated fields had more than 25% loss.

6.5 Trapping

A variety of traps can be tried against rodents-live or snap. Efficacy of trapping, whether live or snap trap, depends on operational situations of traps, number of traps set, type of baits, place and period of placement [14]. Scientific literatures have seldom proved trapping as effective control method against rodents.

6.6 Use of rodenticides

Rodenticides registered under Insecticides Act, 1978 broadly classified into two categories mainly oral and respiratory. Between oral rodenticides again two types exist - (i) fast acting or acute, which results mortality within 24 hours and (ii) slow acting or chronic, which produces mortality after 3-5 days. Two rodenticides exist under the acute, while four falls under the category of chronic [15].

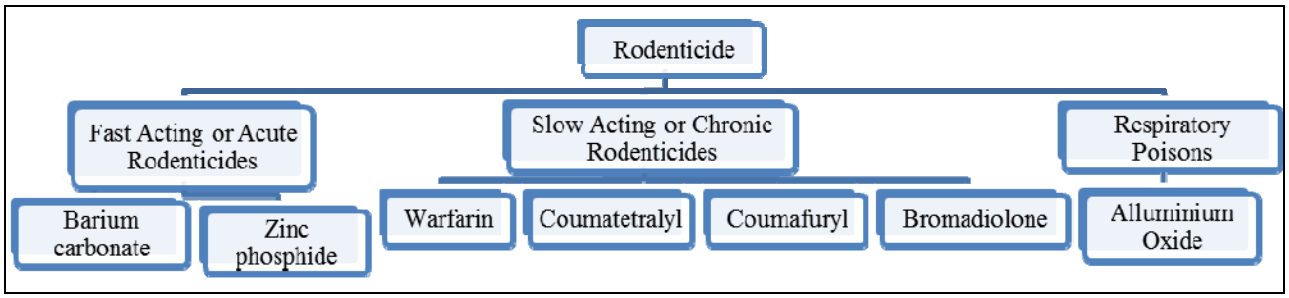

Fig 2: Different types of presently available rodenticides

7. Rodenticide resistance

Rodents are now becoming resistant to poisons [16]. One gene that has been identified which is responsible for resistance to few rodenticides [17]. Warfarin-resistant mice, Norway rats and ship rats have been reported resistant in England and Europe [18]. Warfarin resistant rodents can be also resistant to difenacoum [17]. Issues of bait avoidance and efficacy of warfarin and difenacoum resistant rats were discussed by Quy *et al*., [19]. Chronic rodenticides are reported to develop resistance due to their repeated applications.

8. Conventional rodenticide formulations

8.1 Loose grain

Description of a formulation type, usually based on marketed products of cereals that are either whole or coarsely grounded. Baits based on food types (especially in relation to grain size, texture and taste) that are 'natural' to rodents should always be acceptable, so that failure to eat baits is due to some other factors [20]. A practical demerit is these are easily distributed into the environment if containers are damaged and any spillage is consequently not easily recovered.

8.2 Wax blocks

Wax Blocks are prepared by advanced melt process to ensure homogeneous mixing of ingredients and highly water resistant surface finish. Very much suitable for use in urban areas. Perfect for use in tamper-resistant bait stations because they can be anchored inside the boxes though main hole in each block. Excellent keeping qualities, remains attractive and good condition for long periods of time. Good for use in damp environments, such as sewer systems [21]. Less attractive than grain baits to non-target organism, particularly to birds which face difficulty in feeding them because of their solid, waxy nature. "Unit dose", facilitating for accurate bait placements without weighing.

8.3 Fumigation

An alternative method of controlling rodents in situations where other rodenticide cannot be tried. Technique covers ad-hoc gassing of rodent burrows to highly specialized application of commodities stored in silos, ships and warehouses [22]. To control rodents in burrows phosphine gas fills whole systems when a tablet of aluminium phosphide is kept well inside each entrance, which is then sealed. Moisture present in air or soil causes the gas to evolve.

9. Factors affecting the efficacy of rodenticide formulations

9.1 Particle size

Each species has a preferred food size range and the general acceptability of the bait is determined by whether or not the bait falls within the range of the target organism. Particle size is proportional to available surface area bait and degree of absorption or adsorption possible [23]. Large particles may be hoarded, while minute pieces may be ignored. Uniformly-sized particles ensure even distribution of the toxicant.

9.2 Particle shape

Particle shape influences whether or not an individual species will choose to eat bait. Neophobia (fear of new objects) can cause a rodent to reject unfamiliar objects or shapes.

9.3 Taste

The product must be palatable enough to compete with alternate food sources, which are ever present in the animal's environment. Any taste that can be related to a negative experience (such as illness) can induce bait shyness [24]. A bland active will be overruled by an inert ingredient that produces an unacceptable taste.

9.4 Odor

Odor acts as a motivating device; it stimulates a rodent to search and locate the source of the odor. Strength of odor can determine whether the product acts as an attractant or as a repellent. Odor identification can be a learned response. If the formulation is palatable, the rodent associates its gustatory experience with the odor of the item.

9.5 Impurities

Impurities in the toxicant can affect the toxicity of the product and influence the taste and acceptance of the bait formulation. They can affect the learned response to the taste and smell of the formulation [25]. Impurities in the inert ingredients can have similar effects and can also influence the mode of action of the toxicant, the shelf life and use life of the product.

9.6 Diluents

Diluents must be bland or they must improve the palatability of the formulation. Diluents can be added to a product to aid in the acceptance of the bait where the toxicant has an unacceptable taste in the field formulation and the diluents can actually mask the unacceptable taste [26]. However, this is not usually a realistic proposition.

9.7 Stickers

Stickers (or binders) are needed to hold the toxicant to the food bait. Stickers are important because they can affect the taste and odor of the bait. Physical properties of the sticker must also be considered. For example, a highly volatile sticker could cause loss of the toxicant, or an inappropriate sticker could reduce the acceptability of the bait by increasing tackiness and rancidity.

10. Possible new rodenticide formulations

10.1 Spreading oil formulation

Spreading oil formulation of rodenticide may be directly dropped on the water surface (especially in wet lands or transplanted rice fields) without spray procedure and spreads to the entire water surface very quickly. Layer of rodenticide maintains on the water surface so that when rodent comes in contact on the water surface it dies.

10.2 Encapsulated bait formulations

The mode of action can influence the acceptance of the bait by the target species. If the action is immediate but not fatal, the animal will usually stop eating upon expression of symptoms (bait shyness), which lessens the chances for control. Encapsulation can eliminate quick expression of intoxication thus increasing the chances of further consumption and improving the probability of control.

10.3 Botanical based bait formulations

Active components of must be botanical origin. Non-toxic and safe to people. Easily and largely available raw materials. Must have good knock-down effects against rodents.

11. Risk to non-targets

Studies have shown that if the target species of a rodenticide application is a prime prey item for a predator, such as a predatory bird or mammal, secondary exposure of the predator to the rodenticide may occur through the consumption of contaminated prey. Field rodents are consumed as human food in some cultures. Rodenticides should never be used for rodent control where the intended targets of the applications may be taken for human food.

12. Antidote

A major safety advantage of all anti-coagulants is the availability of antidotes, i.e. vitamin K1. The established treatment regime for anticoagulants recommends monitoring of prothrombin time, with vitamin K1 administration continued until prothrombin time returns to and remains normal.

13. Conclusion

Knowledge of nature, range of loss and susceptible time for attack in various crops and conditions is critical for proper execution of control measures. Chemical control is the most effective method for rodent management both under farmland and urban conditions [27]. It is also found that the choice for rodenticides or formulations is eventually absent in India. Under such circumstances, there is need for awareness generation on relevant areas of present rodenticides among the farmers & manufacturers, who are involved in using these technologies as well as those developing these technologies [28]. Effort also is needed to develop safer and effective rodenticide formulations.

14. References

1. Grant R, Singleton L, Hinds A, Charles J, Krebs, Dave M *et al*., Rats, mice and people: rodent biology and management. ACIAR Monograph 2003; 96:564.
2. Reports of the APO seminar on Reduction of Postharvest Losses of Fruit and Vegetables held in India, 2004, 5-11.
3. Chopra G, Kaur P, Guraya SS. Predominant rodent species in India. In: R Chand and Co. (ed) Rodents: Ecology, Biology and Control. New Delhi. 1996, 3-19,
4. Kruse H, Kirkemo AM**,** Handeland K**.** Wildlife as Source of Zoonotic Infections. Emerg Infect Dis. 2004; 10(12):2067-2072.
5. Sudha DR, Narasimha ChV, Suryanarayana. A survey on knowledge, attitude and practices of farmers on management of rodent pest. Global J of Science Frontier. 2014; 14 (7):221-253
6. Jackson WB, Current management strategies for commensal rodents. In: Genoway H H (ed) Current Mammology. Plenum Press, New York and London. 1987, 495-512.
7. Thakur NSA, Firake DM. Population dynamics of rodents during bamboo flowering event in North East India. Indian journal of agricultural sciences. 2014; 84(6):754-60.
8. Saravanan K, Kanankasabai R, Thiyagesan K. Field evaluation of Difethialone, a new second generation anticoagulant rodenticide in the rice fields. Indian J Exp. Biol. 2003; 41(6):655-8.
9. Hinds LA, Krebs C, Spratt D. Rodent biology and management. ACIAR Monograph; Canberra, 2003, 440-445.
10. Meerburg BG, Singleton GR, Kijlstra A. Rodent-borne diseases and their risks for public health. Crit Rev Microbiol, 2009; 3:221-270.
11. Brooks EJ, Rowe PF. Commensal Rodent Control. World Health Organization, WHO/VBC/87.949, 1987, 44-49.
12. Mason G, Littin KE. The humaneness of rodent pest control. Anim Welfare. 2003; 12:45-57.
13. Palis FG, Singleton G, Sumalde Z, Hossain M. Social and cultural dimensions of rodent pest management. Integr Zoo, 2007; 3:174-183.
14. Firake DM, Azad NS, Kumar D. Indigenous traps for the management of rodent outbreak in North Eastern Hill region of India. Indian J of Traditional Knowledge. 2013; 12(4):730-753.
15. Buckle AP, Muller F. Rodenticides. In: Muller F (ed) Agrochemicals: Composition, Production, Toxicology and Application. Wiley-VCH, Weinheim, 2000, 667-686.
16. Thijssen HHW. Warfarin - based rodenticides: mode of action and mechanism of resistance. Pestic. Sci. 1995; 43:73-78.
17. Greaves JH, Hepherd D, Gill J. An investigation of difenacoum resistance in Norway rat populations in Hampshire. Ann. App. Biol. 1982; 100:581-587.
18. Boyle CM. Case of apparent resistance of *Rattus norvegicus* Berkenhout to anticoagulant poisons. Nature, London, 1960; 188:517.
19. Quy RJ, Shepherd DS, Inglis IR. Bait avoidance and effectiveness of anticoagulant rodenticides against warfarin- and difenacoum-resistant populations of Norway rats *(Rattus norvegicus).* Crop Protection. 1992; 11:14-20.
20. Chaudhary V, Tripathi RS. Field Efficacy of Second Generation Anticoagulant Rodenticides in Managing Rodents Pests in Poultry Farms. Pestology. 2009; 33(10):41-45.
21. Endepols *S.* Rodenticides–indispensable for safe food production. Pestic. Outlook. 2002; 13:231-232.
22. Johnston JJ, Nolte DL, Kimball BA, Perry KR, Hurley JC. Increasing acceptance and efficacy of zinc phosphide rodenticide baits via modification of the carbohydrate profile. Crop Protection. 2005; 24:381-385
23. Kaur H, Parshad VR. Laboratory and field evaluation of three odorant compounds for improving attraction of the lesser bandicoot rat, *Bandicota bengalensis* (Gray) to

0.0375% coumatetralyl bait. Int. Biodeter. & Biodegr, 2005; 56:135-142.
24. Kocher DK, Parshad VR. Acceptance and Efficacy of baits of three rodenticides against Rattus rattus alexandrinus. Pestology, 2003; 27:18-20
25. Prakash S, Kumar S, Veer V, Gopalan N, Purnanand D, Pandey KS *et al*. Laboratory evaluation of four rodenticides admixed in a cereal-based bait against commensal rat, *Rattus rattus* (L) (Rodentia: Muridae: Murinae). J Stored Prod. Res. 2003; 39:141-147.
26. Pandey KS, Rao KM. Laboratory evaluation of four rodenticides admixed in a cereal-based bait against commensal rat, *Rattus rattus* (L) (Rodentia: Muridae: Murinae). J Stored Prod. Res. 2003; 39:141-147.
27. Revathi K, Yogananda M. Effect of bromadiolone on haematology, liver and kidney in Mus musculus. J Env. Biol. 2006; 27(1):135-40.
28. Zatsepin VG, Kadirov AF, Klementeva SA. Resistance of rats to first generation anticoagulants and ways of overcoming it using synergists. Russ. Agri. Sci. 2006; 9:39-42.