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# Critical timings of rodenticidal application for rodent pest management in mixed crop of bajar, moth and gaur

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## ABSTRACT

*Arid Zone being perpetually scarcity biome has low productivity. Bajra, moth and cluster bean (guar) are the major crops grown under rainfed situation in of arid zone. These crops suffer severe infestation of rodents at all stages from sowing to harvest. Critical timing for application of rodenticides to control pest rodents, when the crop suffers more infestation/damage due to population increase is the need of time. Two trials on the field efficacy of zinc phosphide (2%) and bromadiolone (0.005%) as solo and combined treatment was evaluated in mixed rainfed crops at farmers' field at two different crop growth stage. The pest population consisted of six major rodent species viz., Merions hurrianae, Tatera indica and Millardia meltada, Golunda ellioti, Funambulus pennanti and Rattus rattus. In trial one single treatment with test rodenticides was given at vegetative growth stage. Bromadiolone (0.005%, an anticoagulant rodenticide) yielded 78.67% control success, whereas with the acute Zinc phosphide the success was 68.57% on 14th day after treatment. The combination treatment involving application with zinc phosphide (2%) followed by bromadiolone (0.005%) provided over 60% protection from rodent pests from fourth day and reached upto 82.81% on 14th day. In the second trial two treatments with test rodenticides was given, one at vegetative growth stage and another at flowering stage. The solo treatments recorded significantly higher reduction in pest population with zinc phosphide treatment (71.23%) as compared to the bromadiolone (25.37%) on 4$^{th}$ day after treatment. However, on 14th day bromadiolone registered higher control success (82.09%) over zinc phosphide (72.6%). The combination treatment of zinc phosphide (2%) followed by bromadiolone yielded 84.81% control success on 14th DAT. Second treatment at flowering stage yielded a significantly higher reduction in pest population with bromadiolone (85.71%) as compared to the zinc phosphide (31.57%), whereas, combination treatments proved most effective recording a control success of 90% even upto harvesting stage. Results therefore revealed significantly higher reduction in rodent activity with double treatments, than single treatment. Further when second pulse of treatment administered at flowering stage proved most effective (90% success) in suppression of the pest rodents' even up to harvest of the crops.*

**Key Words:** Critical timings, rodent management, rodenticides, bajra, moth and guar

## INTRODUCTION

The production systems in western Rajasthan fall under pastoral and agro-pastoral arid farming systems as classified by Dixon *et al.* (2001), which across south Asia cover 112 m ha. Western Rajasthan accounts for 61% of the total hot arid zone in India (31.7 m ha) with annual rainfall between 100-450 mm. The major rain fed crops sown in the region are pearl millet and legumes (moth bean, mung bean and cluster bean). The general cropping patterns in the arid lands of western Rajasthan are rain-dependent. In years when the monsoon is on time, sowing of pearl millet and sesame is attempted; if the monsoon is delayed by 2-3 weeks, a large part of arid lands is diverted to pulses (moth bean and mung bean). A further delay by one or two weeks (by the first week of August) compels to grow short-duration varieties of cluster bean and dew gram. To cushion the adverse effect of weather aberrations and drought and meet the food needs of the family, mixed cropping of pearl millet + mung bean + cluster bean + sesame (48%), followed by a mixture of the same crops without sesame (24%) is very common in this region (Bhati and Singh, 2002). Moth bean (*Vigna aconitifolia*) crop is one of the important crops of arid region and is sown as kharif crop either solo or mixed with bajra and jowar. The arid legumes constitutes an area of about 37.23 lakh ha with production of 8.45 lakh tons in western Rajasthan of that moth alone shares 34.32% area and 32% production (Chaudhary *et al.*, 2005). Bajra (*Pennisetum glaucum*), which was introduced in India in 3000 BC is the largest producer of this crop, both in terms of area (9.4 m ha) and production (8.5 m tonnes), with an average productivity of 990 kg/ha. The major bajra growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which account for more than 90% of bajra acreage in country. Rajasthan is major producer of pearl millet with 51% share of total production in country.

Guar or cluster bean (*Cyamopsis tetragonaloba*) is a drought hardy, deep-rooted, summer annual legume. India accounts for 80 per cent of the total cluster bean seed produced in the world. About 70 per cent of India's production comes from Rajasthan (Kalasariya *et al.*, 2015). Arid land supports a very high population of rodents, which cause immense losses to various production system of the arid ecosystem (Rana *et al.*, 1999). Eighteen species of rodents have been recorded to inhabit the Indian arid zone, of that a complex of 2-3 species are encountered in various arable cropping system of arid areas (Tripathi *et al.*, 1992). The desert rodents start their destructive activity from the time of sowing to harvest and late in threshing yards also. On an average, 5-10% damage is observed in rainfed crops like pearl millet, moong, moth etc. (Rana *et al.,* 1999). In arid legumes rodents inflict damage by picking the sown seed thereby causing poor germination and continue to do so throughout the crop growth stage (Tripathi *et al.,* 2004). In moth bean the rodent damage is more pronounced at seedling and maturity stages. Tripathi *et al.* (2004) reported 84.0% reduction in plant stand in 15-20 days old crop with a burrow density of 1-2 per $m^2$ whereas, it was almost 100% with burrow density 3-5 $m^2$ in the peripheral region of fields. At pod formation and maturity stage 5-10% pod damage was reported. *Tatera indica* and *Millardia meltada* caused 2–12.4% damage in pearl millet at the maturity stages (Rana *et al.*, 1994). Arid Zone being perpetually scarcity biome has low productivity. Under such conditions losing even a small part of agricultural produce to pest rodents cannot be tolerated and therefore calls for efficient rodent pest management. Critical timing for application of rodenticides to control pest rodents, when the crop suffers more infestation/damage is important. Therefore an attempt in the present investigation has been made to work out critical timings of rodenticidal application along with suitable rodenticidal application method for rodent control in bajra, moth and cluster bean (guar) mixed crop.

## MATERIALS AND METHOD

### Study area

The study areas located Rampura and Padasla village (District Jodhpur) were mainly double-cropped areas, having good irrigation facilities through tube wells, but the *kharif* crops are generally taken under rain fed conditions. The experimental area was about 10 ha for each trial having a fairly uniform infestation of rodent pests. Trial-I, where single treatment at vegetative growth stage of different rodenticides was given were conducted at Rampura village and trial-II, where two treatments of different rodenticides was given one at vegetative growth and other at flowering stage were conducted at Padasla villages. The cropping system under investigation consisting of mixed crop of moong bean, moth bean, bajra, sesame and cluster bean. Depredation of the crop by rodents' started very early with the sowing of seed and continued throughout the crop growth stage. Generally higher rodent infestation was witnessed at peripheral region of the crop fields.

### Poison baiting

Acute rodenticide, zinc phospide (80% technical grade powder) and anticoagulant rodenticide, bromadiolone (0.25% technical grade powder) were evaluated by preparing fresh baits containing 2% zinc phosphide and 0.005% bromadiolone mixed in bajra grains smeared with 2% groundnut oil. The Poison and plain baits were administered directly in live burrows @ of 10g per live burrow and also placed randomly inside the fields and on the bunds in the bait stations made of PVC pipe @ of 20g bait per station as per the experimental design with 50 bait station per ha. In zinc phosphide treatment pre-baiting was done 02 days prior to poison baiting. About 65-70% of bait stations were found disturbed at the time of retrieval indicating that in all the blocks acceptability of poison bait was fairly good.

**Evaluation**

The experimental area was divided into four blocks of 0.5 ha each separated with a space of 0.1ha as per RBD. Three replications for each trial were maintained with all the three treatments applied randomly along with control in each block. In crop field, trial for determination of critical timing of rodent pest management in mixed cropping of bajra, moth and guar were carried out by administering one treatment each of zinc phosphide (2%), bromadiolone (0.005%) and combination treatment of zinc phosphide (2%) followed by bromadiolone (0.005%) in trial-I at vegetative growth stage. In trial-II two treatments of these rodentidides were given, one at vegetative growth stage and other at flowering stage. Since the rodents starts dying after 3-4 days of anticoagulant baiting and continue upto 14 days, the efficacy of each test rodenticide was evaluated on 4 and 14$^{th}$ days after treatment.

Pre and post treatment rodent population was estimated by counting live burrows following Mathur and Prakash (1983). For this all the existing burrows were plugged one day prior to poison baiting. A freshly opened burrow next morning was counted as a live burrow. Efficacy of rodenticide was evaluated using following formula:

$$\text{Per cent control success} = 100\,(1-[(T_2 \times C_1)/(T_1 \times C_2)])$$

Where:

$T_1$= Pre-treatment population of rodents in treatment plots.
$T_2$= Post-treatment population of rodents in treatment plots.
$C_1$= Pre-treatment population of rodents in reference plots.
$C_2$= Post-treatment population of rodents in reference plots.

Data on percent control success chieved under different treatments in the field trial were subject to angular transformation. The transformed data for different treatments were subjected to Analysis of Variance (ANOVA) for comparing the level of significance within and between the treatments. Student's T test was used to compare the control success between the two trials at harvest stage.

**RESULTS AND DISCUSSION**

**Species composition:**

Six species of rodents belonging to two families were collected from both the trial site (i.e Rampura and Padasla). *Tatera indica* was predominant at both the sites with a mean abundance of 28.47% followed by *Funambulus pennanti* (19.61%), *Golunda ellioti* (17.69%), *Meriones hurrinae* and *Millardia meltada* (12.69) each) and *Rattus rattus* (8.84%) (Table 1). Contrary to present findings Tripathi *et al.* (2004), Chaudhary and Tripathi (2005) and Chaudhary *et al.* (2005) recorded *M. hurrinae* to be predominant species followed by *T. indica* in rain fed crop, however in rabi crop of cumin *T. indica* was predominand (Chaudhary and Tripathi, 2010). The burrows of *M. hurrinae*, which were mainly concentrated at peripheral region initially during vegetative growth stage, later shifted to the central region of crop field also at maturity. Similar observation was recorded by Chaudhary *et al.* (2005) in moth crop, Tripathi *et al.* (2004) in moong-moth cropping system and Chaudhary and Tripathi (2010) in cumin crop. *T indica. M. meltada* and *G. elloiti* were observed to inhabit the surrounding bunds.

Table 1: Rodent species composition

| Rodent Species | % Relative abundance | | |
|---|---|---|---|
| | Trial-I | Trial-II | Mean of two Trial sites |
| Tatera indica | 26.93 | 30.00 | 28.47 |
| Meriones hurrinae | 15.38 | 10.00 | 12.69 |
| Millardia meltada | 15.39 | 10.00 | 12.69 |
| Golunda elloiti | 15.38 | 20.00 | 17.69 |
| Rattus rattus | 7.69 | 10.00 | 8.84 |
| Funambulus Pennanti | 19.23 | 20.00 | 19.61 |

**Trial I:** In the trial single treatment with bromadiolone (0.005%), zinc phosphide (2%) and zinc phosphide (2%) followed by bromadiolone (0.005%) was given at vegetative growth stage in separate blocks and the observation were recorded upto the harvest of the crops. Among the two solo treatments, bromadiolone (0.005%) yielded 78.67% control success, whereas with zinc phosphide the success was 68.67% on 14th day after treatment. At harvesting stage the control success with zinc phosphide (2%) was reduced to 25.28%, however with bromadiolone (0.005%) it was 65.17% (Table 2). Similar observation was recorded by Tripathi *et al.* (2004) in moth crop where single treatment of brodifacoum (0.005%) and bromadiolone (0.005%) yielded a control success of 76.10 and 72.0%, respectively after 30 DAT, whereas with zinc phosphide (2%) it was only 49.72%. Superiority of anticoagulant was recorded by several authors, Chaudhary and Tripathi (2010) in cumin crop, Kaur *et al.* (2018) in potato crop, Singla and Babber (2015) in groundnut crop. The combination treatment involving application with zinc phosphide (2%) followed by bromadiolone (0.005%) provided over 60% protection from rodent pests from fourth day of treatment, which reached upto 82.81% on 14th day. This success though followed a decreasing trend and was reduced to 75.39% at the harvesting stage of the crop. Ahmad *et al.* (1989) recorded that single baiting with zinc phosphide followed by a baiting with brodifacoum or double baiting with brodifacoum or bromadiolone resulted in 89–93 per cent rodent mortality in wheat fields. In arid pulses, follow up by bromadiolone (0.005%) bait after application of zinc phosphide (2%) provides significant control success (Tripathi *et al.*, 2004). The control success was significantly different among the treatment as chronic poison showed their superiority over acute poison, however combination treatment was more effective than solo treatment as control success with combination treatment of zinc phosphide (2%) followed bromadiolone (0.005%) was 75.39% at harvesting stage. Parshad *et al.* (1987) also reported similar results with combination treatment of acute and chronic poison in ground nut crop in Punjab. The study indicates that the combination treatment (zinc phosphide followed by bromadiolone) provides better safety to the crops upto harvest stage (Table 2).

Table 2: Evaluation rodenticidal treatments by LBC method at village Rampura (Trial-I) (One treatment at vegetative growth stage)

| Treatments | Control Success (%) | | |
|---|---|---|---|
| | Vegetative Growth Stage | | Harvesting stage |
| | 4 DAT | 14 DAT | |
| Bromadiolone (0.005%) | 23.25 | 78.67 | 65.17 |
| Zinc Phosphide (2%) | 55.46 | 68.67 | 25.28 |
| Zinc Phosphide (2%) followed by Bromadiolone (0.005%) | 60.15 | 82.81 | 75.39 |
| CD | 5.26 | 5.40 | 6.74 |

**Trial II:** In the trial two treatments with bromadiolone (0.005%), zinc phosphide (2%) and zinc phosphide (2%) followed by bromadiolone (0.005%) were given, one at vegetative growth stage and another at flowering stage. Observation of solo treatments recorded on 4th day after baiting resulted in significantly higher reduction in pest population with zinc phosphide treatment (71.23%) as compared to the bromadiolone (25.37%). However, data recorded from 14th DAT revealed a significant superiority of anticoagulant treatment (82.09%) (Table 2). The combination treatment of zinc phosphide (2%) followed by bromadiolone yielded 84.80% control success on 14th DAT, which was significantly higher than solo treatment of zinc phosphide (2%). This success later followed a decreasing trend at flowering stage and maximum decrease was recorded with acute rodenticide (47.95%). Second treatment at flowering stage yielded a significantly higher reduction in pest population with bromadiolone treatment (85.71%) as compared to the zinc phosphide (31.57%). The combination treatments proved most effective recording a control success of over 90% even upto harvesting stage. The effect of combination treatment was at par with that of solo treatment with bromadiolone (0.005%) but significantly higher with zinc phosphide (2%) treatment revealing that second pulse of treatment with bromadiolone alone at flowering stage proves effective in suppression of the pest rodents upto harvest of the crops (Table 3). The present finding of two treatments at two crop growth stage corroborates with the finding of Chaudhary and Tripathi (2005) in kharif crops and Chaudhary and Tripathi (2010) in cumin crop, where baiting with anticoagulant rodenticides, at vegetative growth and flowering stage provided effective management of pest rodents. Similarly, Singla and Parshad (2010), Singla and Babbar (2012, 2015) recorded higher reduction in rodent activity in groundnut crop with two rodenticidal treatments.

Table 3: Evaluation rodenticidal treatments by LBCmethod at village Padasla (Trial-II) (Two treatment one each at vegetative growth and flowering stage)

| Treatments | Treatment-I (at vegetative growth stage) | | | Treatment-II (at flowering stage) | | |
|---|---|---|---|---|---|---|
| | Control Success (%) | | | Control Success (%) | | |
| | Vegetative Growth Stage | | Flowering Stage | Flowering Stage | | Harvesting Stage |
| | 4 DAT | 14 DAT | | 4 DAT | 14 DAT | |
| Bromadiolone (0.005%) | 25.37 | 82.09 | 68.65 | 60.00 | 85.71 | 85.71 |
| Zinc Phosphide (2%) | 71.23 | 72.60 | 47.95 | 34.21 | 31.57 | 28.95 |
| Zinc Phosphide (2%) followed by Bromadiolone (0.005%) | 59.49 | 84.81 | 77.20 | 68.67 | 94.45 | 90.00 |
| CD | 8.46 | 5.25 | 5.73 | 3.045 | 2.97 | 4.50 |

The present finding revealed that reduction in activity of rodent pest was more in fields given two treatments (Av. 68.22%) than the fields with single treatment (55.28%). Similar observation was recorded by Singla and Babbar (2015) in groundnut crop where reduction in activity of pest rodents was in the range of 79.98-92.18% in the field given two treatments and 54.38-65.93% in the fields given single treatment likewise two treatment of bromadiolone one at pod formation stage and other at pod maturity stage proved effective in management of rodents in groundnut crop (Butani *et al.*, 2006). Parshad *et al.* (1987) observed that higher rodent control was obtained with two treatments of either brodifacoum or bromadiolone than with a single treatment of any rodenticide.

Table 4: Efficacy of various treatments at harvesting stage after single and double treatment

| Treatment | Control success after one treatment* | Control success after two treatment* | Pooled mean |
|---|---|---|---|
| Bromadiolone (0.005%) | 65.17 | 85.71 | 75.44 |
| Zinc Phosphide (2%) | 25.28 | 28.95 | 27.12 |
| Zinc Phosphide (2%) followed by Bromadiolone (0.005%) | 75.39 | 90.00 | 82.70 |
| CD | 6.74 | 4.50 | 4.82 |

**T Test: NS*

In the present study the reduction in activity of rodents was significantly different among the treatments in both trials (Table 2, 3, & 4) and bromadiolone, an anticoagulants proved more effective than zinc phosphide, an acute rodentcides, as re-infestation and population rebuild-up in fields treated with anticoagulant rodenticide was significantly slower than those treated with acute rodenticide. From the finding of the present study it may be concluded that the combination treatment (zinc phosphide followed by bromadiolone) provides higher rodent control success resulting into better safety to the crops upto harvest stage. However, two treatments one at vegetative growth stage and other at flowering stage proved most effective in providing complete safety from pest rodents in mixed cropping of bajra, moth and cluster bean (guar) in arid regions.

## REFERENCES

Bhati, T.K. and Singh, R. (2002) Identification of Research Gaps in Inter/Mixed Cropping System under Rainfed Condition. Final Report of NATP Project.

Butani, P.G., Vyas, H.J. and Kapadia, M.N. (2006) Rodent management in groundnut in Gujarat. *In*: Vertebrate Pests in Agriculture: The Indian Scenario. Sridhra, S. (ed.) pp. 193-204.

Chaudhary, V. and Tripathi, R.S. (2005) Bio-efficacy of second-generation anticoagulants in pearl millet-moong-moth bean cropping system in Indian arid region. *Indian Journal of Plant protection* **33**(2): 167-171.

Chaudhary, V., Tripathi, R.S. (2010) Incidence of rodent pests in cumin (*Cuminum cyminum* L.) and their management. *Journal of Horticultural Science* **5**(1): 64-67.

Chaudhary, V., Mohd. Idris and Tripathi, R.S. (2005) Field evaluation of second-generation anticoagulant rodenticides in moth bean crop. *Journal of Arid Legumes* **2**(1): 116-119.

Dixon, J., Gulliver, A., Gibbon, D. and Hall, M. (2001). Farming Systems and Poverty. Improving Farmer's Livelihoods in a Changing World. FAO and World Bank, Rome, Italy and Washington D.C. USA. Available Online at: http://www.fao.org/DOCREP/003/Y1860E/y1860e00.htm

Kalasariya, R., Parmar, K. and Litoriya, N. (2015) Management of Major Insect Pests of Cluster bean (*Cyamopsis tetragonaloba* (Linn.). Lambert Academic Publishing. Pp 57.

Mathur, R.P. and Prakash, I. (1983) Methods used in the field evaluation of anticoagulant rodenticides in India. *In* Vert. Pest Control Mgmt. Materials: fourth Symposium. ASTM STP 817 (Ed. Kaukeinen, D.E.). Am. Soc. Testing and Material, Philadelpha, pp. 256-261.

Kaur, N., Singla, N. and Singh, R. (2018) Efficacy of rodenticide bait application for rodent pest management in potato crop. *Journal of Entomology and Zoology Studies* **6**(2): 2149-2152.

Parshad, V.R., Ahmad, N. and Chopra, G. (1987) Deterioration of poultry farm environment by commensal rodents and their control. *International Biodeterioration and Biodegradation* **23**: 29–46.

Rana, B.D., Jain, A.P. and Tripathi, R.S. (1994) *Fifteen years of Coordinated Research on Rodent Control*. Technical Bulletin No. 3, Indian Council of Agricultural Research, New Delhi, pp. 141.

Rana, B.D. Tripathi, R.S., Chaudhary, V and Idris, M. (1999) Rodents: the visible menace. The Hindu Survey of Environment, 111-115.

Singla, N. and Babbar, B.K. (2012) Critical Timings of Rodenticide Bait Application for Controlling Rodents in Sugarcane Crop Grown in Situations Like Punjab, India. *Sugarcane Technology* **14**(1): 76–82.

Singla, N., and Babbar, B.K. (2015) Critical timings and methods of rodent pest management in groundnut (*Arachis hypogaea* L.) crop. *Legume Research* **38**(5): 681-686

Singla, S. and Parshad, V.R., (2010) Efficacy of acute and anticoagulant rodenticide baiting in sugarcane fields of Punjab, India. *International Journal of Pest Management* **56**(3): 201-210.

Tripathi, R.S., Chaudhary, V. and Idris, M. (2004) Incidence of rodent pest and their management in pulse crop under arid agro-ecosystem. *Pestology* **XXVIII** (6): 67-70

Tripathi, R.S., Jain, A.P., Kashyap, N., Rana, B.D. and Prakash, I. (1992) North Western Desert. In Rodents in Indian Agriculture (Eds. Prakash, I. and Ghosh, P.K.). Scientific Publisher (India), Jodhpur, 357-396.