



## RESEARCH ARTICLE

## Potential of triptolide in management of post control rodent population rebuildup in sugarcane crop fields

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### Manuscript Info

### Abstract

#### Manuscript History:

Received: 15 July 2014  
Final Accepted: 29 August 2014  
Published Online: September 2014

#### Key words:

Triptolide; Sugarcane; Rodents;  
Population rebuildup;  
Bandidotabengalensis

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Sugarcane crop fields at village Palahi, District Kapurthala, Punjab, India were treated with 0.25% triptolide after 15 days of first treatment with 0.005% bromadiolone to record the affect on post control rodent population rebuildup. Bait census before treatment revealed similar level of rodent population in all the blocks. Post census after 15 and 30 days of first treatment with bromadiolone revealed a significant decrease in rodent population in treated blocks II and III as compared to untreated block I. Post census after 30 days of triptolide treatment revealed an increase in rodent population in block II as well as III which may be due to breeding of female rats already pregnant before triptolide treatment. Autopsy of mature male *Bandidota Bengalensis* trapped from fields of untreated block I and triptolide treated block III after 60 days of triptolide treatment revealed significantly ( $P \leq 0.05$ ) low weights of reproductive organs and decrease in sperm parameters in rats trapped from block III. Percent cut canes and yield loss due to rodents was found to be significantly ( $P \leq .05$ ) less in treated fields as compared to untreated fields. Present studies suggest potential of triptolide treatment in management of rodent population in integration with chemical control.

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### Introduction

Rodents are considered as one of the major pests of agricultural crops and stored food grains. Rodent damage to sugarcane, a major cash crop of India, has always been a matter of economic concern. The problems of rodent damage and control in sugarcane are particularly severe in tropical and subtropical Asia because the average size of cane fields is less than one hectare and the cane fields are surrounded by fields of short-duration crops such as wheat, rice, oilseeds and vegetables (Parshad, 1999; Sarwar et al., 2011; Singla and Mittal, 2012). Migration of rodents from the surrounding fields relating to agronomic practices along with a high rate of breeding (Bindra and Sagar, 1975) results in a great abundance of rodents in the canefields mainly from September to early February (Ahmad 1996).

In Punjab (India), rodents in sugarcane fields were found to cut 8.6% canes partially and 3.2% completely, resulting in a 6.4% loss in potential yield (Parshad, 1987). Average rodent damage of 6.22% was observed in sugarcane fields in three districts of Punjab (Singla and Parshad, 2010). Elsewhere in India, rodents were reported to damage on an average, 29.86% (Dubey and Awasthi, 1991), 5.36% (Chopra and Sabharwal, 1993) and 18.3% (Ahmad, 1996) canes, with staggered damage of 63% in neglected canefields (Rao, 2003), indicating substantial losses to sugarcane production. Damage is caused mainly by gnawing through the rind of the lower internodes of canes and by damage to the roots during digging of burrows by rodents (Parshad, 1987). The lesser bandicoot rat, *Bandidota Bengalensis*, Gray and Hardwicke is the most predominant rodent pest species found in sugarcane crop in South Asia (Khatri et al., 1989; Dubey and Awasthi, 1991; Chopra and Sabharwal, 1993; Saini and Parshad, 1993; Bhaduria and Singh, 1996; Ali et al., 2003; Singla and Parshad, 2010) causing direct and indirect damages to crops

by their feeding, burrowing and breeding activities. The success of this species lies in its highly adaptable nature coupled with high reproductive capacity.

After natural reduction or control with rodenticides and other methods, rodents rapidly re-build their population (Shilova and Tchabovsky, 2009) by enhancing their reproduction. Repeated use of rodenticides may lead to several problems including bait shyness, resistance and other non-target toxicity hazards (Mineau et al., 2004; Brakes and Smith, 2005). For rodent populations, fertility control has been identified as a more appropriate, environmentally benign and humane strategy than increasing mortality by poisons (Chambers et al., 1999; Zhang et al., 2009). The importance of plant products in the pursuit of fertility regulating agents has long been recognized (Sharma et al., 2001; Singla et al., 2008 a,b and 2013; Singla and Garg, 2013).

The antifertility effects of extracts of different parts of the plant, *Tripterygium Wilfordii* Hook F. (TWHF) came into light from studies on rats and mice and retrospective studies on men taking *T. wilfordii* preparations for some other medical reason (Chen et al., 2010). Triptolide, a diterpene triepoxide, is one of the major biologically active components purified from TWHF having antifertility effects (Luet et al., 1998; Huynh et al., 2000; SinhaHikim et al., 2000; Ni et al., 2008). Triptolide has been reported to play inhibitory roles in rapidly proliferative cells such as testicular germ cells and ovarian follicular cells leading to inhibition of reproduction in male and female rats (Deng et al., 2011; Dhar and Singla, 2013 and 2014; Singla et al., 2013). Till date there is no report on field evaluation of triptolide in managing post control resiliency in rodent population. Our laboratory studies revealed maximum potential of 0.25% triptolide as antifertility agent against male *B. Bengalensis* (Dhar and Singla, 2013, Dhar et al., 2014) and that of 0.20% triptolide against female *B. Bengalensis* (Dhar and Singla, 2014). Present studies were hence conducted to evaluate the potential of 0.25% triptolide bait in the management of post control rodent population rebuildup in sugarcane crop fields.

## Materials and methods

### Treatment and effect on rodent population

Farmer's fields of sugarcane crop infested mainly with *B. Bengalensis* were selected at village Palahi, District Kapurthala, Punjab, India in August, 2013. Three separate blocks (I, II and III) of sugarcane fields each further consisting of three replicated fields of 0.4 ha area were selected. These fields of sugarcane were surrounded by fields of rice crop. Pre-census bait consumption to determine the level of rodent population before treatment was recorded from all the fields by keeping 400g of the plain WSO bait (cracked wheat, powdered sugar and groundnut oil in the ratio of 96:2:2) on pieces of paper at 20 bait points per field arranged in a grid (Singla and Parshad, 2010). On third day, remaining bait was collected and weighed to determine the consumption (g/100g bait). After record of pre-census, fields of blocks II and III were given first treatment of 0.005% bromadiolone bait formulated with WSO by placing 400g of bait per field at 20 bait points arranged in a grid. After 15 days of first treatment with 0.005% bromadiolone, post census bait consumption was recorded from all the fields to determine the changes in level of rodent population. After first post-census, fields of block III were treated with 0.25% triptolide bait (prepared by mixing desired amount of triptolide dissolved in 1% carboxy methyl cellulose with mixture of cracked wheat and powdered sugar in the ratio of 98:2). This bait was also placed at the rate of 400g bait per field at 20 bait points arranged in a grid. After 15 and 30 days of second treatment with triptolide in block III, again post census, second and third was taken from all the fields by the method described above. From census data, per cent reduction in rodent population was calculated with respect to fields of untreated block I (Singla and Parshad, 1999) and also with respect to fields of same block (Singla and Mittal, 2012). The difference in per cent reduction in rodent population obtained at second and third post census, gave the per cent rebuildup in rodent population after bromadiolone and triptolide treatments in fields of blocks II and III.

### Rodent trapping

After the 60 days of triptolide treatment, rodent trapping was carried out with single rat traps from all the fields of treated and untreated blocks during the months of October-November, 2013. In each field, four trap lines of five traps each were set for three consecutive nights (60 trap nights in each field). Indian bread (chapatti piece) was used as the bait to attract rodents into each trap. Traps were checked daily before 12.00 mid day for animals trapped and rebaited. The trap index (number of animals trapped/100 trap nights) was calculated for each species (Parshadet al., 2006) after their identification as per the description given by Jain and Tripathi (1988). Trapped animals were brought to the laboratory for recording their sex, maturity level and antifertility effects of triptolide.

### Antifertility effects

In male rats, effect of treatment was observed on weights of reproductive organs such as testis, epididymis, seminal vesicles and prostate gland and that of vital organs such as liver, kidney, adrenal glands, spleen and heart. Effect of

treatment was also observed on sperm motility, sperm viability and sperm density in cauda epididymal fluid as per the methods described by Dhar and Singla (2013). In female rats, effect of triptolide treatment was observed on duration of estrous cycle and its different stages as per the method described by Dhar and Singla (2014).

### **Effect of treatment on rodent damage and yield loss**

After the treatments, rodent damage was recorded from all the fields of treated and untreated blocks. As the damage inflicted by rodents occurs unevenly (Lefebvre et al., 1978), 5 sites were sampled in each field, covering its centre as well as its edges. At each sample site, 50 canes were screened for presence of damaged canes (those with signs of rodent gnawing). Damaged canes were identified from the canoe-shaped cavities formed in hollowed-out internodes (Singla and Parshad, 2010; Singla and Babbar, 2012). The percentage of canes damaged, yield loss (Q/ha) and yield loss saved (Q/ha) in sugarcane crop were determined as per the method described by Singla and Parshad (2010).

### **Statistical analysis**

All values were expressed as mean  $\pm$  SEM. Significance of differences was determined using one way analysis of variance and Tukey's test. The statistical analyses were performed using Graph Pad InStat Version 3.0 for Windows (Graph Pad Software, San Diego, CA, USA and <http://www.graphpad.com>). Critical differences were considered significant at  $P \leq 0.05$ .

## **Results and Discussion**

### **Effect on rodent population**

Pre census bait consumption by rodents in sugarcane crop fields of blocks I, II and III was found to vary from 90.67 to 96.50 g/100g bait with no significant difference in consumption among the three blocks indicating almost similar level rodent population before treatment (Table 1). First post census bait consumption after fifteen days of first treatment with 0.005% bromadiolone in fields of blocks II and III revealed 45.32 and 39.55% reduction in rodent population, respectively with respect to same fields and 33.28 and 27.78, respectively with respect to untreated fields. There was no significant difference in percent reduction in rodent population between the blocks II and III (Table 2). Second post census after fifteen days of 0.25% triptolide treatment in fields of block III (or after 30 days of bromadiolone treatment) revealed 74.14 and 90.02% reduction in rodent population in blocks II and III, respectively with respect to same fields and 61.14 and 85.63%, respectively with respect to untreated fields. Statistically, there was no significant difference in post census bait consumption and reduction in rodent population (Tables 1 and 2) between the fields of blocks II and III. Further reduction in rodent population in fields of blocks II and III within 15 to 30 days of bromadiolone treatment may be due to delayed effect of bromadiolone treatment combined with migration of rodents to adjoining fields of rice crop in the month of September when the rice crop was at its reproductive stage. Rodent population was also found reduced by 29.35% in fields of untreated block which may again be due to migration of rodents to adjoining rice crop which was at ripening stage. However, percent reduction in rodent population was significantly ( $P \leq 0.05$ ) high in fields of block II and III as compared to fields of untreated block I (Table 2). Gogoi and Borah (2013) reported highest trap index of *B. Bengalensis* in rice crop at ripening stage.

Post census bait consumption after 30 days of triptolide treatment (or after 45 days of bromadiolone treatment) revealed 29.46 and 31.54% reduction in rodent population in blocks II and III, respectively with respect to same fields and 21.92 and 24.64%, respectively with respect to untreated fields indicating rebuildup in rodent population. From the reduction in rodent activity estimated after two treatments, per cent rodent population rebuildup was calculated to be 44.69% with respect to the same field and 44.05% with respect to untreated fields in block II, treated only with bromadiolone and 58.48% with respect to the same field and 62.35% with respect to control fields in block III, treated with bromadiolone and triptolide both (Table 3). There was no significant difference in rodent population rebuildup as determined by two methods between the fields of blocks II and III. In field of untreated block I, population rebuildup of 14.95% was observed. However, the rebuildup in rodent population was significantly ( $P \leq 0.05$ ) more in the two treated blocks as compared to untreated block (Table 3). Ahmad and Parshad (1991) and Singla and Babbar (2012) also observed rapid resurgence in the rodent population in sugarcane fields with higher rodent mortality.

Present studies could not clearly reveal the effect of triptolide treatment as the same was found combined with delayed effect of bromadiolone and migration of rodents to surrounding rice crop. Rodent population rebuildup observed after 30 days of triptolide treatment or 45 days of bromadiolone treatment during present studies may be due to the delivery of pups by the residual population of female rats after a gestation period of 21-23 days which were pregnant before treatment with triptolide and the effect of triptolide treatment might have come at a later stage.

### **Rodent trapping and antifertility effects**

Rodent species trapped from sugarcane crop fields were *B. Bengalensis* and *Millardia Meltada*. From fields of blocks I, II and III, respectively 5, 1 and 7 female *B. Bengalensis* were trapped with trap indices (no. of animals trapped per 100 traps/night) of 8.33, 1.67 and 11.67, respectively (Table 4). All the 5 female rats trapped from block I were mature, whereas, out of the 7 female rats trapped from block III, only 4 were mature. One female rat trapped from block II was also immature. From fields of untreated block I and triptolide treated block III, 3 male *B. Bengalensis* each were trapped with trap indices of 5.00 each. No male rat was trapped from fields of block II. Two immature female *M. Meltada* with trap index of 3.33 were trapped only from fields of block II. The antifertility effects of triptolide were observed in mature rats only. Singla and Mittal (2012) were able to trap three rodent species from sugarcane crop fields namely *Mus Booduga*, *M. Meltada* and *B. Bengalensis*.

### **Antifertility effects in female rats**

Daily examination of vaginal fluid of mature female *B. Bengalensis* trapped from fields of block III (n = 4) treated with triptolide and fields of untreated block I (n = 5) in the laboratory for a period of thirteen days revealed average duration of estrous cycle to be 3.25 and 4.00 days, respectively with number of estrous cycles to be 4.25 and 3.50 in a period of thirteen days (Table 5). There was no significant difference in the duration and number of estrous cycles between rats trapped from blocks I and III. Also no significant difference was found in durations of proestrous, estrous, metestrous and diestrous stages between rats trapped from blocks I and III (Table 5) indicating not much affect of triptolide treatment on estrous cycle of female rats. Singla and Mittal (2012) found duration of estrous cycle to be 4.00 days in female *B. Bengalensis* trapped from sugarcane fields treated with 2% zinc phosphide followed by treatment with 10% crude cotton seed oil. They found no significant difference in duration of estrous cycle between female *M. Meltada* trapped from fields treated only with 2% zinc phosphide and those trapped from fields treated with 2% zinc phosphide followed by treatment with 10% crude cotton seed oil.

### **Antifertility effects in male rats**

Autopsy of male *B. Bengalensis* trapped from fields of untreated block I and triptolide treated block III (n = 3 each) to record antifertility effects revealed significantly low weights (g/100gbw) of reproductive organs such as testis, epididymis, seminal vesicles and prostate gland in rats trapped from treated fields of block III as compared to those trapped from untreated fields of block I. The sperm motility (%), sperm viability (%) and sperm density (millions/ml) were also found to be significantly reduced in rats trapped from treated block III compared to those trapped from untreated block I (Table 6). No significant difference was found in weights of vital organs such as liver, kidney, adrenal glands, spleen and heart between male rats trapped from blocks I and III (Table 7) indicating no effect of triptolide treatment on vital organs. Also no effect of triptolide treatment was observed on vital organs of male rats in our laboratory studies (Dhar et al., 2014). Significant antifertility effects of triptolide in male rats trapped from fields of block III after 60 days of triptolide treatment revealed delayed effect of triptolide which was manifested between 30 to 60 days after treatment. Singla and Parshad (2000) reported 0.5% alphachlorohydrin (chemosterilant) treatment to be effective in managing post control rodent population rebuildup in rice crop fields. Male *B. Bengalensis* trapped after treatment were found having sperm motility less than 30%, obviously, a handicap for successful fertilization. Most of the surviving male *B. Bengalensis*, captured after 15 days of the treatment with 0.5% alphachlorohydrin in sugarcane fields had developed sterility as revealed by the functional abnormalities in their testes and epididymides (Sani and Parshad, 1993).

### **Effect on rodent damage and yield loss**

Record of rodent damage from all the fields of treated and untreated blocks in the month of November, 2013 revealed on an average 0.67 and 0.53% cut canes in treated blocks II and III, respectively as against 2.27% cut canes in fields of untreated block I (Table 8). A significant ( $P \leq 0.05$ ) difference in per cent cut canes was observed between untreated block I and treated blocks II and III. Weighing of bundles (n =5) of healthy and damaged canes (10 each) revealed an average yield loss of  $277.00 \pm 29.0g$  per damaged cane by rodents. Counting of number of canes in sugarcane fields revealed on an average 32 canes/4m<sup>2</sup> area. A significant ( $P \leq 0.05$ ) difference was observed in yield loss (Q/ha) between treated and untreated blocks. Similar differences among the two treated blocks were, however, found to be non-significant (Table 8). Yield loss saved (Q/ha) as a result of present treatment was found to be 3.54 and 3.84 Q/ha in treated blocks II and III, respectively with no significant differences among them. Singla and Mittal (2012) also reported a significant difference in percent cut canes and yield loss between fields of treated and untreated blocks, but similar differences among blocks treated only with 2% zinc phosphide and those treated with 2% zinc phosphide followed by treatment with 10% crude cotton seed oil were non significant. Present studies

suggest the integration of 0.25% triptolide treatment with rodenticide treatment for management of post control rodent population in field conditions.

**Table 1: Effect of bromadiolone and triptolide treatments on census bait consumption in sugarcane crop fields**

| Block<br>(n =3<br>each) | Treatment | Food consumption (g/100g) |                           |                           |                           |
|-------------------------|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
|                         |           | Pre-census                | Post-census I             | Post-census II            | Post-census III           |
| I                       | Untreated | 96.50 ± 1.45 <sup>a</sup> | 80.92 ± 0.83 <sup>a</sup> | 68.00 ± 5.33 <sup>a</sup> | 88.25 ± 2.35 <sup>a</sup> |
| II                      | Br        | 90.67 ± 1.41 <sup>a</sup> | 49.42 ± 6.21 <sup>b</sup> | 23.50 ± 6.31 <sup>b</sup> | 63.75 ± 3.98 <sup>b</sup> |
| III                     | Br+Trp    | 95.33 ± 2.91 <sup>a</sup> | 57.67 ± 4.13 <sup>b</sup> | 10.33 ± 0.71 <sup>b</sup> | 64.83 ± 6.67 <sup>b</sup> |

-Values are Mean ± SEM, n=Number of fields, Br=0.005% bromadiolone, Trp=0.25% triptolide

**Table 2: Effect of bromadiolone and triptolide treatments on reduction in rodent population in sugarcane crop fields**

| Block<br>(n=3<br>each) | Treatment | Percent reduction in rodent population with respect to same fields |                                |                                | Percent reduction in rodent population with respect to untreated fields |                                |                                |
|------------------------|-----------|--|--------------------------------|--------------------------------|---|--------------------------------|--------------------------------|
|                        |           | After 15 days of Br treatment                                      | After 15 days of Trp treatment | After 30 days of Trp treatment | After 15 days of Br treatment   | After 15 days of Trp treatment | After 30 days of Trp treatment |
| I                      | Untreated | 16.08 ± 1.69 <sup>a</sup>  | 29.35 ± 6.24 <sup>a</sup>      | 8.38 ± 3.73 <sup>a</sup>       | -   | -                              | -                              |
| II                     | Br        | 45.32 ± 7.16 <sup>b</sup>  | 74.14 ± 6.78 <sup>b</sup>      | 29.46 ± 5.40 <sup>b</sup>      | 33.28 ± 8.69 <sup>a</sup>   | 61.14 ± 11.81 <sup>a</sup>     | 21.92 ± 9.20 <sup>a</sup>      |
| III                    | Br+Trp    | 39.55 ± 3.57 <sup>b</sup>  | 90.02 ± 0.44 <sup>b</sup>      | 31.54 ± 8.04 <sup>b</sup>      | 27.78 ± 5.09 <sup>a</sup>   | 85.63 ± 1.11 <sup>a</sup>      | 24.64 ± 9.73 <sup>a</sup>      |

-Values are Mean ± SEM, n=Number of fields, Br=0.005% bromadiolone, Trp=0.25% triptolide

**Table 3: Post control Population rebuildup in sugarcane fields**

| Block<br>(n=3 each) | Treatment | Population rebuildup with respect to same field | Population rebuildup with respect to control field |
|---------------------|-----------|---|--|
| I                   | Untreated | 14.95 ± 4.19 <sup>a</sup>                       | -  |
| II                  | Br        | 44.69 ± 7.73 <sup>b</sup>                       | 44.05 ± 13.08 <sup>a</sup>                         |
| III                 | Br+Trp    | 58.48 ± 7.62 <sup>b</sup>                       | 62.35 ± 9.30 <sup>a</sup>                          |

-Values are Mean ± SEM, n=Number of fields, Br=0.005% bromadiolone, Trp=0.25% triptolide

**Table 4: Trap indices of animals trapped from sugarcane crop fields at the end of treatment**

| Block<br>(n=3) | Treatment | Trap index (no. of animals trapped per 100 trap nights) |                          |
|----------------|-----------|---|--------------------------|
|                |           | <i>Bandicota Bengalensis</i>                            | <i>Millardia Meltada</i> |
| I              | Untreated | 8.33 (F)<br>5.00 (M)                                    | -                        |
| II             | Br        | 1.67 (F)  | 3.33 (F)                 |
| III            | Br+Trp    | 11.67 (F)<br>5.00 (M)                                   | -                        |

-Values are Mean  $\pm$  SEM, n=Number of fields, Br=0.005% bromadiolone, Trp=0.25% triptolide

**Table 5: Antifertility effect of triptolide treatment on duration of estrous cycle of female *B. Bengalensis* trapped from sugarcane fields**

| Estrous cycle in 13 days period      | Untreated fields<br>(n = 5) | Triptolide treated fields<br>(n =4) |
|--------------------------------------|-----------------------------|-------------------------------------|
| Duration of one estrous cycle (days) | 4.00 $\pm$ 0.33             | 3.25 $\pm$ 0.18                     |
| No. of estrous cycles                | 3.50 $\pm$ 0.20             | 4.25 $\pm$ 0.18                     |
| Duration of proestrous stage (days)  | 3.42 $\pm$ 0.18             | 3.13 $\pm$ 0.09                     |
| Duration of estrous stage (days)     | 2.17 $\pm$ 0.28             | 1.75 $\pm$ 0.18                     |
| Duration of metestrous stage (days)  | 4.33 $\pm$ 0.15             | 4.13 $\pm$ 0.09                     |
| Duration of diestrous stage (days)   | 5.50 $\pm$ 0.29             | 4.63 $\pm$ 0.17                     |

-Values are Mean  $\pm$  SEM, n= Number of rats

**Table 6: Antifertility effect of triptolide treatment on weights of reproductive organs and caudaepididymal sperm parameters after treatment in sugarcane fields**

| Antifertility parameters<br>(n = 3 each) | Sugarcane fields                |                                 |
|--|---------------------------------|---------------------------------|
|  | Untreated fields                | Triptolide treated fields       |
| Testis (g/100g bw)                       | 0.34 $\pm$ 0.02 <sup>a</sup>    | 0.14 $\pm$ 0.004 <sup>b</sup>   |
| Epididymis (g/100g bw)                   | 0.09 $\pm$ 0.01 <sup>a</sup>    | 0.04 $\pm$ 0.002 <sup>b</sup>   |
| Seminal vesicles (g/100g bw)             | 0.51 $\pm$ 0.06 <sup>a</sup>    | 0.02 $\pm$ 0.001 <sup>b</sup>   |
| Prostate gland (g/100g bw)               | 0.29 $\pm$ 0.04 <sup>a</sup>    | 0.02 $\pm$ 0.001 <sup>b</sup>   |
| Sperm motility (%)                       | 69.00 $\pm$ 3.06 <sup>a</sup>   | 30.83 $\pm$ 6.08 <sup>b</sup>   |
| Sperm viability (%)                      | 75.79 $\pm$ 1.90 <sup>a</sup>   | 52.41 $\pm$ 5.60 <sup>b</sup>   |
| Sperm density (millions/ml)              | 360.00 $\pm$ 20.14 <sup>a</sup> | 113.33 $\pm$ 14.18 <sup>b</sup> |

-Values are Mean  $\pm$  SEM, n= Number of rats

**Table 7: Effect of triptolide treatment on weights of vital organs of rats trapped from sugarcane fields**

| Organs weight (g/100g bw)<br>(n=3 each) | Sugarcane fields |                           |
|---|------------------|---------------------------|
|   | Untreated fields | Triptolide treated fields |
| Liver                                   | 4.06±0.07        | 4.07±0.07                 |
| Kidneys                                 | 0.35±0.02        | 0.039±0.01                |
| Adrenal glands                          | 0.01±0.001       | 0.02±0.001                |
| Spleen                                  | 0.47±0.16        | 0.43±0.02                 |
| Heart                                   | 0.31±0.04        | 0.36±0.01                 |

-Values are Mean ± SEM, n= Number of rats

**Table 8: Effect of bromadiolone and triptolide treatments on rodent damage and yield in sugarcane crop fields**

| Block<br>(n=3) | Treatment | Cut canes (%)          | Yield loss (Q/ha)      | Yield loss saved (Q/ha) |
|----------------|-----------|------------------------|------------------------|-------------------------|
| I              | Untreated | 2.27±0.11 <sup>a</sup> | 5.02±0.24 <sup>a</sup> | -                       |
| II             | Br        | 0.67±0.11 <sup>b</sup> | 1.48±0.24 <sup>b</sup> | 3.54±0.00 <sup>a</sup>  |
| III            | Br+Trp    | 0.53±0.29 <sup>b</sup> | 1.18±0.64 <sup>b</sup> | 3.84±0.87 <sup>a</sup>  |

-Values are Mean ± SEM, n=Number of fields, Br=0.005% bromadiolone, Trp=0.25% triptolide

## Conclusion

Present study conducted in sugarcane crop by integrating 0.25% triptolide treatment with 0.005% bromadiolone treatment at the interval of 15 days revealed significant antifertility effects in male rats trapped after 60 days of triptolide treatment thus suggesting use of triptolide in integration with chemical control for management of post control rodent population rebuildup in crop fields.

## Acknowledgements

Thanks are due to the Indian Council of Agricultural Research (ICAR), New Delhi, India for financial support and the Professor and Head, Department of Zoology, Punjab Agricultural University, Ludhiana, India for the facilities provided. There is no conflict of interest.

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