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Efficacy of the Rodenticide Bromethalin in the Control of *Microtus arvalis* and *Nesokia indica* in Alfalfa Fields

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Abstract: Rodents cause huge losses to agricultural crops annually. During outbreaks, this pest can cause irreversibly high damage. Solely non-chemical control measures have not been successful in reducing the population of this pest; therefore, the use of chemical rodenticides, especially on crops like alfalfa, is unavoidable. Bromethalin is a neurotoxic, acute, single-dose rodenticide with high efficacy, and since it is mostly used in wax formulation it is not attractive to non-target organisms, and hence is not very dangerous. Bromethalin 0.01% was tested in alfalfa fields of west Azerbaijan, Tehran, and Kerman provinces in completely randomised treatment blocks with 4 treatments (bromethalin wax block, bromethalin pellets, 2% zinc phosphide baits, and control) and 4 replicates. Efficacy was calculated using the Henderson and Tilton formula and the results were analysed by SPSS. The results show that bromethalin with pellet formulation had the highest efficiency in controlling *Microtus arvalis* and *Nesokia indica* in the alfalfa fields, followed by bromethalin with wax block formulation, and the least efficient was zinc phosphide baits (2% Zn_2P_3 mixed with wheat and oil) in W. Azerbaijan. In the alfalfa fields of Kerman and Tehran provinces bromethalin wax was more effective than bromethalin pellets. Considering the ready-made bait formulation of bromethalin, it is much safer and easier to use than zinc phosphide bait, which has to be prepared on the farm, and this can cause higher contamination and poisoning risk to the environment and the applicators.

Key Words: *Nesokia indica, Microtus arvalis*, efficacy, bromethalin, alfalfa, Iran

Introduction

Rodents are the major group of mammals, and contribute to great losses in agricultural production throughout Iran. Damage is caused by feeding on the roots of the crops and to the irrigation canals by making their burrows close to them. Many methods have been implemented to control the rodent population in urban and agricultural fields. The easiest way for farmers is the use of chemical rodenticides.

Bromethalin has the capacity to be used against rodents with resistance to anticoagulant rodenticides. The chemical formula of bromethalin is N-methyl-2, 4-dinitro-n-(2, 4, 6-tribromophenyl)-6-(trifluoromethyl) benzenamine. This rodenticide acts as an oxidative phosphorylation inhibitor in the central nervous system, blocking Na^+/K^+ ATP^{ase} pump activity. This leads to cerebral spinal fluid accumulation and myelin sheet disintegration in neurons, increasing intracranial pressure in the brain, causing paralysis, convulsion and finally death (Cherry et al., 1982, Dreikom et al., 1984). In laboratory experiments, up to 90% mortality in the Norway rat and house mouse has been reported with bromethalin rodenticide (Jackson et al., 1982). In food preference trials, bromethalin proved to be the most preferred bait (compared with other rodenticides), and all the experimental animals died 3 days after the treatment (Vanlier, 1980). In an experiment on *Bandicota bengalensis*, bromethalin had high efficacy; in this research, all the animals survived only for 4 days after the treatment (Main et al., 1994). In field trials Zhao-Mingeli et al. (1994) found bromethalin within chlorophacinone and butaline c to be a potent compound to control the genus Microtinae. In our study, the efficacy of bromethalin (as a new rodenticide for Iran) was compared with zinc phosphide against *Microtus arvalis* and *Nesokia indica* in alfalfa fields.

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Materials and Methods

This study was carried out between 28 March 2003 and 20 March 2004. A few infested alfalfa farms were identified and chosen in different provinces. The infested alfalfa fields were selected in Salmas city (W. Azerbaijan province), Bardsir city (Kerman province), and Karaj and Varamin cities (Tehran province). The dominant rodent identified in Salmas was *Microtus arvalis* (common vole), and in Bardsir, Karaj, and Varamin it was *Nesokia indica* (short-tailed mole).

Bromethalin 0.01% (each pellet was small and the wax block was 14 g) was tested in alfalfa fields in W. Azerbaijan (Salmas city), Tehran (Karaj and Varamin cities), and Kerman (Bardsir city) provinces in completely randomised treatment blocks with 4 treatments, i.e. bromethalin wax block, bromethalin pellets (3.5 g per complex burrow), 2% zinc phosphide baits (5 g per complex burrow) and control, with 4 replicates. The area of each replicate was 100 m^2.

All burrows were stamped closed a day before the commencement of the treatments. The next day all the opened burrows (active burrows) were counted, and rodenticides were put in the opened burrows. No rodenticide was used in the control blocks. Then all the burrows were stamped closed again. All the reactive burrows were counted as the burrows with no mortality in them after 2 days.

The efficacy of the rodenticides was calculated using the Henderson and Tilton formula and the results were analysed statistically with SPSS. Duncan's method was used to compare means.

$$\text{Percent Mortality} = (1- \{(T_2C_1) / (T_1C_2)\}) 100$$

T_1 = Number of opened burrows before rodenticide use,

T_2 = Number of re-opened burrows after rodenticide use,

C_1 = Number of opened burrows in control blocks, and

C_2 = Number of re-opened burrows in control blocks.

Results and Discussion

The results show a significant difference between treatments ($F (2, 11) = 31.39$, $P < 0.05$) (Table 2) in the Salmas region. The comparison of means showed bromethalin pellet with 81.43 ± 4.30% mortality in group A, bromethalin wax block with 71.88 ± 4.48% mortality in groups A and B, and zinc phosphide with 61.79 ± 4.87% mortality in group B (Tables 1 and 6).

In Karaj significant differences were observed between the treatments ($F (2, 11) = 14.79$, $P < 0.01$) (Table 3). The comparison of means showed bromethalin wax block with 82.98 ± 4.30% mortality and bromethalin pellet with 80.05 ± 2.09% mortality in group A and zinc phosphide with 62.13 ± 4.16% mortality in group B (Tables 1 and 6).

In Varamin, significant differences were observed between the treatments ($F (2, 11) = 31.39$, $P < 0.01$) (Table 4). The comparison of means showed bromethalin wax block with 86.01 ± 1.87% mortality in group A, bromethalin pellet with 75.05 ± 0.70% mortality in group B and zinc phosphide with 60.11 ± 3.49% mortality in group C (Tables 1 and 6).

In Bardsir, significant differences were seen between the treatments ($F (2, 11) = 10.77$, $P < 0.05$) (Table 5). The comparison of means showed bromethalin wax block

Table 1. Average of efficacy of rodenticides on mouse mortality in alfalfa in 2003.

Name of Rodenticides	Experimental fields			
	Salmas ± Se (*M. arvalis*)	Karaj ± Se (*N. indica*)	Varamin ± Se (*N. indica*)	Bardsir ± Se (*N. indica*)
Zinc Phosphate bait 2%	61.79 ± 4.87	62.13 ± 4.16	60.11 ± 3.49	39.10 ± 0.91
Bromethalin Block 0.01%	71.88 ± 4.48	82.98 ± 2.06	86.01 ± 1.87	91.31 ± 8.70
Bromethalin Pellet 0.01%	81.43 ± 4.30	80.05 ± 2.09	75.00 ± 0.70	74.20 ± 10.99

Table 2. Analysis of variance of Salmas experimental fields.

S.O.V.	S.S.	d.f.	M.S.	F	
Within Groups	771.650	2	385.825	4.648	0.041*
Between Groups	747.135	9	83.015		
Total	1518.785	11			

* Significant at 5%

Table 3. Analysis of variance of Karaj experimental fields.

S.O.V.	S.S.	d.f.	M.S.	F	
Within Groups	1019.604	2	509.802	14.785	0.001**
Between Groups	310.328	9	34.481		
Total	1329.931	11			

** Significant at 1%

Table 4. Analysis of variance of Varamin experimental fields.

S.O.V.	S.S.	d.f.	M.S.	F	
Within Groups	1351.954	2	675.977	31.392	0.00**
Between Groups	193.800	9	21.533		
Total	1545.745	11			

** Significant at 1%

Table 5. Analysis of variance of Bardsir experimental fields.

S.O.V.	S.S.	d.f.	M.S.	F	
Within Groups	283.346	2	1417.173	10.773	0.045*
Between Groups	752.642	9	250.881		
Total	5250.655	11			

* Significant at 5%

with 91.31 ± 8.70% mortality in group A, bromethalin pellet with 74.20 ± 10.99% mortality in groups A and B, and zinc phosphide with 39.10 ± 0.91% mortality in group B (Tables 1 and 6).

The results of different locations showed significant differences between them. Bromethalin wax block and pellet showed different efficacies in different localities. *M. arvalis* preferred the pellet formulation (small size)

Table 6. Ranking of treatments in experimental fields at $\alpha = 5\%$.

Name of Rodenticides	Efficacy in Salmas (*M. arvalis*)		Efficacy in Karaj (*N. indica*)		Efficacy in Varamin (*N. indica*)		Efficacy in Bardsir (*N. indica*)	
	Mean±Se	Ranking	Mean±Se	Ranking	Mean±Se	Ranking	Mean±Se	Ranking
Zinc Phosphate bait	61.79 ± 4.87	B	62.13 ± 4.16	B	60.11 ± 3.49	C	39.10 ± 0.91	B
Bromethalin Block	71.88 ± 4.48	AB	82.98 ± 2.06	A	86.01 ± 1.87	A	91.31 ± 8.70	A
Bromethalin Pellet	81.43 ± 4.30	A	80.05 ± 2.09	A	75.00 ± 0.70	B	74.20 ± 10.99	A-B

and *N. indica* preferred the wax block formulation (large size) of bromethalin (Prakash, 1986). Vanlier (1980) observed the highest preference to be of bromethalin compared with other rodenticides in his experiments. Main (1993) observed similar results in his experiments. In the present experiment, a higher preference for pellets by *M. arvalis* species was observed and for wax block formulation by *N. indica*. This difference could be due to the size of the baits. As is known, rodents hold the bait in their forelimbs and nibble it; therefore, as *M. arvalis* is smaller, it preferred smaller baits (pellets) and *N. indica* due to its larger size preferred larger baits (wax blocks).

On the other hand, bromethalin baits could be a good alternative to be used for rodents resistant to anticoagulant rodenticides, and also to zinc phosphide as bromethalin is in ready-to-use formulation while zinc phosphide has to be prepared in the field. This study shows that the applied bromethalin baits were highly successful in controlling *M. arvalis* and *N. indica* in alfalfa fields in Iran. Both the wax block and the pellet formulation were more efficient than the zinc phosphide bait (2% Zn_2P_3 mixed with wheat and oil). These acute rodenticides could be a good alternative to control rodents resistant to anticoagulant rodenticides.

References

Cherry, L.D., Gunnoe, M.D. and Vanlier, R.B.L. 1982. The metabolism of bromethalin and its effects on oxidative phosphorylation and cerebrospinal fluid pressure. The Toxicologist 2: 108.

Dreikom, B. and O'Dorherty, G.O. 1984. The discovery and development of bromethalin, an acute rodenticide with a unique mode of action. American Chemical Society. 45-63.

Jackson, W.B., Sqaulding, S.R., Vanlier, R.B.L. and Dreikom, B.A. 1982. Bromethalin-a promising new rodenticide. Proceedings of tenth vertebrate pest conference (R.E. Marsh, Ed.). University of California, Davis, California.

Main, Y., Haque, E., J.E. Brooks and Savarie, P.J. 1993. Laboratory evaluation of bromethalin as a rodenticide against *Bandicota bengalensis*. Gray, Univ. J. Zoology, Rajshahi University. 12: 15-19.

Prakash, I., 1986. Rodent Pest Management. CRC Press Inc, Boca Raton, Florida.

Vanlier, R.B.I., Ottosen, L.D., Hanasono, G.K. and Carter, J.L. 1980. Studies on the toxicity of El-614 (bromethalin), a new rodenticide. Presentation 19th Annual Meeting of the Society of Toxicology.

Zhao-Mingeli, Feng, Q., Shuting, G., Yansheng, S., Nasitu, Z., Zhongfu, D., Jun, H., Shenyun, D., Zhao, M.L., Qiao, F., Gao, S.T., Shi, Y.S., Zhao, N.S.T., Dong, Z.F., Hao, J. and Du, S.Y. 1994. A test on the use of rodenticides against *Microtus brandti*. Grassland of China. 4: 51-53.