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COMBATING HARMFUL RODENTS IN FOREST OAK SAPLING PLANTATIONS

SUMMARY

During any forest renewal process, human activity disturbs forest ecosystems and creates conditions for development of certain species of rodents. At the beginning of recovery process in forest areas, sources of seed material or herbaceous plant cover rich in nutrients are readily available, favoring populations of small rodents, especially mice and voles.

We tested the effectiveness of a preparation based on the active ingredient difenacoum for applications in forests under rodent infestation category four. The rodenticide Ratak Forst, difenacoum (0.005%), a granular bait GB, was tested in comparison with a pellet formulation of BRODISAN-A, bromadiolone (0.005%). The experiments were performed according to EPPO Standards (2004) methodology, in a randomized complete block design with four replications at two locations. Plot size was 20x20 m2. Baits were laid in amount of 30 g (one bag) per commercial plastic box. One hundred and five boxes were installed per plot, i.e. a total of 420 boxes per preparation.

The results show that the tested Ratak Forst (76.46%) and the standard preparation BRODISAN-A (79.85%) had very good efficacy in controlling rodents.

Keywords: forest damage, harmful rodents, rodenticide, difenacoum, bromadiolone, efficacy, control.

INTRODUCTION

Forests are complex ecosystems, rich in a variety of plant and animal species, often protected ones. Due to specific ecological conditions, forest ecosystems make a suitable environment for habitation of various species of rodents. In stable ecosystems, the presence of rodents may ensure natural regulation, preservation and renewal in forest areas.

Human activities destabilize forest ecosystems under renewal and create favorable conditions for various species of rodents. At the beginning of forest renewal, seeds and green plant cover rich in nutrients are readily available, offering a suitable environment for development of harmful small rodent species,

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especially voles and mice. From seeding until stable ecosystem establishment, the activity of rodents may cause significant losses in oak saplings during the renewal process. Initial losses are associated with the collection and consumption of acorns in newly established sapling plots. Such activities lead to thinning and spreading of resulting clearings. Further damaging of roots, root necks and stems of oak saplings, more evident during winter months, carries on the thinning in stands and expands bare areas. In oak forests grown for produce, rodents may cause significant losses by dispersing, consuming and damaging uneaten seeds.

Considering the perennial and specific technology of oak cultivation, various activities are expected to ensure a sufficient number of trees until their periodic planned thinning. An acceptable form of protection of oak forests from damaging rodents, before using any control measures, should include an identification of species that are present in any such environment, as well as their biological properties and mutual competition. Such knowledge is a basis for measures of protection that will include preventive and curative activities.

Protection of oak forests from harmful rodents begins with preparing an area for seeding and lasts until a stable ecosystem, i.e. competitive relations among the present species, have been established.

Over a period of several years, we monitored the levels of rodent infestation, presence of species, and degrees of damage caused by rodents, and suggested measures of protection from rodents in a number of locations throughout Vojvodina Province of Serbia. Our research resulted from a need to protect forests, especially oak sapling stands and renewed forest stands. Determination of the presence and abundance of harmful species of small rodents in selected sites was carried out using Longworth traps. The results confirmed a predominance of the herbivorous common vole, *Microtus arvalis*, and the granivorous small forest mouse *Apodemus sylvaticus*, as the most damaging species of small rodents, compared to all other rodent species found (field mouse *Apodemus agrarius*, yellow-necked wood mouse *Apodemus flavicolis*, and ginger Poland vole *Chletrionomys glareolus*). This kind of population structure indicates abnormal interspecific relationships that call for measures of protection in order to reduce their numbers. Considered from a geomorphological point of view, large numbers of *Apodemus agrarius* may be attributed to the insufficient number of oak saplings in renewed stands in the vicinity of their habitats in field crops. A comparison with the harmful species of small rodents present in old plantations inferred that a natural balance requires a greater representation of species that are typical for forest habitats, especially of the yellow-necked mouse. Further research should be directed towards ensuring a required representation of that species, i.e. the number sufficient to establish competitive relationships and so naturally regulate the abundance of the most damaging species found in oak plantings under renewal. Considering forest stands under renewal, higher representation of the yellow-necked forest mouse is desirable. In 2013, a significant damage was reported in the locations Morović and Kupinovo in May-June (more than 30%). In parts of these sites with very favorable microclimate,

small rodents were responsible for a 60% reduction in the number of oak saplings. At a number of sites, we found increased numbers of rodents (category four), and we considered it necessary to apply anticoagulant rodenticides based on bromadiolone, brodifacoum and difenacoum. For lower categories, properly applied rodenticides based on the trace elements selenium and vitamin D3 achieved adequate efficiency (determined by EPPO methods 2004). (Draganić et al, 2008.; Đedović, et al, 2012.; Jokić et al, 2010.; Vukša et al. 2010.).

We tested the effectiveness of a difenacoum-based product in forests exposed to category four of rodent infestation. Tested was the rodenticide Ratak Forst, difenacoum (0.005%), as a granular bait GB, in comparison to BRODISAN-A in a pellet formulation, bromadiolone (0.005%). (BASF, 2013.; HSDB, 2013.; Liste 2013. Greaves, 1995.; Lund 1984.).

In accordance with findings on site, the difenacoum-based product was tested in 2013 for product registration for use in forests under rodent infestation category four.

MATERIALS AND METHODS

The rodenticide product Ratak Forst BAS 405 09 I based on difenacoum (0.005%), formulated as granular bait (GB), was tested in comparison to BRODISAN–A, a standard bromadiolone product in pellet formulation, because no difenacoum-based product was registered in Serbia at the time. The experiments were conducted according to EPPO Standards (2004) methodology, using a randomized block design with four replicates.

Plot size depended on area cover and abundance of small rodent species, and was set to 20x20 m2. Baits in the amount of 30 g (1 bag) were laid in commercial plastic boxes.

A total of 105 boxes were laid in each plot, i.e. a total of 420 boxes per product.

- Standard methods: Biological efficacy: EPPO (2004): PP1 Vol 5 pp 36-48; 48-57; Phytotoxicity: EPPO 2004b: PP 1/135 (2).Vol. 1, pp. 32-37.
- Crop/forest stand: forest, oak sapling stands; Species, hybrid/cultivar: common oak; Cultivation type: common oak stand under renewal ; Development stage: 3-yr oak stand at Morovići, and 5-yr stand at Kupinovo
- Location (Naziv): „Sremska Mitrovica“ Forest Holding; Morović (N45000'03; E 019008'997") and Kupinovo (N 44042'20"; E 20039'25"); Soil data (corresponding to method): chernozem
- Harmful rodent species: Common vole *(Microtus arvalis),* Striped field mouse *(Apodemus agrarius),* Yellow-necked mouse *(Apodemus flavicolis);* Wood mouse *(Apodemus sylvaticus);* Bank vole *(Clethrionomys glareolus)*
- Experimental design: complete randomized block
- Replicates: four
- Plot size: 20x20 m
- Meteorological data at time of application: precipitation and temperature suitable for activity of high numbers of rodents

- Application time: 20 May 2013 – baits laid
- Application rate: 30 g (1 bag)/box of tested product; 30 g/box of standard product

Application:

The product Ratak Forst BAS 405 09 I was laid at places frequently visited by rodents. Prior to laying the product, a detailed examination of the infested area was required to discover rodent tracks and hiding places after their active (inhabited) holes have been found. Baits were laid near the holes, i.e. 30 g of bait per box or plastic bag per active hole. The tested product was laid in bait boxes to prevent accidental poisoning of wildlife and other non-target organisms and protect the product from moisture occurring in forest habitats. The standard product was applied in the same way as the test product.

- Character observed and assessment method: average number of rodents per forest plot calculated from the number of active holes.
- Time of assessment of rodent infestation: 18 May 2013; Time of bait laying: 20 May 2013; Efficacy assessment timing: 3, 7, 14 and 28 days after treatment, i.e. on 23 May, and 3, 6 and 17 June 2013.
- Statistical processing: Means, standard deviation, Henderson-Tilton (1955) formula.

RESULTS

The efficacy of the test product Ratak Forst BAS 405 09 I was low in the early stage (3.96%), similar to the standard product BRODISAN-A, (1.03%) at the locality Morović.

Table 1. Average number of rodents (*M. arvalis, A. agrarius, A. flavicolis, A. Sylvaticus and C. glareolus*) prior to treatment at MOROVIĆ location

Product	Replicates				Sv± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	22	30	26	23	25.25 ± 3.59	-
BRODISAN-A	19	26	25	27	24.25 ± 3.59	-
Control	19	22	24	22	21.75 ± 2.06	-

Fourteen days after treatment, a significant increase in efficacy was noted both for the tested and standard products, as compared to their initial effects.

Table 2. Average number of rodents (*M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus*) 3 days after treatnebt abd rodenticide efficacy (EF %) at MOROVIĆ location

Product	Replicates				Sv ± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	21	29	26	21	24.25 ± 3.95	3.96
BRODISAN-A	19	25	25	27	24.00 ± 3.46	1.03
Control	19	22	24	22	21.75 ± 2.06	-

The results showed that the test product Ratak Forst BAS 405 09 I (78.74%) and the standard product BRODISAN-A (76.70%) achieved good

efficacy in controlling the rodents (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus).

Table 3. Average number of rodents *(M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus)* 14 days after treatment and rodenticide efficacy (EF %) at MOROVIĆ location

Product	Replicates				Sv± sd	Efficacy %
	I	II	III	IV		
RatakForst BAS	6	8	7	5	6.50 ± 1.29	72.00
BRODISAN-A	6	7	7	6	6.50 ± 0.58	70.85
Control	19	20	21	20	20.00 ± 0.82	-

Table 4. Average number of rodents *(M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C.glareolus)* 28 days after treatment and rodenticide efficacy (EF %) at MOROVIĆ location

Product	Replicates				Sv ± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	4	6	5	4	4.75 ± 0.96	78.74
BRODISAN-A	4	6	6	4	5.00 ± 1.15	76.70
Control	18	19	20	20	19.25 ± 0.96	-

Ratak Forst BAS 405 09 I had low efficacy in the initial interval (2.29%), similar to the product BRODISAN-A (2.09%) at the locality Kupinovo.

Fourteen days after treatment, the efficacy of the tested and standard products increased, compared to their initial effects.

The results showed that the tested product Ratak Forst BAS 405 09 I (76.46%) and standard product BRODISAN-A (79,85%) achieved good efficacy in rodent control (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus).

Table 5. Average number of rodents (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus) prior to treatment at KUPINOVO location

Product	Replicates				Sv ± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	19	25	22	21	21.75 ± 2.50	-
BRODISAN-A	23	22	24	27	24.00 ± 2.16	-
Control	24	25	28	22	24.75 ± 2.50	-

Table 6. Average number of rodents (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C.glareolus) 3 days after treatment and rodenticide efficacy (EF %) at KUPINOVO location

Product	Replicates				Sv ± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	19	24	22	20	21.25 ± 2.22	2.29
BRODISAN-A	22	21	24	27	23.50 ± 2.65	2.09
Control	24	25	28	22	24.75 ± 2.50	-

Table 7. Average number of rodents (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus) 14 days after treatment and rodenticide efficacy (EF %) at KUPINOVO location

Product	Replicates				Sv ± sd	Efficacy %
	I	II	III	IV		
Ratak Forst BAS	8	8	6	8	7.50 ± 1.00	61.64
BRODISAN-A	7	7	9	11	8.50 ± 1.91	60.60
Control	20	22	25	22	22.25 ± 2.06	-

Table 8. Average number of rodents (M. arvalis, A. agrarius, A. flavicolis, A. sylvaticus and C. glareolus) 28 days after treatment and rodenticide efficacy (EF %) at KUPINOVO location

Product	Replicates				Sv± sd	Efficacy %
	I	II	III	IV		
RatakForstBAS	2	7	3	6	4.50 ± 2.38	76.46
BRODISAN-A	3	5	5	4	4.25 ± 0.96	79.85
Control	20	22	24	21	21.75 ± 1.71	-

DISCUSSION

The data show that the efficacy of the tested product Ratak Forst BAS 405 09 I was either higher or on a par with the standard product.

The monitoring results had indicated that infestation with small rodents reached category four in a number of locations. Based on hitherto research data on the efficacy of naturally-occurring rodenticides and available literature it is possible to infer that their use has proved insufficiently effective in reducing rodent numbers to acceptable economic levels. It is especially important in areas in which category four infestation was reported. At lower infestation categories, regularly applied rodenticides based on naturally-occurring compounds achieve adequate efficacy.

The data available so far show that, in areas with high rodent infestation, i.e. categories four and five, rodenticide treatments should be made based on second-generation anticoagulant products such as Ratak Forst BAS 405 09 I. (Jokić et al, 2010.; Vukša et al. 2010.).

Figure 1. Damage caused by rodents

Figure 2. Bait boxes

Figure 3. Longworth live trap

CONCLUSION

Rodenticides are not to be applied in moist habitats, i.e. immediately after rain- or snowfall. Such applications would stimulate bait degradation and deactivation of its active ingredient, and reduce bait attractiveness and palatability. Insufficient efficacy and soil pollution are the consequences of such inadequate application. When weather conditions include precipitation, special encapsulated formulations are recommended, especially paraffin pellets (PEF) or bags. Bait application on bare surface is excluded. Baits need to be laid in commercial plastic boxes because it reduces possible accidental poisoning of humans, as well as domestic and wild animals. It also extends bait persistence, its attractiveness and successfulness in rodent control.

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