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Original scientific paper

Improvement of rodent pest control strategy: I - Selection of an adequate preservative for bait base longevity under unfavourable environmental conditions

Tanja Blažić[1]*, Rada Đurović-Pejčev[1], Tijana Đorđević[1], Ivana Jovičić[1], Irena Međo[1], Bojan Stojnić[2] and Goran Jokić[1]

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SUMMARY

Preservation of the appearance, structure and most importantly the attractiveness of baits targeting harmful rodents over extended periods of their exposure is one of the main tasks in the process of bait formulation. The impact of several preservatives, different methods of homogenization of main bait components, and base-paraffin ratios on the extension of longevity of bait base was examined under controlled laboratory conditions. Baits based on ground maize grain were exposed to unfavourable environmental conditions, such as high temperature (30 °C-35 °C) and air humidity (90%-95%). The exposure period was 9 days, and potential mold development was monitored over the same period of time. Sodium benzoate was found deficient in providing a satisfactory effect on bait longevity (<5 days), in contrast to potassium sorbate (>7 days) and sorbic acid, which provided the longest extension in bait sustainability (>9 days). Preservative application can significantly extend bait longevity under unfavourable environmental conditions. Extended bait functionality is important for rodent pest control procedures in habitats where unfavourable environmental conditions prevail, such as sewers and water supply grids (collectors and pumping stations), public areas, housing facilities (boiler rooms, moist sellers, etc.).

Keywords: baits, preservatives, mold, longevity, palatability

INTRODUCTION

The brown rat (*Rattus norvegicus*) is one of the most important harmful rodent pests that cause significant economic losses in the process of production, processing and storage of plant and animal products. Brown rats pose health risks for humans, as well as domestic and wild animals, being the hosts and vectors of many infectious diseases (Battersby et al., 2008; Kataranovski & Kataranovski, 2021; Jokić et al., 2022). Their exceptional adaptability to extremely variable types of habitats (rural, suburban and urban), and not being exacting in nutritional requirements, enables them to survive in habitats with unfavourable environmental conditions, such as sewers and water supply grids and other moist areas (Lund, 1994).

Considering the damage that they cause, and a need to protect public health, as well as the health of domestic

and wild animals, it is necessary to undertake regular monitoring and control of brown rats. Rodenticide applications are the most frequent measure, as well as the most effective way of controlling harmful rodents (Bentley, 1972; McGee et al., 2020). In order for a rodenticide to acheive good efficacy in rodent control, it needs to demonstrate adequate toxicity, as well as satisfactory palatability. It means that the structure, quality and appearance of bait need to stay unchanged throughout the exposure period in order to ensure satisfactory intake of the toxic active ingredient in bait (Buckle, 1994).

Rodent control in habitats characterized by high humidity and temperature (sewer pipes, moist sellers, canals) is often hindered to a significant degree by reduced bait palatability, which results in lower bait efficacy. Under conditions of high humidity and temperature, baits undergo degradation, which allows microorganisms to thrive and spoil the structure and quality of bait. Such baits loose their attractiveness, which is based on good organoleptic properties. The consequence of reduced bait attractiveness is a decrease in its consumption, even its complete cessation, which results in a failed procedure of rodent pest control (Blažić et al., 2017).

Good palatability, and widespread availability, make cereals one of the most frequent base materials for rodenticide baits. A good-quality cereal is sufficiently attractive to rodents to produce excellent results when used with an effective rodenticide. However, increased temperature and moisture turn cereals into excellent bases for microorganism development. They further produce toxins that affect in a negative way the appearance, taste and odour of baits, which decreases their practical value (Buckle, 1994).

Substances that may significantly extend the freshness and persistence of products are known as preservatives. Sorbic acid and its salts (sorbates) are listed as additives in legislative provisions of the Republic of Serbia. Sorbic acid (E200), potassium sorbate (E202) and sodium benzoate (E211) have broad applications in food processing and pharmaceutical industries as preservatives (Lazarević et al., 2012; Shahmohammadi et al., 2016). The use of these substances is allowed, and their non-toxicity is of great importance from an ecotoxicological point of view. After breakdown of any product containing them, they would no longer be expected to pose a danger to non-target animals, considering the results obtained in some earlier studies where sorbic acid, applied at a concentration of 5%, did not have any harmful effect on laboratory rats (Demaree et al., 1955).

Initial attempts to delay rodenticide degradation under conditions of high humidity were made in the 1950s. Paraffin was then used for the first time as an additive to rodenticides intended for controlling brown rats in sewers because it was noticed that it extends bait longevity. Paraffin was found to have a number of advantages which ensure its wide applicability. Primarily, it significantly delays bait degradation (Marsh & Plesse, 1960). Considering the firmness that baits are given by its application, they have become safer due to a level of selectivity as some species are repelled by the need to bite and chew in order to get to the tastier but toxic part of the bait. Baits also became more tolerant to insect infestation, which resulted in lower bait dissipation. However, paraffin deficits include higher production cost, as well as melting and change of structure at high temperatures (Marsh, 2012). Another important shortcoming is its effect on rodenticide persistence in natural environments. Paraffin slows down rodenticide degradation, and thereby extends its availability to nontarget species, which is a serious issue from the ecotoxicological aspect (Lund & Lodal, 1990). Depending on the type of formulation and intended purpose of bait, some 40-50 % of paraffin in baits is considered sufficient to ensure bait persistence over longer periods of exposure in rodent habitats characterized by unfavourable environmental conditions (Marsh, 2012). However, paraffin has a negative impact on bait palatability, so that bait becomes less acceptable to rodents as the content of paraffin increases.

Baits must remain palatable and attractive to rodents for an eradication effort to be effective. Extended periods of bait persistence would significantly improve rodent control effectiveness. Short longivity periods of rodenticide carriers of up to 5 days under unfavourable environmental conditions are insufficient for successfull rodent control, which had been confirmed in our earlier preliminary research (Blažić et al., 2017). Efforts were therefore directed towards finding a procedure that would delay mold development on bait carriers, and extend the longevity and attractiveness of bait by adding preservatives. Research tasks focused on choosing the proper type and concentration of preservative (sorbic acid, potassium sorbat and sodium benzoate), content of paraffin in bait, and method of mixing the components, in order to achieve a more persistent and effective bait for rodent control.

MATERIALS AND METHODS

Bait preparation

Test baits

Three types of preservatives were used to prepare the test bait: sodium benzoate (E211), potassium sorbate (E202) and sorbic acid (E200). The effectiveness of the chosen preservatives was determined for 4 contents in bait: 0.3%, 0.5%, 1% and 2%.

The effect of four different contents of paraffin on bait persistence was also tested in combinations with different

types and contents of preservatives: 75%:25%,70%:30%, 65%:35% and 60%:40%, respectively.

The longevity of two types of bait were tested: bait without paraffin (base+preservative) and bait containing paraffin (base+preservative+paraffin). Different contents of preservatives and paraffin were tested for each type of bait. Bait longevity was tested for baits without paraffin: base+E211, base+E202, base+E200; and baits with paraffin: base+E202+paraffin (25%-40%) and base+E200+paraffin (25%-40%). Sodium benzoate was excluded from the second trial stage (with paraffin) because of unsatisfactory results in the first stage.

Bait homogenization

Bait preparation was based on maize grain ground to a fineness sufficient to facilitate the required homogenization of bait components (Table 1). Cold homogenization was chosen as a method of bait preparation in which the main components are added without raising temperature in the mixture. The bait components were mixed on a rotary mixer for an hour at a speed of 20 rounds per minute.

Preparation of paraffin-free baits

Baits were made by mixing the product base with preservatives. Control baits consisted of the base without added preservative. They were exposed to the same conditions as test baits in order to determine the period of bait persistence without any added preservative.

Preparation of baits with paraffin

Besides determining the effects of preservatives in baits containing only the base and preservative, the impact of paraffin on bait persistence was also tested.

Simultaneous mixing of bait components

Simultaneous mixing implies that all components (base+preservative+paraffin) are added and homogenized at the same time. The content of the tested base and paraffin was 75%:25%. The test results showed that there was no need for testing the other three proportions of base and paraffin (70%:30%, 65%:35% and 60%:40%).

Gradual mixing of bait components

Gradual mixing implies that bait components were mixed by gradually adding and mixing them. The base and preservatives were the first to undergo homogenization. After their homogenization on a rotary mixer, paraffin was added and the process of homogenization proceeded. All four proportions of base and paraffin were examined (75%:25%,70%:30%, 65%:35% and 60%:40%).

Experimental design

Dishes were filled with 100 g of bait preparation each and put in a climate chamber. Each type of bait was exposed in 4 replicates. Following the ECHA (2023) methodology, chamber conditions were set to simulate unfavourable environmental conditions of high temperature and humidity. Ambient temperature was 30-35 °C, while air humidity ranged from 90% to 95%. Mold development was inspected daily, ending with day 9. The dishes were removed from the chamber after first symptoms of mold have appeared. After day 9, baits were checked once more two days later (i.e. on day 11). All baits were removed from the climate chamber after 11 days.

Table 1. Grinding fineness of maize grain (MS-mean value of different fractions of ground maize grain, SE-standard error)

Sieve opening (mm)	Replicates					MS (%)	SE
	I (%)	II (%)	III (%)	IV (%)	V (%)		
2	1.86	2.81	1.66	1.2	1.69	1.87	0.23
1.25	22.2	24.16	25.69	20.21	22.22	19.28	4.04
0.8	25.85	25.31	23.27	26.94	23.6	20.96	4.46
0.5	17.33	13.81	15.11	26.94	23.75	16.24	4.13
≤ 0.5	32.74	33.9	34.26	24.74	28.75	30.88	1.82

Data analysis

Statistical analysis was conducted using ANOVA and Tukey's HSD test to examine the influence of preservative content and base-paraffin ratio on bait longevity. For all groups in which bait longevity exceeded the test period of 9 days, an 11-day period was used for the analysis. P-values below 0.05 were considered as statistically significant in all analyses.

RESULTS

Longevity of paraffin-free baits

Mold development was detected on baits containing low concentrations of sodium benzoate (0.3% - 0.5%) between the 3rd and 5th day. Bait longevity was 4-6 days when higher contents of that preservative were applied (Table 2).

Baits containing low concentrations of potassium sorbate had 5-6 days longevity, while higher contents allowed either 7-9 days logevity period or there were no mold symptoms at all on the 9th day.

The lowest concentration of sorbic acid was found to allow mold development from 6 to ≥9 days of the test. No mold development was found in dishes with the three highest concentrations of the preservative until the end of testing (>9).

Table 2. The effects of preservatives on bait longevity (paraffin-free)

Preservatives	Contents (%)	Symptoms appearance (days)
Sodium benzoate	0.3	3.75
	0.5	4.75
	1	5.5
	2	5.25
Potassium sorbate	0.3	5.25
	0.5	5.25
	1	7.75
	2	>9
Sorbic acid	0.3	7.0
	0.5	>9
	1	>9
	2	>9

Control baits developed symptoms of mold after three days (Figure 1).

Figure 1. Development of microorganisms on bait base (ground maize grain): a) one and three days, b) four and six days after baits were exposed to unfavourable environmental conditions (temperature 30-35 °C and air humidity 90-95%).

Longevity of baits containing paraffin

Simultaneous mixing of components

When bait components were simultaneously mixed, the longevity of those containing potassium sorbate did not exceed 5 days in the climate chamber (Table 3). Initial symptoms of mold were detected as early as on the 3rd day of the test. In dishes containing sorbic acid, symptoms were found to develop after 4-5 days.

Table 3. The effects of preservatives on bait longevity after simultaneous mixing of components

Preservatives	Contents (%)	Symptoms appearance (days)
Potassium sorbate	1	4
	2	4.5
Sorbic acid	0.5	4.5
	1	4.75

Mold symptoms in control dishes developed after three days.

Gradual mixing of bait components

The longevity of baits containing sorbic acid was longer than 9 days, i.e. no symptoms of microorganism development appeared on those baits until the end of the observed test period, regardless of paraffin content. Potassium sorbate showed a similar effect, considering that microorganisms developed after 8 days (Table 4).

A statistically significant influence of preservative concentration on bait longevity was found ($F_{3,60}$=53.97; P=0.00). The longest longevity period was found in test baits that contained sorbic acid, while baits with potassium sorbate achieved longer longevity periods only at higher concentrations. Regarding potassium sorbate bait (2%), paraffin was found to influence bait longevity ($F_{3,12}$=97.00; P=0.00). The longevity period was longer for baits with higher paraffin contents (65-35% and 60-40%). For baits with a low content of potassium sorbate (1%), no statistically significant effect of paraffin on bait longevity was detected ($F_{3,12}$=2.86; P=0.08).

Table 4. The effects of types and contents of preservatives on the longevity of baits with different contents of paraffin

Base-paraffin ratio (%)	Preservatives	Contents (%)	Symptoms appearance (days)
75:25	Potassium sorbate	1	8.25
		2	9
	Sorbic acid	0.5	>9
		1	>9
70:30	Potassium sorbate	1	8
		2	8.75
	Sorbic acid	0.5	>9
		1	>9
65:35	Potassium sorbate	1	8.75
		2	>9
	Sorbic acid	0.5	>9
		1	>9
60:40	Potassium sorbate	1	9
		2	>9
	Sorbic acid	0.5	>9
		1	>9

DISCUSSION

The results of this research indicate that the use of preservatives can significantly delay the development of microorganisms on bait base and prolong its freshness and persistence. Our earlier preliminary research had indicated that the first visible symptoms of microorganism development on baits made from broken wheat grain occurred after three days, and after that an accelerated decrease in bait consumption took place before it fully stopped by the sixth test day (Blažić et al. 2017). Ground maize grain as bait base was exposed to elevated temperatures and humidity, and the first visible symptoms of mold developed after three days of the test, which is consistent with previous results of our research, in which ground wheat grain was used as bait base. When preservatives were added, the longevity of baits whose carrier was ground maize grain was extended to more than 5 days for potassium sorbate and sorbic acid. On baits that contained potassium sorbate (2%) or sorbic acid (≥0.5%), microorganisms were unable to develop until the end of the observed period (>9 days).

Demaree et al. (1955) found that 5% sorbic acid had no harmful effect on rats in feeding tests lasting 90 days. Concentration increase to 8% resulted in some liver problems in the observed rats. Low doses of sorbic acid preservative which were used in our research are not expected to have any negative impact on other non-target species that may come into contact with bait through

secondary poisoning. The tested content of 0.5% sorbic acid is ten times lower than the content tested in toxicity tests on laboratory rats over the period of 90 days.

Our results indicate that the method of mixing bait components significantly affected the effectiveness of preservatives and bait longevity. When all bait components (base+preservative+paraffin) were mixed at the same time, bait longevity was shorter than 5 days. It is assumed that simultaneous mixing does not achieve good homogenization, and the preservative does not have a good dispersion within a mixture. By mixing baits gradually, i.e. by initially mixing the base and preservative, and then adding paraffin, an optimal homogenization of the mixture and dispersion of preservative are achieved. Baits obtained in this way showed much better longevity (>9 days), compared to those with the same preservative content but mixed simultaneously (<5 days).

Howald et al. (2004) and Alifano et al. (2010) reported rapid degradation of rodenticides in their studies due to bait exposure to tropical environments. As a result, the first signs of rodenticide degradation were noted after merely two days of exposure. During the five-day test period, degradation was observed in most of the exposed baits. These results are consistent with data in our present study, where baits without preservatives were completely covered with mold after 5 days of the test.

The impact of paraffin content on bait longevity was not clearly determined because it was not possible to distinguish between the observed groups of baits. All groups containing sorbic acid, unlike those with potassium sorbate, had the same values of bait longevity, and therefore showed no variance, which is why it was not possible to apply statistical analysis. However, the results show that the longevity periods of baits from all observed base-preservative ratio groups exceeded the observed test period. Such results may indicate that only the type and content of preservative had effect on bait longevity, rather than the base-preservative ratio. Future research is planned to test an extended period of bait exposure, which is expected to further clarify the impact of preservatives, as well as the base-preservative ratio, on bait longevity periods.

CONCLUSION

The use of preservatives can significantly improve bait quality during periods of exposure to unfavorable environmental conditions. By maintaining good quality and attractiveness, baits remain palatable to rodents for longer periods of time, which is vital for the process of rodent pest control. The results indicate that sorbic acid application would achieve the best results in practice, considering its positive impact through extending bait longevity under unfavourable environmental conditions. The same applies to potassium sorbate applied at the concentration of 2%. The results indicate no practical significance of sodium benzoate applications. The focus of future research will be on bait palatability.

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Unapređenje strategije suzbijanja štetnih glodara: I - Izbor odgovarajućeg konzervansa za održivost baze mamka u nepovoljnim uslovima sredine

REZIME

Očuvanje izgleda, strukture i ponajviše atraktivnosti mamka za ciljane štetne vrste glodara u dužem vremenskom periodu izlaganja jedan je od glavnih zadataka u procesu njihovog formulisanja. U laboratorijskim, kontrolisanim uslovima ispitivan je uticaj različitih konzervanasa na produženje perioda održivosti osnove mamka, način homogenizacije osnovnih komponenti mamka kao i odnos baze i parafina na period održivosti mamka. Mamci na bazi mlevenog zrna kukuruza izlagani su nepovoljnim uslovima sredine kao što su visoka temperatura (30° C-35° C) i vlažnost vazduha (90%-95%). Period izlaganja bio je 9 dana, koliko je trajao i period praćenja razvoja prouzrokovača plesni. Utvrđeno je da natrijum benzoat nema zadovoljavajući uticaj na održivost mamka (<5 dana), za razliku od kalijum sorbata (>7 dana) i sorbinske kiseline, koja je uticala na najdužu održivost mamka (>9 dana). Primenom konzervanasa značajno se može produžiti period održivosti mamka u nepovoljnim uslovima sredine. Produžena upotrebna vrednost mamka, značajna je u praksi u postupku suzbijanja štetnih glodara na staništima gde preovladavaju nepovoljni uslovi sredine, kao što su kanalizacioni i vodovodni sistemi (kolektori, crpne stanice), javne površine, stambeni objekti (kotlarnice, vlažni podrumi i sl).

Ključne reči: mamci, konzervansi, plesan, održivost, prihvatljivost

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Neopulvinaria innumerabilis (Rathvon, 1854), a new species of Coccidae in Serbia

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SUMMARY

In 2016, the species *Neopulvinaria innumerabilis* (Rathvon, 1854), belonging to the scale insect family Coccidae, was for the first time found in Serbia, in the location Radmilovac on *Cornus sanguinea* L. It reproduces by gamogenesis, develops one generation annually, and overwinters as a fertilized female on the trunk or branches of its host plant. During this research, the species was detected on five host plants at six locations in Serbia. It feeds by sucking sap from leaves, young shoots and branches of infested plants, causing desiccation of leaves and individual twigs. Four species of its natural enemies were collected and reared from colonies of *N. innumerabilis*. Two species of parasitoid wasps, *Coccophagus lycimnia* (Walker) (Aphelinidae) and *Metaphycus hageni* Daane and Caltagirone (Encyrtidae), were found, while the ladybird *Exochomus quadripustulatus* L. (Coccinellidae) and the fly *Leucopomyia silesiaca* (Egger) (Chamaemyiidae) were identified as predators. The most abundant entomophagous species was *L. silesiaca*.

Keywords: cottony maple scale, Coccidae, natural enemies, Serbia

INTRODUCTION

The cottony maple scale, *Neopulvinaria innumerabilis* (Rathvon), is an insect belonging to the family Coccidae (Hemiptera: Coccomorpha). The species is native to North America from where it was likely introduced to many European countries through plant material transport. It was first recorded in France (Cannard, 1966), then in Italy (Pellizzari, 1977), Azerbaijan, Armenia, Georgia, Russia (Hadzibeyli, 1983; Hodgson, 1994), Slovenia (Seljak, 1995) and Croatia (Masten-Milek, 2007). The species is polyphagous and infests over 50 plant species from 29 genera (García-Morales et al., 2016), and it is found as an important pest in vineyards in North America (Gill, 1988), France and Italy (Pellizzari, 1977; Pellizzari & Germain, 2010), Croatia (Masten-Milek, 2007) and Slovenia (Štrukelj et al., 2012). It causes damage by direct feeding, which leads to stunted growth, premature leaf fall, as well as reduced quantity and market value of plants (Ülgentürk & Ayhan, 2011). It is also a vector of viruses from the family Closteroviridae, including Grapevine leafroll viruses (GLRaV-1, GLRaV-3) and Grapevine virus A (GVA) in vines (Sforza et al. 2003; Herrbach et al., 2017).

In 2016, *Neopulvinaria innumerabilis* was detected for the first time in Serbia at the location Radmilovac

on *Cornus sanguinea* L., which initiated a more detailed study of this species. The current paper presents the results of studies on its distribution, damage that it causes, morphological characteristics and development cycle, as well as the natural enemies of this scale pest in Serbia.

MATERIAL AND METHODS

The current study of the life cycle of *N. innumerabilis* was carried out on *Cornus sanguinea* L. at the location Radmilovac during 2016 and 2017.

N. innumerabilis presence, distribution, intensity of infestation and symptoms of damage that it causes were determined by visual inspection of plants and sampling of infested plant material. Infestation intensity was determined using the Borchsenius (1963) scale. Plant material was sampled every 7-10 days during vegetation, and once a month during vegetative rest. Samples of five one- or two-year-old twigs, 20 cm long, were taken from each infested plant.

In the laboratory, we examined the sampled plant material, reared and made permanent microscopic slides of soft scales, and identified the scale and its natural enemies.

To analyze the morphological characteristics of the scale, permanent microscopic slides of females were made following a method developed by Kosztarab & Kozár (1988), and identification was performed using the identification keys of Gill (1988) and Kosztarab & Kozár (1988).

For rearing purposes, the sampled twigs with scale colonies were placed in glass cylinders covered with dense synthetic meshes. The time of oviposition, number of laid eggs, and duration of embryonic and postembryonic development of scales were monitored by daily inspection of twigs. The average number of eggs laid by females was determined by counting the eggs of 10 females.

The plant material with scale colonies was placed in glass cylinders for rearing parasitoids. They were checked daily to determine the time and number of eclosed parasitoid specimens. Wasps were collected using a mouth aspirator, killed with ethyl acetate, mounted on cards and identified by Aleksandar Stojanović (Natural History Museum, Belgrade, Serbia). The mounted specimens are preserved in the Laboratory for Entomology and Agricultural Zoology, Faculty of Agriculture, University of Belgrade, Serbia.

Determination of ladybird species (Coleoptera: Coccinellidae) was carried out using the key of Bieńkowski (2018), while predatory flies (Diptera: Chamaemyiidae) were determined by Radoslava Spasić (University of Belgrade, Faculty of Agriculture, Serbia).

RESULTS

Based on female morphological characteristics, the species was identified as *Neopulvinaria innumerabilis* (Rathvon), a member of the family Coccidae.

Morphological characteristics of *N. innumerabilis*

The female of *N. innumerabilis* is 3-10 mm long. It is light yellowish-brown with purple patterns on dorsal surface (Figure 1). Female antennae are 8-segmented. Its legs are very small compared to the body. Sclerotization is noticed between the tarsus and tibia. Marginal setae are spine-like, with blunt tips. Stigmal setae are present, three in each group. Body setae are spine-like and scattered over the entire body. Submarginal glands are absent. Simple discoid pores are distributed all over the dorsal surface. Quinquelocular pores are present in the area of stigmas. Multilocular pores (10 loculi) form transverse rows around the vulva. There are three types of tubular glands on the body. As the female matures, its skin on the dorsal surface becomes slightly sclerotized.

N. innumerabilis life cycle

During this research, *N. innumerabilis* was found to reproduce by gamogenesis, develop one generation annually, and overwinter as a fertilized female on the trunk or branch of its host plant. In the spring, females continue development, forming ovisacs (Figure 2) to lay eggs into. Oviposition was recorded in the second half of May (Table 1). The average number of eggs laid per female was 998.3 ± 5.6 (Figure 3). Embryonic development lasts between two and three weeks before first-instar nymphs hatch. The hatched nymphs actively move around the plant, searching for suitable feeding site. They mostly concentrate on the underside of leaves where they feed by sucking plant sap. Second-instar nymphs developed by the end of July (Figure 4). During this period, sexual differentiation becomes noticeable. The larvae of future females developed until the end of August 2016, and early September 2017, when they molted and became females. The larvae of future males briefly fed before going through prepupal and pupal stages. Prepupae were observed in the first ten days of

August 2016 and in the second decade of August 2017. Pupae were found in the second decade of August 2016 and third decade of August 2017. The prepupal and pupal stages lasted 10-12 days each, after which males hatched. Their appearance is synchronized with the appearance of females, and they flew in late August or early September. The sex ratio was 0.9. After copulation males die and fertilized females descend to the trunk or thicker branches to overwinter.

N. innumerabilis distribution, host plants, infestation intensity and damage symptoms

After its first detection at Radmilovac, *Neopulvinaria innumerabilis* was detected at five more locations in Serbia (Bečmen, Košutnjak, Kragujevac, Ušće, Zemun Polje). Infestation was recorded on five plant species from five botanical families (*Cornus sanguinea* L. [Cornaceae] *Maclura pomifera* [Raf.] Schneid. [Moraceae]; *Acer pseudoplatanus* L. [Sapindaceae]; *Ulmus minor* Mill. [Ulmaceae] and *Vitis vinifera* L. [Vitaceae]) (Table 2).

Two plant species, *Maclura pomifera* and *Ulmus minor*, were found for the first time to be hosts of *N. innumerabilis*, which represents a new finding in the world literature.

N. innumerabilis scales found on *Vitis vinifera* at Bečmen and Ušće, and on *Maclura pomifera* at Košutnjak, formed dense colonies with infestation intensity 4 (Figures 5-6). Larvae feed by sucking sap from leaves, young shoots, and branches, causing leaves and individual twigs to dry. In the spring, infested plants are readily noticed owing to large scales with white ovisacs covering plant branches.

On *Acer pseudoplatanus* at the location Kragujevac, *Cornus sanguinea* at Radmilovac, and *Ulmus minor* at Radmilovac and Zemun Polje, *N. innumerabilis* was found sporadically or in small colonies with infestation intensity 3 and 4 and no visible symptoms of damage.

Table 1. The life cycle of *N. innumerabilis* on *Cornus sanguinea*

Year	2016		2017	
Development stage	Female development	Male development	Female development	Male development
egg	20.05.	20.05.	22.05.	22.05.
N_1	07.06.	07.06.	11.06.	11.06.
N_2	24.07.	24.07.	29.07.	29.07.
prepupa	-	07.08.	-	12.08.
pupa	-	18.08.	-	22.08.
male	-	28.08.	-	04.09.
female	30.08.	-	06.09.	-

N_1 – first-instar
N_2 – second-instar

Table 2. Distribution, host plants, and infestation intensity of *N. innumerabilis*

Location	Host plant	Infestation intensity
Bečmen	*Vitis vinifera*	4
Košutnjak	*Maclura pomifera**	4
Kragujevac	*Acer pseudoplatanus*	2
Radmilovac	*Cornus sanguinea* *Ulmus minor**	2 2
Ušće	*Vitis vinifera*	4
Zemun Polje	*Ulmus minor*	2

* Host plants on which *N. innumerabilis* was detected for the first time

Figure 1. Female of *N. innumerabilis* (orig.)

Figure 2. Female of *N. innumerabilis* with ovisac (orig.)

Figure 3. Eggs of *N. innumerabilis* (orig.)

Figure 4. Second-instar nymph of *N. innumerabilis* (orig.)

Figure 5. Colony of *N. innumerabilis* on *V. vinifera* (orig.)

Figure 6. Colony of *N. innumerabilis* on *M. pomifera* (orig.)

Table 3. Natural enemies of *N. innumerabilis*

Order	Family	Species	Location	Total eclosed individuals
Hymenoptera	Aphelinidae	*Coccophagus lycimnia* (Walker)	Zemun polje	4
	Encyrtidae	*Metaphycus hageni* Daane and Caltagirone	Košutnjak	2
			Radmilovac	1
Coleoptera	Coccinellidae	*Exochomus quadripustulatus* L.	Radmilovac	1
Diptera	Chamaemyiidae	*Leucopomyia silesiaca* (Egger)	Radmilovac	25

Natural enemies of *N. innumerabilis*

Four species of natural enemies were collected from *N. innumerabilis* colonies and reared, two of which were parasitoids of the order Hymenoptera, and the other two were predators of the orders Coleoptera and Diptera (Table 3).

Specimens of the parasitoid species *C. lycimnia* and *M. hageni* were found at three locations (Zemun polje, Košutnjak and Radmilovac). *C. lycimnia* parasitizes second instar larvae and females, while *M. hageni* parasitizes only females of *N. innumerabilis*. The predatory species *E. quadripustulatus* and *L. silesiaca* were recorded at Radmilovac. A total of 25 adults of the predatory fly *L. silesiaca*, whose larvae feed on scale eggs laid in egg sacs, were reared. Between one and four larvae of the predator completed their development in each ovisac of *N. innumerabilis*. The species *E. quadripustulatus* was represented by a single specimen.

DISCUSSION

N. innumerabilis was first recorded in Serbia at the location Radmilovac, on *Cornus sanguinea* in 2016. It reproduces by gamogenesis and develops one generation annually. Fertilized females overwinter on branches or trunks of their host plant, which coincides with data presented by other authors (Hadzibeyli, 1955; Phillips, 1962; Canard, 1966; Seljak, 1995; Pellizzari, 1997; Ülgentürk & Ayhan, 2011). In the spring, females become active, continue feeding, and begin laying eggs at the end of May. In our research, one female was found to lay up to 1000 eggs into a white ovisac, while other authors have reported the number of eggs to be as high as 3000 (Hadzibeyli, 1955) or even 8000 (Cannard, 1966). After hatching, mobile larvae move over the plant and feed intensively after finding a suitable site to settle down. Females and males develop at the beginning of autumn. After copulation, males die and fertilized females overwinter. Similar data on the life cycle were reported by Gill (1988) and Štrukelj (2012).

N. innumerabilis was in this research found on five plant species at six locations. To date, it has been recorded on over 50 host plants, including a large number of fruit trees and ornamental plants (García-Morales et al., 2016). Regarding ornamental plants, *Maclura pomifera* and *Ulmus minor* were identified as new hosts of *N. innumerabilis*.

The scale forms colonies of variable size on infested plants. Numerous colonies were discovered on grapevines at the locations Bečmen and Ušće, as well as on *Maclura pomifera* in Košutnjak. Symptoms of drying and premature leaf fall were observed on these plants.

Neopulvinaria innumerabilis prefers grapevines, to which it is able to cause significant economic damage (Seljak, 2007; Pellizzari, 1997). Due to feeding by larvae and females, plants become physiologically weakened, shoots are thinner, and leaves are smaller. Additionally, the species secretes honeydew on which sooty mold fungi settle, covering leaves and fruits, which ultimately reduces yield and market value of grapes (Seljak & Žežlina, 2007). Similar damage has been observed on ornamental plants in Georgia (Pellizzari, 1997).

Four entomophagous species originating from colonies of *N. innumerabilis* were reared, of which *C. lycimnia* and *M. hageni* are parasitoids, while *E. quadripustulatus* and *L. silesiaca* are predators. All recorded natural enemies are present in small numbers. *Metaphycus hageni* is a recent addition to the fauna of Serbia, and *N. innumerabilis* is a new host for this parasitoid wasp (Dervišević et al., 2024b). It has only been reported in global literature as a parasitoid of olive black scale *Saissetia oleae* (Olivier) (Daane et al., 2000). *Coccophagus lycimnia* is often

found in colonies of scale insects. In Serbia, it has been recorded on 16 species (Mitić-Mužina, 1964; Mihajlović & Kozarževskaja, 1983; Dervišević et al., 2024a), while over 100 species in the family Coccidae host it worldwide (Noyes, 2019).

The predatory ladybird *E. quadripustulatus* has been recorded in Serbia on species in the family Coccidae (Mitić-Mužina, 1964; Graora et al., 2012; Simonović et al., 2018; Dervišević et al., 2024a) and Diaspididae (Mihjalović & Kozarževskaja, 1983). It is considered an effective predator of scale insects of the families Coccidae, Diaspididae, Eriococcidae, and Kermesidae (García-Morales et al., 2016). The predatory fly *L. silesiaca* has been recorded in Serbia on *Pulvinaria vitis*, *P. hydrangeae*, and *P. flocifera* so far (Graora et al., 2016), while on *N. innumerabilis* it has been recorded only recently (Dervišević et al., 2024a). In Europe, *L. silesiaca* is reported as a predator of numerous species in the families Coccidae, Pseudococcidae, and Eriococcidae (Teodorescu & Maican, 2014).

Low abundance of natural enemies is probably due to the low abundance of scale populations on most infested plants. Considering this is a new species in Serbia, further research should focus both on studying *N. innumerabilis* and on studying the role and importance of its natural enemies.

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Neopulvinaria innumerabilis (Rathvon, 1854), nova vrsta štitaste vaši u Srbiji

REZIME

Tokom 2016. godine u lokalitetu Radmilovac na *Cornus sanguinea* L., prvi put je utvrđena vrsta *Neopulvinaria innumerabilis* (Rathvon, 1854), koja pripada štitastim vašima iz familije Coccidae. Razmnožava se gamogenezom, razvija jednu generaciju godišnje i prezimljava u stadijumu oplođene ženke na stablu ili granama domaćina. Tokom istraživanja vrsta je u Srbiji registrovana na šest lokaliteta i pet biljaka domaćina. Na infestiranim biljkama hrani se isisavanjem sokova iz lišća, mladih izbojaka i grana, izazivajući sušenje listova i pojedinačnih grančica. U kolonijama *N. innumerabilis* sakupljene su i odgajene četiri vrsta prirodnih neprijatelja. Od parazitoida, *Coccophagus lycimnia* (Walker) (Aphelinidae) i *Metaphycus hageni* Daane and Caltagirone (Encyrtidae), a od predatora *Exochomus quadripustulatus* L. (Coccinellidae) i *Leucopomyia silesiaca* (Egger) (Chamaemyiidae). Najbrojnija entomofagna vrsta je *L. silesiaca*.

Ključne reči: javorova štitasta vaš, Coccidae, prirodni neprijatelji, Srbija

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Prikaz knjige „Bolesti gajenih biljaka i njihovo suzbijanje“, autora prof. dr Draga Miloševića

Početkom 2024. godine, svetlost dana ugledala je knjiga „Bolesti gajenih biljaka i njihovo suzbijanje“ našeg istaknutog naučnog radnika i fitopatologa, profesora Agronomskog fakulteta u Čačku, dr Draga Miloševića. Ovo monumentalno delo je monografskog tipa, izdavač je Agronomski fakultet, Čačak, a tiraž je 700 primeraka.

Kako bi budući čitaoci shvatili o kakvom delu se radi, iznećemo nekoliko činjenica: knjiga je napisana na **704 stranice** na kvalitetnom papiru i u tvrdom povezu; u knjizi je opisano ukupno **555 različitih bolesti** 61 vrste gajenih biljaka; knjiga je izuzetno bogato ilustrovana sa **546 složenih slika ili više od 1200 pojedinačnih slika**, zatim 50 crteža i šema ciklusa razvoja patogena i 7 tabela. U knjizi je citirano **611 referenci**, što ovoj monografiji daje posebnu vrednost i relevantnost u oblasti fitopatologije i zaštite bilja.

Ono što ovu knjigu čini jedinstvenom je činjenica da su na jednom mestu opisane kako bolesti voćaka i vinove loze, tako i bolesti ratarskih, povrtarskih, ali i krmnih biljaka. Autor je utkao svoje višedecenijsko naučno i stručno iskustvo iz oblasti fitopatologije i zaštite bilja u ovo kapitalno delo.

U prvom delu knjige, koji možemo nazvati „Opšti deo“, na jasan i razumljiv način opisane su sve grupe prouzrokovača bolesti biljaka: gljive i gljivoliki mikroorganizmi, bakterije, virusi, viroidi, fitoplazme, parazitske cvetnice, lišajevi i mahovine, ali i neparazitske bolesti gajenih biljaka. Dalje, prikazan je proces patogeneze, uticaj ekoloških činilaca na nastanak bolesti, kao i prognoza bolesti biljaka. U ovom delu autor podrobno opisuje nehemijske mere suzbijanja prouzrokovača bolesti biljaka (stvaranje i gajenje otpornih i tolerantnih sorti i hibrida, upotreba zdravog semena i sadnog materijala, administrativne, biološke, agrotehničke, mehaničke i fizičke mere suzbijanja). U nastavku, detaljno su opisane hemijske mere suzbijanja biljnih bolesti uključujući načine primene pesticida, njihove formulacije, pripremu i mogućnost mešanja pesticida, pojam rezistentnosti, kao i otrovnost sredstava za zaštitu bilja.

U drugom delu knjige, koji kolokvijalno možemo nazvati „Posebni deo“, dr Milošević studiozno opisuje ekonomski najznačajnije mikoze, potom pseudomikoze, bakterioze, fitoplazmoze i viroze za pojedine grupe biljaka. Za svako pojedinačno oboljenje autor prikazuje naziv bolesti na srpskom i engleskom jeziku, rasprostranjenost i štetnost oboljenja, simptome bolesti, osnovne odlike prouzrokovača bolesti, epidemiologiju i ekologiju oboljenja i na kraju nehemijske i hemijske mere zaštite. Kako bi čitaoci lakše pratili tematiku monografije, gotovo sve opisane bolesti prate fotografije simptoma u boji visokog kvaliteta, od kojih su većina originalne, a kod onih koje nisu, naznačen je originalni izvor u vidu literature ili http linka. Kod ekonomski najznačajnijih bolesti, šematski su prikazani ciklusi razvoja što čitaocima olakšava razumevanje epidemiologije i ekologije patogena.

U knjizi je predstavljen i kompletan spisak svih registrovanih sredstava za suzbijanje prouzrokovača bolesti biljaka koji imaju dozvolu za korišćenje u našoj zemlji, uključujući nazive aktivnih materija i preparata. Osim toga, sve navedene aktivne materije tj. preparate prati popis prouzrokovača koji se mogu suzbijati korišćenjem ovih aktivnih materija.

Iako se radi o veoma obimnom pisanom delu, poglavlja su prikazana u harmoničnom odnosu, međusobno su povezana i uspešno ukomponovana u jednu celinu. Međusobna povezanost poglavlja sa uspehom slaže prikazanu materiju u jednu celinu, što olakšava praćenje informacija tokom čitanja. Obim informacija i stil pisanja prilagođen je širokom auditorijumu i sigurno je da će ova monografija privući pažnju mnogih čitalaca profesionalno orijentisanih na proizvodnju gajenih biljaka. Nakon čitanja ovog kapitalnog dela, preporučujemo je svima koga interesuju bolesti biljaka, njihov nastanak, razvoj i suzbijanje. To mogu biti studenti osnovnih, master i doktorskih studija, stručnjaci zaštite bilja, agronomi, neposredni proizvođači, naučni radnici i svi ostali koje interesuje ova problematika.

Sigurni smo da će informacije sadržane u ovoj sveobuhvatnoj monografiji omogućiti efikasnije rešavanje problema u zaštiti bilja od fitopatogenih mikroorganizama, smanjenje gubitaka i veću ponudu zdravijih i kvalitetnijih proizvoda.

Instructions for Authors

About Journal

Pesticidi i fitomedicina (Pesticides and Phytomedicine) is dedicated to the following research fields: toxicology and ecotoxicology of pesticides; phytopathology; applied entomology and zoology; weed science; plant and food products protection; use of pesticides in agriculture, sanitation and public health.

The journal continues the title *Pesticidi*, which was published over the period 1986-2003.

Pesticidi i fitomedicina (Pesticides and Phytomedicine) publishes original scientific papers and review papers that have not been published previously.

Pesticidi i fitomedicina (Pesticides and Phytomedicine) is an **Open Access** journal.

Contributions to the journal must be submitted in English, with summaries in English and Serbian (Serbian-speaking authors only).

As of 2020, *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* is issued triannually (three issues annually).

As of 2021, Pesticides and Phytomedicine (Pesticidi i fitomedicina) has been published **online only,** and paper copies of future issues will no longer be available. The primary platforms for journal publication will continue to be: Scindeks (http://scindeks.ceon.rs/journaldetails.aspx?issn=1820-3949) and the publisher's official web site (http://www.pesting.org.rs/).

The journal is indexed in: Chemical Abstracts, CAB International; DOAJ, EBSCO, AGRIS, Scindeks.

In 2011, the journal converted to an electronic online journal management system on the SCIndeks Assistant portal at **http://scindeks.ceon.rs/journaldetails.aspx?issn=1820-3949.** The system enables easy article submission and communication among the editorial staff, reviewers and authors. It also includes several quality control services: *CrossRef* for DOI assignment, and iThenticate for plagiarism prevention. Electronic editing is in compliance with the Journal Editing Act of the Ministry of Education, Science and Technological Development of the Republic of Serbia, and provides record-keeping stipulated in the Act.

Manuscript submission

To be published in *Pesticidi i fitomedicina (Pesticides and Phytomedicine),* an article must be based on original scientific results that have not been previously published and are not under consideration for publication elsewhere. Review articles should contain a comprehensive survey of a particular subject based on referenced literature and published results of the author(s) own research. All contributions are peer reviewed in a double blind process.

A click on "submit a manuscript" on the left-hand side of the journal home page in SCIndeks Assistant will lead users to a registration page and further on into a guided process of electronic manuscript submission. Serbian authors are requested to fill out the application form in both English and Serbian. Each visual or graphic item (table, chart, diagram or photo) should be submitted as a separate (supplementary) file.

Authors need NOT specify keywords in their articles. The Editor-in-Chief will propose a choice of keywords, and the authors are entitled to accept or change some of them.

Manuscript preparation

The manuscript should be prepared in Microsoft Word (A4 format, all margins 25 mm, font Times New Roman 12 pt). Articles have to be written in the English language, and only the title and abstract in both English and Serbian (Serbian summary will be furnished by the copyeditor for foreign authors'manuscripts).

Title should be concise and refer to the subject. Full names and surnames of all authors, details of their respective affiliations and emails should be indicated below the title. If discrepancy in such data occurs between the textual document and submission metadata in Assistant, the former will be given precedence. All authors will be required to confirm their co-authorship in writing during the copyediting stage of manuscript preparation.

Abstract (not exceeding 300 words) should briefly state the main results and conclusions.

Original scientific articles should contain the following sections: Introduction, Material and Methods, Results, Discussion, Acknowledgement and References.

Introduction should present the state-of-the-art in a particular research field, as well as research intent.

Material and Methods should provide sufficient detail to allow the work to be reproduced. Conventional methods should only be referenced.

Results should be presented in a logical order, clearly and concisely, using adequate tables and graphics. Avoid repetition of the results in tables and graphics, or in the text.

Discussion should emphasize the importance of the results, as well as their place within the context of previous research. Wherever possible, Results and Discussion should be separate sections.

Acknowledgement should be collated at the end of the manuscript before References.

References cited in the text need to include the author's/ authors' surname(s) and year of publication:

- author, year;
- first & second author, year;
- first author et al., year.

References mentioned in the manuscript must be listed in the References section at its end, in alphabetic order and using the **APA citation style**.

Journal references are required to contain the following information: name(s) of author(s), year of publication, title of article, title of journal, volume, issue number (unless pagination is continuous), pages (from-to) and DOI if available.

Dedić, B. (2012). Testing sunflower inbred lines for tolerance to phoma black stem. *Pesticides* & *Phytomedicine*, *27*(4), 299-303. doi:10.2298/PIF1204299D

Abbaspoor, M. & Streibig, J.C. (2005). Clodinafop changes the chlorophyll fluorescence induction curve. *Weed Science, 53*(1), 1-9. doi:10.1614/WS-04-131R

Abbaspoor, M., Teicher, H.B. & Streibig, J.C. (2006). The effect of root-absorbed PSII inhibitors on Kautsky curve parameters in sugar beet. *Weed Research, 46*(3), 226-235. doi:10.1111/j.1365-3180.2006.00498.x

Books: name(s) of author(s) or editor(s), year of publication, title, place of publication and name of publisher.

Timbrell, J. (2000). *Principles of biochemical toxicology* (3rd ed). London, UK: Taylor and Francis Ltd.

Frank, R. H. & Bernanke, B. (2007). *Principles of macroeconomics* (3rd ed.). Boston, MA: McGraw-Hill/Irwin.

Saari L.L. & Thill, D.C. (Eds.). (1994). *Resistance to acetolactate synthase inhibiting herbicides: Herbicide resistance in plants*. Boca Raton, FL, USA: CRC Press.

Dissertations: author's name, year of presentation, title, full name of the institution at which dissertation was defended.

Stepanović, M. (2012). *Osetljivost izolata Alternaria solani (Sorauer) iz različitih krajeva Srbije na fungicide i rizik rezistentnosti*. (Doktorska disertacija). Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd.

Book chapters and articles in conference proceedings: author(s), year of publication, title of chapter/article/abstract, source title (with editors names), pages, place of publication and publisher.

Hammond, K. R. & Adelman, L. (1986). Science, values, and human judgment. In H. R. Arkes & K. R. Hammond (Eds.), *Judgement and decision making: An interdisciplinary reader* (pp. 127-143). Cambridge, England: Cambridge University Press.

Edwards, J.P., Fitches, E.C., Audsley, N. & Gatehouse, J.A. (2002). Insect neuropeptide fusion proteins – A new generation of orally active insect control agents. In T. Margini (Ed.), *Proceedings of the BCPC – Pests and diseases* (pp. 237-242). Brighton, UK: University of Brighton Press.

Internet references: author(s), year of publication, title, source title, link.

Graora, D., & Spasić, R. (2008). Prirodni neprijatelji *Pseudaulacaspis pentagona* Targioni-Tozzetti u Srbiji. *Pesticidi i fitomedicina*, *23*(1) 11-16. Retrieved from http://www.pesting.org.rs/media/casopis/2008/no.1/23_1_11-16.pdf

Radunović, D., Gavrilović, V., Gašić, K., Krstić, M. (2015). Monitoring of *Erwinia amylovora* in Montenegro. *Pesticides and Phytomedicine*, 30(3), 179-185. doi 10.2298/PIF1503179R or http://www.pesting.org.rs/media/casopis/2015/no.3/30-3_179-185.pdf

Kerruish, R.M. & Unger, P.W. (2010). *Plant protection 1 – Pests, diseases and weeds*. Retrieved from APPS at http://www.appsnet.org/Publications/Kerruish/PP1.pdf

Tables need to be numbered in Arabic numerals consecutively as they appear in text. Tables should be made exclusively in Word for Windows using the toolbar menu Table-Insert-Table, Times New Roman font, 12 pt, and single line spacing. Footnotes immediately below the table body should be given priority over other explanation in table header or in table cells, and text should be in Times New Roman font, 10 pt. Each table must have a header. Tables should be submitted as supplementary (separate) files, and their approximate location in the text marked.

Graphs should be processed in Microsoft Excel and all data in Times New Roman black font. Explanations should be provided in captions, consecutively and marked with Arabic numerals. Graphs should be submitted as supplementary files, and their approximate location in the text marked.

Figures and diagrams should be processed in Adobe Illustrator (version 9 or later) and all data written in Times New Roman black font. Diagrams should be submitted as supplementary files and their approximate locations in the text marked.

Photos need to be submitted in JPG or TIFF formate and the resolution should be at least 300 dpi. Photos need to be marked with Arabic numerals in consecutive order. Provide each photo with a caption, mark its approximate location in the text and submit it as a supplementary file.

Any use of artificial inteligence tools (e.g. ChatGpT) should be explained (e.g. for improving English text, which is acceptable).

Authors are expected to use the accepted International System of Units (SI). Abbreviations should be defined in brackets at their first in-text mention. Provide full Latin names along with common names of organisms, and italicize only Latin names of genera and species, e.g. Colorado potato beetle, *Leptinotarsa decemlineata* (Coleoptera: Chrysomelidae). After first mention, the Latin name can be abbreviated (e.g. *L. decemlineata*).

Review articles need to contain an introduction, appropriate subtitles and a reference list.

Publishing in *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* is free of charge.

The editorial staff practice a policy of plagiarism prevention.

Uputstvo autorima

O časopisu

Časopis *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* objavljuje naučne radove iz oblasti: toksikologije i ekotoksikologije pesticida; fitopatologije; primenjene entomologije i zoologije; herbologije; zaštite bilja i prehrambenih proizvoda; primene pesticida u poljoprivredi, komunalnoj higijeni i javnom zdravstvu.

Časopis *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* predstavlja nastavak publikacije *Pesticidi*, koja je pod tim imenom izlazila u periodu 1986-2003.

Časopis *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* objavljuje originalne i pregledne, prethodno neobjavljene radove.

Časopis *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* je dostupan u režimu **otvorenog pristupa**.

Radovi koji se prilažu moraju biti napisani na engleskom jeziku, sa rezimeom na engleskom i srpskom jeziku.

Od 2020. godine, časopis izlazi četvoromesečno (tri broja godišnje).

Od 2021. godine, časopis Pesticidi i fitomedicina (Pesticides and Phytomedicine) objavljuje sveske samo u **elektronskom obliku**, bez štampane verzije. Osnovne platforme na kojima se postavljaju sadržaji časopisa su: Scindeks (http://scindeks.ceon.rs/journaldetails.aspx?issn=1820-3949) i zvanična veb stranica izdavača (http://www.pesting.org.rs/).

Časopis se indeksira u sledećim bazama: Chemical Abstracts, CAB International; DOAJ, EBSCO, AGRIS, Scindeks.

Tokom 2011. godine, časopis je prešao na sistem onlajn uređivanja (Elektronsko uređivanje – e-Ur) na portalu SCIndeks Asistent **http://scindeks.ceon.rs/journaldetails.aspx?issn=1820-3949**. Ovaj sistem uređivanja omogućava funkcionalniju prijavu radova i komunikaciju uredništva sa recenzentima i autorima, a obuhvata i servise za kontrolu kvaliteta radova: *CrossRef* za dodelu DOI i iThenticate za prevenciju plagijarizma. Elektronsko uređivanje je usaglašeno sa Aktom o uređivanju časopisa Ministarstva prosvete, nauke i tehnološkog razvoja RS i obezbeđuje vođenje evidencije koje ovaj akt nalaže.

Prijavljivanje radova

Publikovanje u časopisu *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* podrazumeva da rad sadrži rezultate originalnih istraživanja koji nisu objavljeni, odnosno nisu dostavljeni nekom drugom časopisu za objavljivanje. Pregledni radovi treba da sadrže sveobuhvatan prikaz određene teme zasnovan na referentnoj literaturi i publikovanim rezultatima sopstvenih istraživanja. Svi radovi se recenziraju, a recenzija je obostrano anonimna.

Klikom na "submit a manuscript" na levoj polovini početne stranice u SCIndeks Asistentu, dolazi se do opcije za registraciju i prijavu rukopisa i ulazi u vođeni postupak elektronske prijave rada. Obaveza srpskih korisnika je da prijavu popune na oba jezika (srpskom i engleskom). Svaki likovno-grafički prilog (tabela, grafikon, dijagram, slika) se prilaže kao zasebna (dopunska) datoteka.

Autori u radu NE NAVODE ključne reči. Njih će predložiti urednik, a autori imaju pravo da dodeljene ključne reči prihvate ili da neke od njih zamene.

Priprema rada

Rad treba pripremiti u programu za obradu teksta Word (format A4, margine 25 mm, font Times New Roman 12 pt). Radovi treba da budu isključivo na engleskom jeziku sa naslovom i rezimeom na oba jezika (engleskom i srpskom).

Naslov treba da bude kratak i da upućuje na temu. Puna imena i prezimena svih autora, puni nazivi i adrese institucija svih autora i njihove email adrese treba navesti ispod naslova rada. U slučaju neslaganja ovih podataka u samom tekstu rada i u prijavi na platformi za uređivanje, prioritet će se dati podacima u samom tekstu rada. U toku faze lekture, tražiće se da svi autori u pisanom obliku potvrde svoje autorstvo.

Rezime (obima do 300 reči) treba da predstavi ono što je za rad najznačajnije.

Originalni naučni rad treba, po pravilu, da sadrži sledeća poglavlja: Uvod, Materijal i metode, Rezultati, Diskusija, Zahvalnica i Literatura.

Uvod treba da sadrži najnužniji pregled istraživanja u datoj oblasti i ciljeve istraživanja.

Materijal i metode treba opisati dovoljno detaljno da omogućе ponavljanje ispitivanja. Poznate metode i tehnike označiti samo odrednicom iz literature.

Rezultate predstaviti logičnim redosledom, jasno i precizno, koristeći prigodne tabele i grafičke prikaze. Izbegavati ponavljanje rezultata u tabelama i grafikonima, ali i u tekstu rada.

Diskusija treba da istakne značaj dobijenih rezultata, kao i njihovo mesto u kontekstu prethodnih istraživanja. Kad god je to moguće, diskusiju treba odvojiti od rezultata.

Zahvalnica se navodi na kraju teksta rada, pre literature.

Literatura se u tekstu rada citira navođenjem prezimena autora i godine:

- autor, godina;
- prvi & drugi autor, godina;
- prvi autor et al., godina.

Literatura citirana u radu se navodi na kraju rada, abecednim redom prema pravilima **APA citatnog stila**.

Reference u časopisima treba da sadrže sledeće podatke: autor(i), godina publikovanja, naslov rada, naslov časopisa, volumen, broj (ako se paginacija ponavlja), brojeve stranica (od – do) i doi broj (ukoliko postoji).

Dedić, B. (2012). Testing sunflower inbred lines for tolerance to phoma black stem. *Pesticides* & *Phytomedicine*, *27*(4), 299-303. doi:10.2298/PIF1204299D

Abbaspoor, M., & Streibig, J.C. (2005). Clodinafop changes the chlorophyll fluorescence induction curve. *Weed Science, 53*(1), 1-9. doi:10.1614/WS-04-131R

Abbaspoor, M., Teicher, H.B., & Streibig, J.C. (2006). The effect of root-absorbed PSII inhibitors on Kautsky curve parameters in sugar beet. *Weed Research, 46*(3), 226-235. doi:10.1111/j.1365-3180.2006.00498.x

Knjige: autor(i) ili editor(i), godina publikovanja, naslov, mesto publikovanja i naziv izdavača.

Timbrell, J. (2000). *Principles of biochemical toxicology* (3rd ed). London, UK: Taylor and Francis Ltd.

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Saari L.L., & Thill, D.C. (Eds.). (1994). *Resistance to acetolactate synthase inhibiting herbicides: Herbicide resistance in plants*. Boca Raton, FL, USA: CRC Press.

Disertacije: autor, godina odbrane, naslov, i puni naziv institucije u kojoj je disertacija odbranjena.

Stepanović, M. (2012). *Osetljivost izolata Alternaria solani (Sorauer) iz različitih krajeva Srbije na fungicide i rizik rezistentnosti*. (Doktorska disertacija). Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd.

Poglavlja u knjigama i radovi u zbornicima: autor(i), godina publikovanja, naslov poglavlja/rada/apstrakta, naslov izvornika sa imenom (imenima) urednika, strane priloga, mesto publikovanja i naziv izdavača.

Hammond, K. R., & Adelman, L. (1986). Science, values, and human judgment. In H. R. Arkes & K. R. Hammond (Eds.), *Judgement and decision making: An interdisciplinary reader* (pp 127-143). Cambridge, UK: Cambridge University Press.

Edwards, J.P., Fitches, E.C., Audsley, N. & Gatehouse, J.A. (2002). Insect neuropeptide fusion proteins – A new generation of orally active insect control agents. In T. Margini (Ed.), *Proceedings of the BCPC – Pests and diseases* (pp 237-242). Brighton, UK: University of Brighton Press.

Internet reference: autor(i), godina publikovanja, naslov, naziv izvornika, link.

Graora, D., & Spasić, R. (2008). Prirodni neprijatelji *Pseudaulacaspis pentagona* Targioni-Tozzetti u Srbiji. *Pesticidi i fitomedicina*, *23*(1) 11-16. Retrieved from http://www.pesting.org.rs/media/casopis/2008/no.1/23_1_11-16.pdf

Radunović, D., Gavrilović, V., Gašić, K., Krstić, M. (2015). Monitoring of *Erwinia amylovora* in Montenegro. *Pesticides and Phytomedicine*, 30(3), 179-185. doi 10.2298/PIF1503179R or http://www.pesting.org.rs/media/casopis/2015/no.3/30-3_179-185.pdf

Kerruish, R.M. & Unger, P.W. (2010). *Plant protection 1 – Pests, diseases and weeds*. Retrieved from APPS at http://www.appsnet.org/Publications/Kerruish/PP1.pdf

Tabele se obeležavaju arapskim brojevima prema predviđenom redosledu. Tabele se izrađuju isključivo u programu Word for Windows, kroz meni Table-Insert-Table, koristeći font Times New Roman, 12 pt i osnovni prored. Fusnotama neposredno ispod tabela treba dati prednost nad drugim objašnjenima u zaglavlju tabela ili u samim tabelama, a tekst se daje u fontu Times New Roman, 10 pt. Svaka tabela mora imati zaglavlje. Tabele se prilažu kao dopunske (zasebne) datoteke, a u samom tekstu se obeležava njihovo približno mesto.

Grafikoni treba da budu urađeni i dostavljeni u programu Excel, sa podacima u fontu Times New Roman, u crnoj boji. Potrebna objašnjenja daju se u legendama obeleženim arapskim brojevima prema redosledu. Grafikoni se prilažu kao zasebne (dopunske) datoteke, a u samom tekstu se obeležava njihovo približno mesto.

Dijagrami treba da budu urađeni i dostavljeni u programu Adobe Illustrator (verzija 9 ili novija). Za unos podataka treba koristiti font Times New Roman. Grafikoni se prilažu kao zasebne (dopunske) datoteke, a u samom tekstu se obeležava njihovo približno mesto.

Fotografije treba da budu snimljene u JPG ili TIFF formatu, sa rezolucijom najmanje 300 dpi. Fotografije je potrebno obeležiti arapskim brojevima prema predviđenom redosledu. Za svaku fotografiju se daje legenda i obeležava njeno približno mesto pojavljivanja u tekstu. Svaka fotografija se prilaže kao zasebna (dopunska) datoteka.

Svako korišćenje alata zasnovanog na veštačkoj inteligenciji (npr. ChatGpT) treba da bude opisano (npr. za popravak kvaliteta engleskog jezika, što je dopušteno).

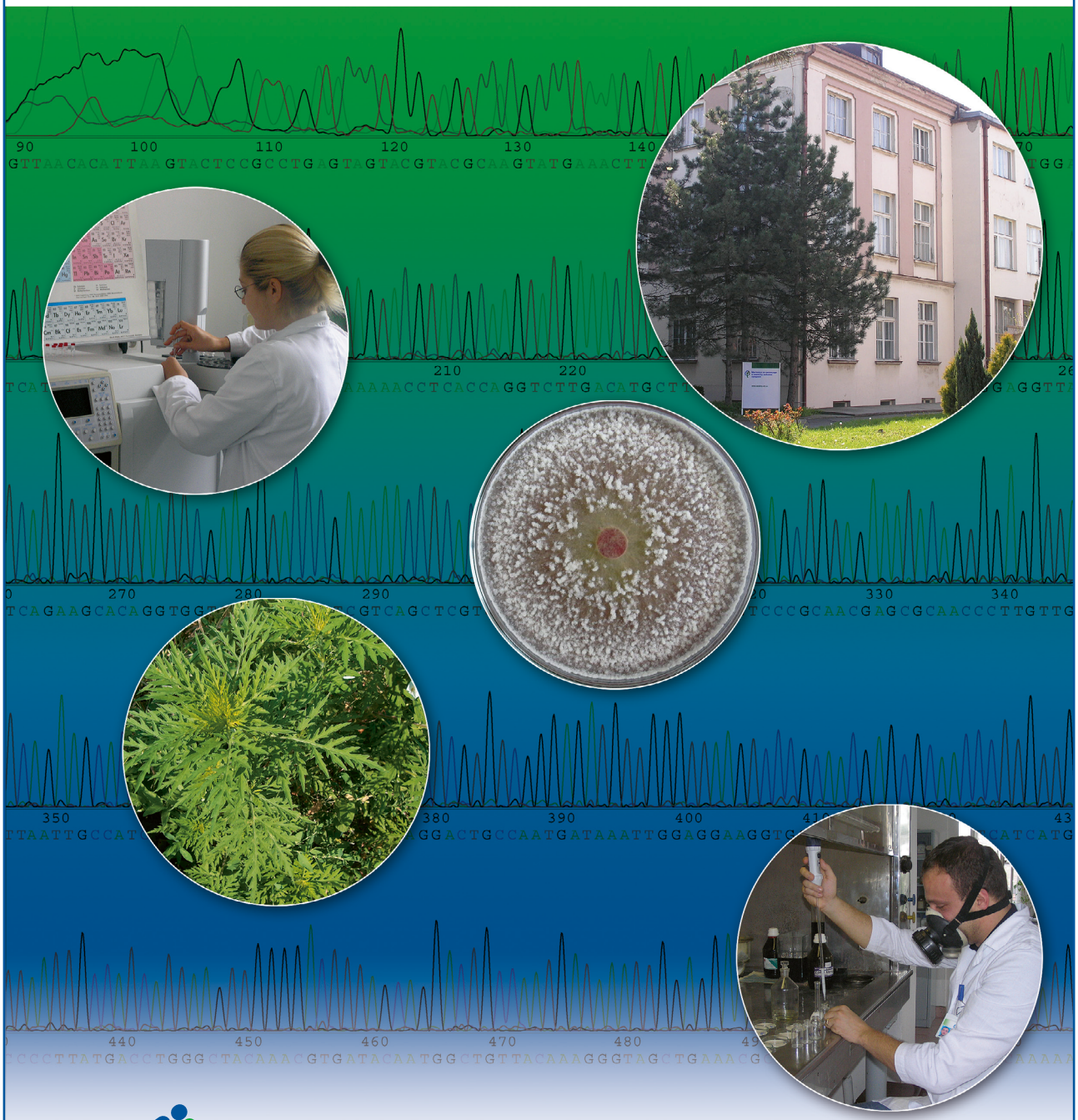
Od autora se očekuje da koriste preporučene jedinice međunarodnog sistema (SI). Skraćenice je potrebno definisati u zagradama nakon prvog pominjanja u tekstu. Narodni nazivi organizama se daju uz pun latinski naziv, a kurzivom se obeležavaju samo latinski nazivi rodova i vrsta, npr. krompirova zlatica, *Leptinotarsa decemlineata* (Coleoptera: Chrysomelidae). Nakon prvog pojavljivanja, latinsko ime dalje treba pisati skraćeno (npr. *L. decemlineata*).

Pregledni radovi treba da sadrže uvod, odgovarajuće podnaslove i spisak literature.

Objavljivanje radova u časopisu *Pesticidi i fitomedicina (Pesticides and Phytomedicine)* je besplatno.

Uredništvo preduzima mere protiv grubog kršenja etičkih normi u vezi sa plagijarizmom.

Nauka u službi zdravlja bilja, čoveka i prirode



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