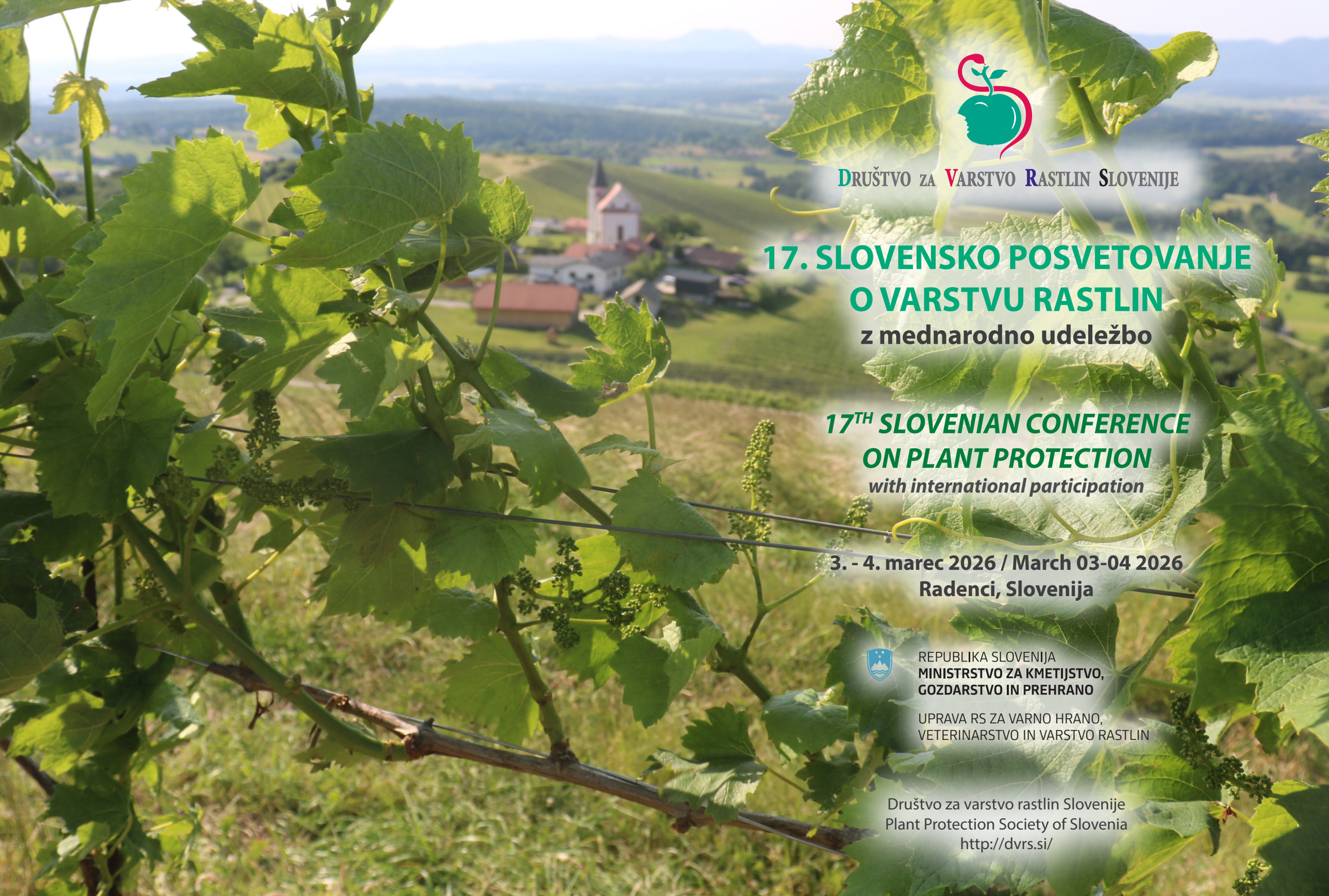

DRUŠTVO ZA VARSTVO RASTLIN SLOVENIJE

17. SLOVENSKO POSVETOVANJE O VARSTVU RASTLIN

z mednarodno udeležbo

17TH SLOVENIAN CONFERENCE ON PLANT PROTECTION

with international participation

3. - 4. marec 2026 / March 03-04 2026
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KAZALO

Uvodni referati

Challenges and opportunities for the utilization of biological control agents in the EPPO region

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Biological control is a pest management method that can offer an alternative to chemical pesticides. With a proven safety record, it can be used against indigenous and non-indigenous pests within protected conditions or in open field cropping systems. The European and Mediterranean Plant Protection Organization (EPPO) is an international organization responsible for cooperation and harmonization in plant protection within the European and Mediterranean region. EPPO develops Standards on the safe use of biological control with the aim to harmonise approaches for the introduction of BCAs across the region and to promote increased utilization of biological control against regulated pests. This presentation will discuss these Standards and also address other challenges and opportunities in the utilization of biological control against regulated pests of protected crops.

IZVLEČEK

Izzivi in priložnosti za uporabo biotičnega varstva na območju EPPO

Biotično varstvo rastlin je metoda zatiranja škodljivcev, ki lahko predstavlja alternativo fitofarmacevtskim sredstvom. Zaradi dokazane varnosti se lahko uporablja proti avtohtonim in tujerodnim škodljivcem tako v zavarovanih prostorih kot tudi v pridelovalnih sistemih na prostem. Evropska in sredozemska organizacija za varstvo rastlin (EPPO) je mednarodna organizacija, odgovorna za sodelovanje in usklajevanje na področju varstva rastlin v evropski in sredozemski regiji. EPPO pripravlja standarde za varno uporabo biotičnih pripravkov za varstvo rastlin z namenom uskladitve pristopov pri uvajanju biotičnih agensov (BCA) v regiji ter spodbujanja večje uporabe biotičnega varstva proti reguliranim škodljivcem. Predstavitev bo obravnavala te standarde ter izpostavila druge izzive in priložnosti pri uporabi biotičnega varstva proti reguliranim škodljivcem v zavarovanih pridelovalnih sistemih.

The Decision Support Systems for the plant protection in Germany: from the algorithm (ZEPP) to the praxis ISIP"

Paolo RACCA[1], Juliane SCHMITT[1], Manfred ROHERIG[2], Rheinhard SANDER[2]

[1] ZEPP - Kompetenzzentrum für Entscheidungshilfen im Pflanzenschutz (ex Zentralstelle der Länder für EDV-gestützte Entscheidungshilfen und Programme im Pflanzenschutz, Central Institution for Decision Support Systems in Crop Protection and Crop Production)
[2] ISIP - Informationssystem für die integrierte Pflanzenproduktion (Information system for integrate Plant production)

The Central Institution for Decision Support Systems in Crop Protection and Crop Production (German acronym ZEPP) was founded in October 1997 on the basis of an administrative agreement of the Federal States. ZEPP was founded on the basis of a successful model project funded by the Federal Ministry of Food, Agriculture and Forestry between the years 1993 through 1997.

The mission of ZEPP is to collect and examine existing predictive and simulation models for important agricultural and horticultural pests and diseases and to develop these models for practical use. More over, it initiates the development of predictive models for further pests and diseases not yet considered. A universally applicable time-reduced procedure enables ZEPP taking up scientific model approaches, to adapt them regionally and to develop them for practical use. The realisation is carried out in close cooperation with Researches institutions in Germany, e.g. the Julius Kühn Institute (ex Federal Biological Agency for Agriculture and Forestry), universities (e.g. University of Göttingen and Hanover) and other Researcher institutions. In addition manifold co-operations exist with European foreign countries (e.g. Plant Protection Offices in Austria and Poland, University of Ljubliana in Slowenia and University of Piacenza in Italy). More than 40 met-based predictive models for pests and diseases have been successfully developed and introduced for practical use by means of governmental crop protection services within the last years. The occurrence of pests and periods of high-intensity attacks can be calculated with high accuracy. Thus it is possible to reduce the intensity of chemical control in combination with a high effectiveness and thus contributing to an environment-friendly agriculture. The predictions are suitable for both conventional, integrated and organic (bio-) farming. Plant protection products are being saved particularly in fungal control of arable crops and cereals as well as for horticultural crops. ISIP (acronim of Information system for integrate Plant production) is a web-base platform in whicht the models algorithms produced by the ZEPP where integrated and able to run and produce results with interaction with meteorological data. This prediction information where transfer to technicians, farmers and horticulturists in real time. The calculation of pest attack and disease predictions arfe based on more than 360000 virtual meteorological stations covering the entire German territory. A detailed example of a DSS for the scheduling of the treatments against cercospora leaf spot (*Cercospora beticola*) and a DSS for the population dynamic of the *Pentastiridius leporinus*, a new pest main vector of the syndrome 'basses richesses' in sugar beet are illustrated on the presentation.

IZVLEČEK

Sistemi za podporo odločanju v varstvu rastlin v Nemčiji: od algoritma (ZEPP) do prakse ISIP

Osrednja institucija za sisteme za podporo odločanju v varstvu rastlin in pridelavi rastlin (nemška kratica ZEPP) je bila ustanovljena oktobra 1997 na podlagi upravnega dogovora zveznih dežel. ZEPP je nastal na osnovi uspešnega modelnega projekta, ki ga je med letoma 1993 in 1997 financiralo Zvezno ministrstvo za prehrano, kmetijstvo in gozdarstvo. Poslanstvo ZEPP je zbiranje in vrednotenje obstoječih napovednih in simulacijskih modelov za pomembne kmetijske in vrtnarske škodljivce ter bolezni ter njihov nadaljnji razvoj za praktično uporabo. Poleg tega ZEPP spodbuja razvoj napovednih modelov za dodatne škodljivce in bolezni, ki doslej še niso bili vključeni. Univerzalno uporaben in časovno učinkovit postopek omogoča ZEPP, da prevzame znanstvene modelske pristope, jih regionalno prilagodi in razvije za praktično uporabo. Izvajanje poteka v tesnem sodelovanju z raziskovalnimi ustanovami v Nemčiji, kot so Inštitut Julius Kühn (nekdanja Zvezna biološka agencija za kmetijstvo in gozdarstvo), univerze (npr. Univerza v Göttingenu in Hannovru) ter druge raziskovalne institucije. Poleg tega obstajajo številna sodelovanja z evropskimi tujimi državami (npr. zavodi za varstvo rastlin v Avstriji in na Poljskem, Univerza v Ljubljani v Sloveniji ter Univerza v Piacenzi v Italiji). V zadnjih letih je bilo razvitih in uspešno uvedenih v prakso več kot 40 meteorološko osnovanih napovednih modelov za škodljivce in bolezni, ki jih uporabljajo državne službe za varstvo rastlin. Pojav škodljivcev in obdobja njihovega intenzivnega napada je mogoče z visoko natančnostjo

napovedati. To omogoča zmanjšanje intenzivnosti kemičnega varstva ob hkratni visoki učinkovitosti ter tako prispeva k okolju prijaznemu kmetijstvu. Napovedi so primerne za konvencionalno, integrirano in ekološko (bio) kmetovanje. Prihranek fitofarmacevtskih sredstev je posebej izrazit pri zatiranju glivičnih bolezni v poljščinah in žitih ter pri vrtnarskih kulturah. ISIP (kratica za Information System for Integrated Plant Production – informacijski sistem za integrirano pridelavo rastlin) je spletna platforma, v katero so integrirani modelski algoritmi, razviti v okviru ZEPP, in ki omogoča njihovo delovanje ter generiranje rezultatov v povezavi z meteorološkimi podatki. Te napovedne informacije se v realnem času posredujejo svetovalcem, kmetom in vrtnarjem. Izračuni pojava škodljivcev in napovedi bolezni temeljijo na več kot 360.000 virtualnih meteoroloških postajah, ki pokrivajo celotno ozemlje Nemčije. V predstavitvi sta podrobno prikazana primera sistema za podporo odločanju pri časovnem načrtovanju ukrepov proti pegavosti listov sladkorne pese (*Cercospora beticola*) ter sistema za podporo odločanju za populacijsko dinamiko vrste *Pentastiridius leporinus*, novega pomembnega škodljivca in glavnega prenašalca sindroma »basses richesses« pri sladkorni pesi.

Biological pesticides as an alternative to synthetics - what do we talk about?

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Although growing demands for environmentally-friendly management of plant pests (animal pests, microbial pests, weeds) have increased general interest in biopesticides as an alternative to synthetic chemical pesticides, there is no general consensus on the definition of the term biopesticide. The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) define biopesticides as natural substances formulated and applied in a manner similar to synthetics. This definition encompasses microbial pesticides (microorganisms: bacteria, fungi, viruses), botanical pesticides (plant extracts and their components), and semiochemicals (allelochemicals and pheromones). In addition to these three types, the Organization for Economic Co-operation and Development (OECD) also includes invertebrates (predators and parasitoids of pests) as another type of biopesticides. On the other hand, the Environmental Protection Agency of the United States (US EPA), which includes microbials in its classification, also distinguishes two other types: biochemical pesticides (natural substances with non-toxic action) and plant incorporated protectants (pesticidal substances that plants produce from the added genetic material). In the European Union (EU), biopesticides are not formally treated as a distinct category, but microorganisms are recognized as one type of active substance used in plant protection products. The Chinese classification of biopesticides accepts microbial pesticides, botanical pesticides, biochemical pesticides (with some modifications), and invertebrates, but also includes agricultural antibiotics (microbial metabolites produced at the industrial scale). Regardless the lack of a globally agreed definition, the further expansion of the biopesticide sector depends on the successful overcoming of various technical constraints (lower efficacy of biopesticides and their greater susceptibility to unfavorable environmental conditions compared to the synthetics, the issue of quality and availability of resources) and socio-political obstacles (inconsistent policies and regulatory procedures across regions, limited awareness of biopesticides among the end-users). There is no doubt that further technological advances, legislation

expediting registration and increased adoption should contribute to the future growth of the biopesticide sector. However, the key driver of biopesticide success in the global market is and will remain profit.

IZVLEČEK

Biotični pripravki kot alternativa sintetičnim – o čem pravzaprav govorimo?

Čeprav naraščajoče zahteve po okolju prijaznem varstvu rastlin pred škodljivci (živalskimi škodljivci, mikrobnimi povzročitelji bolezni, pleveli) povečujejo splošno zanimanje za biopesticide kot alternativo sintetičnim kemičnim FFS, enotne in splošno sprejete definicije pojma biopesticid še vedno ni. Organizacija Združenih narodov za prehrano in kmetijstvo (FAO) ter Svetovna zdravstvena organizacija (WHO) biopesticide opredeljujeta kot naravne snovi, formulirane in uporabljene na podoben način kot sintetični pesticidi. Ta opredelitev zajema mikrobne pesticide (mikroorganizme: bakterije, glive, viruse), botanične pesticide (rastlinske izvlečke in njihove sestavine) ter semiokemikalije (alelokemikalije in feromone). Poleg teh treh skupin Organizacija za gospodarsko sodelovanje in razvoj (OECD) med biopesticide uvršča tudi nevretenčarje (plenilce in parazitoide škodljivcev). Po drugi strani Ameriška agencija za varstvo okolja (US EPA), ki v svojo klasifikacijo vključuje mikrobne pesticide, razlikuje še dve dodatni skupini: biokemične pesticide (naravne snovi z netoksičnim načinom delovanja) in rastlinske vgrajene zaščitne snovi (pesticidne snovi, ki jih rastline proizvajajo iz dodanega genskega materiala). V Evropski uniji (EU) biopesticidi niso formalno obravnavani kot posebna kategorija, vendar so mikroorganizmi priznani kot ena izmed vrst aktivnih snovi, ki se uporabljajo v fitofarmacevtskih sredstvih. Kitajska klasifikacija biopesticidov vključuje mikrobne pesticide, botanične pesticide, biokemične pesticide (z določenimi prilagoditvami) in nevretenčarje, hkrati pa zajema tudi kmetijske antibiotike (mikrobne metabolite, proizvedene v industrijskem merilu). Ne glede na pomanjkanje globalno usklajene definicije je nadaljnja rast sektorja biopesticidov odvisna od uspešnega premagovanja različnih tehničnih omejitev (nižja učinkovitost biopesticidov in njihova večja občutljivost na neugodne okoljske razmere v primerjavi s sintetičnimi pesticidi, vprašanja kakovosti in razpoložljivosti virov) ter družbeno-političnih ovir (neenotne politike in regulativni postopki med regijami, omejena ozaveščenost končnih uporabnikov o biopesticidih). Ni dvoma, da bodo nadaljnji tehnološki napredek, zakonodaja, ki bo pospešila postopke registracije, ter večja uporaba prispevali k prihodnji rasti sektorja biopesticidov. Kljub temu pa je ključno gonilo uspeha biopesticidov na svetovnem trgu – in bo to tudi v prihodnje – dobičkonosnost.

Varstvo sadnega drevja, oljk in jagodičja

Monitoring jablanovega cvetožera (*Anthonomus pomorum* L.) za potrebe napovedovanja njegovega zatiranja v Sloveniji

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Jablanov cvetožer (*Anthonomus pomorum* L.) je pomemben škodljivec jablan, katerega pojav in škodljivost sta močno odvisna od vremenskih razmer v zgodnjem spomladanskem obdobju. V Sloveniji se v okviru napovedovalne službe zdravstvenega varstva rastlin že vrsto let izvaja sistematično spremljanje njegovega pojava z namenom pravočasnega in utemeljenega priporočanja ukrepov zatiranja. V prispevku so predstavljeni rezultati večletnega monitoringa jablanovega cvetožera na izbranih lokacijah v Sloveniji, ki vključuje spremljanje začetka aktivnosti odraslih osebkov in dinamike populacije v povezavi z meteorološkimi podatki. Na podlagi teh podatkov se oblikujejo napovedi in priporočila za optimalen čas zatiranja. Poleg monitoringa so predstavljeni tudi rezultati poskusov zatiranja z različnimi insekticidi. Rezultati potrjujejo pomen dolgoročnega monitoringa kot ključnega orodja napovedovalne službe ter prispevajo k bolj ciljno usmerjenemu in strokovno utemeljenemu varstvu jablan.

ABSTRACT

Monitoring of apple blossom weevil (*Anthonomus pomorum* L.) for pest control forecasting in Slovenia

Apple blossom weevil (*Anthonomus pomorum* L.) is an important pest of apple orchards, with its occurrence and damage strongly influenced by weather conditions in early spring. In Slovenia, systematic monitoring of this pest has been carried out for several years within the national plant protection forecasting service, with the aim of providing timely and well-founded recommendations for pest control. This paper presents the results of multi-year monitoring of apple blossom weevil at selected locations in Slovenia. Monitoring included observations of the onset of adult activity and population dynamics in relation to meteorological data. These data form the basis for pest control forecasting and for issuing recommendations on the optimal timing of control measures. In addition to monitoring results, pest control trials with different insecticides are presented. The results confirm the importance of long-term monitoring as a key tool of the forecasting service and contribute to more targeted and professionally justified pest control in apple production.

Bionomija vzhodnjaškega škržatka (*Orientus ishidae*) (Hemiptera: Cicadellidae) v Sloveniji

Magda RAK CIZEJ[1], Octave LACROIX[1], Franček POLIČNIK[1], Alenka FERLEŽ RUS[1], Jože MIKLAVC[2], Leonida LEŠNIK[2], Miroslav MEŠL[2], Urška ŠKRABAR RAKUŠA[2], Rok VEBER[2], Mojca ROT[3], Ivan ŽEŽLINA[3], Branko CARLEVARIS[3], Marko

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Vzhodnjaški škržatek (*Orientus ishidae*, Matsumura, 1902) je polifagna tujerodna vrsta, ki je v Sloveniji prisotna že dlje časa. Ker lahko prenaša fitoplazme iz skupine 16SrV med leskami in potencialno posredno tudi na vinsko trto, predstavlja pomemben dejavnik prenosa bolezni zlate trsne rumenice v vinograde. Namen raziskave je bil preučiti biologijo (razvojne stadije vzhodnjaškega škržatka) in ugotoviti sezonsko dinamiko v različnih klimatskih območjih Slovenije. V okviru CRP projekta FD GAMEPLAN smo v letu 2024 na treh lokacijah v Sloveniji (zahodna Slovenija – Brje, severovzhodna Slovenija – Savci, osrednja Slovenija – Kasaze) preučevali bionomijo vzhodnjaškega škržatka v ekoloških nasadih jablan. Dvakrat tedensko smo vizualno pregledali približno 250 naključno izbranih listov jablan z namenom ugotavljanja števila in odstotnega deleža posameznih razvojnih stopenj ličink vzhodnjaškega škržatka (L1–L5). Vizualne preglede preimaginalnih stadijev smo izvajali od sredine meseca maja do konca julija. Odrasle osebke vzhodnjaškega škržatka smo spremljali z rumenimi lepljivimi ploščami (RLP) proizvajalca Unichem, pri čemer smo na vsaki lokaciji namestili tri RLP na višino približno 1,5 m od tal. Odrasle škržatke smo spremljali od sredine meseca junija do oktobra. RLP smo redno pregledovali in menjavali v 7–14-dnevnih intervalih. Ličinke prve razvojne stopnje (L1) vzhodnjaškega škržatka so se pojavile v drugi dekadi maja, v osrednji Sloveniji pa v začetku junija. Vrh pojava ličink druge razvojne stopnje (L2) je bil zabeležen sredi junija, medtem ko so se višje razvojne stopnje ličink (L3–L5) pojavljale v drugi polovici junija in so bile prisotne do sredine julija. Odrasle osebke vzhodnjaškega škržatka smo na RPL prvič zaznali v drugi dekadi junija. Na vseh lokacijah je bil vrh ulova odraslih osebkov sredi julija, ki se je na lokaciji Kasaze nadaljeval še v začetek avgusta. Odrasli škržatki so bili v vseh treh ekoloških nasadih jablan prisotni do začetka oktobra 2024. Številčnost odraslih osebkov vzhodnjaškega škržatka se je med lokacijami razlikovala. Najvišja številčnost na RLP je bila zabeležena v jabolčnem nasadu na lokaciji Kasaze, ki ga obdaja gozd.

ABSTRACT

Bionomics of the mosaic leafhopper (*Orientus ishidae*) (Hemiptera: Cicadellidae) in Slovenia

The mosaic leafhopper (*Orientus ishidae*, Matsumura, 1902) is a polyphagous alien species that has been present in Slovenia for an extended period. The species is known to transmit phytoplasmas of the 16SrV group among woody host plants, such as hazel, and may therefore contribute indirectly to the epidemiology of grapevine Flavescence dorée by facilitating phytoplasma circulation at landscape level. The aim of this study was to investigate the biology of the mosaic leafhopper, with particular emphasis on its

developmental stages, and to determine its seasonal dynamics across different climatic regions of Slovenia. Within the CRP project FD GAMEPLAN, the bionomics of the mosaic leafhopper were studied in 2024 at three locations in Slovenia (western Slovenia – Brje, north-eastern Slovenia – Savci, and central Slovenia – Kasaze) in organic apple orchards. Approximately 250 randomly selected apple leaves were visually inspected twice weekly in order to determine the number and relative proportion of individual larval developmental stages (L1–L5). Visual inspections of pre-imaginal stages were conducted from mid-May to the end of July. Adult mosaic leafhoppers were monitored using yellow sticky traps (YST; Unichem), with three traps installed per location at a height of approximately 1.5 m above ground level. We monitored adult leafhoppers from mid-June to October. YST were regularly checked and replaced at 7–14-day intervals. Larvae of the first developmental stage (L1) appeared in the second ten-day period of May, while in central Slovenia they were first recorded in early June. The peak occurrence of the L2 stage was observed in mid-June, whereas later larval stages (L3–L5) appeared in the second half of June and remained present until mid-July. Adult mosaic leafhoppers were first detected on YST in the second ten-day period of June. At all locations, the peak catch of adult individuals occurred in mid-July, and at the Kasaze site it continued into early August. Adult mosaic leafhoppers were present in all three organic apple orchards until early October 2024. Population abundance varied among locations, with the highest numbers recorded on YST in the apple orchard at Kasaze, which is surrounded by forest.

Vpliv tehničnih parametrov različnih izvedb vlečenih pršilnikov na pokritost listov jablan

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V nasadu jablan na kmetiji Aškerc smo 29. maja 2024 preizkušali različne izvedbe vlečenih pršilnikov. Uporabili smo vlečene pršilnike različnih proizvajalcev, in sicer Zupan DT 1000 in 1500, Lochmann 1000, Dragone DV in Mitterer 81. Glede na izhodiščne nastavitve pršilnikov smo pri preizkusu spreminjali nastavitve ventilatorja, izvedbo šob, vozno hitrost, porabo vode na hektar, vrtilno frekvenco priključne gredi traktorja in tlak škropljenja. Naš namen je bil izboljšati nastavitve pršilnika pri uporabnikih z namenom izboljšanja nanosa na listih jablan. Zato smo postavili na levo in desno stran vrste po 6 na vodo občutljivih lističev v enakomernih razmakih po višini. Škropljenje smo izvedli z vodo brez uporabe fitofarmacevtskih sredstev. Analiza odtisov kapljic je bila izvedena z industrijsko kamero in programom Wise node. Rezultati so predstavljeni kot odstotek pokritosti na merilnih lističih pri različnih nastavitvah škropljenja.

ABSTRACT

The influence of technical parameters of different types of orchard sprayers on coverage of apple leaves

On the apple orchard of Aškerc farm we tested different types of orchard sprayers on 29th May 2024. Orchard sprayers from different manufacturers were used, namely Zupan DT 1000 and 1500, Lochmann 1000, Dragone DV and Mitterer 81. Fan settings, nozzle types,

sprayer speed, water amount per hectare, rotational frequency of p.t.o. and spraying pressure were changed in accordance with starting sprayer adjustments. Our purpose was to improve sprayer adjustments for the users in order to enhance coverage on apple leaves. Therefore, we placed 6 water sensitive papers on each side of the row at equal height intervals. The spraying was executed with water without the use of phytopharmaceutical agents. The droplet impression analysis was carried out using industrial camera and Wise Node programme. The results are presented as coverage value on measuring papers at different spraying settings.

Izkušnje z zatiranjem listnih pegavosti v letih 2022 in 2024

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V zadnjih letih se v nasadih jablan močno pojavlja prezgodnjo odpadanje listja, ki se prične že mesecu juliju, nadaljuje pa se še v avgustu in septembru. Najbolj je prisotno pri sorti zlati delišes in gala. Kot možne povzročitelje so bile v nasadih integrirane pridelave identificirane glive iz rodu *Alternaria* sp. in *Colletotrichum* sp. Zato smo v let 2022 preizkusili tri različne programe varstva jablane proti listnim pegavosti; program 'brez kaptana', v katerega smo v mesecih julij in avgust uporabljali sredstvi Vitisan in Curatio, standardni program in program v katerem so bili uporabljeni samo pripravki dovoljeni v ekološkem varstvu. V letu 2024 so bili preizkušani standardni program integrirane pridelave, škropilni program pridelovalca, program, v katerem so bili vključeni pripravki še na osnovi aktivne snovi fluazinam, mefentriflukonazol, fluksapiroksad in tetrakonazol ter program, kjer je bil ob omenjenimih vključena še foliarna gnojila na osnovi cinka in mangana. V letu 2022 je bilo tik pred obiranjem v kontroli - neškropljeno 92,7 % okuženih listov, povprečno je bilo 32,2% okužene površine lista, v programu standard 57,7%, z 6,19% okužene površine, v ekološkem 88,3% z 34,77% in programu brez kaptana 82,7% z 18,49 % okužene površine. V letu 2024 v programu pridelovalca je bil % okuženih listov s pegavostmi 100 %, povprečna okužena površina listov je bila 15,86 % . V programu v katerem so bili vključena še foliarna gnojila zink in mangan je bil ugotovljen najmanjši % okuženih listov (20,83 %) s povprečno 3,6 % okuženo površino lista, v programu brez foliarnih gnojil 29,96% okuženih listov z 6,77% okužene površine, v standardnemu programu pa 35,82 % listov z bolezenskimi znaki, povprečno je bilo okuženo 6,71 % površine lista.

ABSTRACT

Experiences with leaf spots control in 2022 and 2024

In recent years, premature leaf fall has been occurring frequently in apple orchards, beginning as early as July and continuing into August and September. It is most prevalent in the Golden Delicious and Gala varieties. Fungi of the genus *Alternaria* sp. and *Colletotrichum* sp. have been identified as possible causes in integrated production orchards. Therefore, in 2022, we tested three different apple tree protection programs against leaf spot disease: a 'captan-free' program, in which we used Vitisan and Curatio in July and August, a standard program, and a program in which only preparations permitted

in organic production were used. In 2024, the following programs were tested: the standard integrated production program, the grower's spraying program, a program that included preparations based on the active substances fluazinam, mefentrifluconazole, fluxapyroxad, and tetraconazole, and a program that included the aforementioned preparations as well as foliar fertilizers based on zinc and manganese. In 2022, just before harvesting, 92.7 % of infected leaves were unsprayed in the control group, with an average of 32.2 % of the leaf surface infected, in the standard program 57.7 % with 6.19 % of the surface infected, in the organic program 88.3 % with 34.77 % infected, and in the program without captan 82.7 % with 18.49 % of the surface infected. In 2024, in the grower's program, the percentage of infected leaves with spots was 100 %, and the average infected leaf area was 15.86 %. In the program that also included foliar fertilizers zinc and manganese, the lowest percentage of infected leaves was found.

VACCIPLANT™ - vsestranski, naravni fungicid s širokim spektrom delovanja za varstvo rastlin brez ostankov

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Fungicid VACCIPLANT™ vsebuje aktivno snov laminarin (45 g/L), ki je naravni izvleček, pridobljen iz morskih alg vrste *Laminaria digitata.* Aktivna snov *laminarin* (=elicitor) ima podobne strukturne lastnosti kot razgradni produkti poškodovanih rastlinskih celic ali celic patogenov, ki stimulirajo odziv lastnega obrambnega mehanizma rastlin. Po razvrstitvi FRAC spada laminarin v skupino P04. Sredstvo nima neposrednega delovanja na škodljive organizme, ampak po vezavi na specifične receptorje, posredno aktivira obrambne mehanizme rastlin (tvorba fitoaleksinov in PR proteinov), ojača celične stene in pripravi rastlino na napad patogenih organizmov (gliv, bakterij, virusov) še preden se ta dejansko zgodi. Učinek inducirane odpornosti rastlin se vzpostavi v 1-2 dneh po aplikaciji in traja nekje od 7 do 10 dni. Reakcija rastlin na Vacciplant™ je primerljiva s cepljenjem zato se pripravek praviloma uporablja preventivno. Po rastlini se premešča sistemično in s tem zaščiti tudi novozrasle dele rastlin. Ima širok spekter delovanja in je dobro kompatibilno z drugimi SVR ter gnojili. Pri nas je uporaba registrirana na jablani, hruški, jagodi, paradižniku, jajčevcu, papriki, bučevkah z užitno in neužitno lupino ter fižolu. Odmerek sredstva se giblje od 1 do 3 L/ha. Uporabljamo ga lahko v kombinacij z drugimi sredstvi za varstvo rastlin, še posebej, ko je pritisk bolezni zelo velik. Možno ga je uporabljati izmenično z drugimi sredstvi za varstvo rastlin ali pa na koncu rastne sezone, ko nam karenčne dobe ne dovoljujejo več uporabe ostalih pripravkov. Vacciplant™ omogoča pridelavo hrane brez ostankov ali pa močno redukcijo le-teh. Spada v skupino sredstev z nizkim tveganjem, ima zelo dober ekotoksikološki in okoljski profil, je varen za uporabnika in koristne organizme in kot tak primeren za pridelavo hrane ob upoštevanju najvišjih okoljskih standardov, tudi ekoloških. Sredstvo je bilo proti jablanovemu škrlupu (*Venturia inaequalis*) v letih 2024 in 2025 preiskušano na KGZ Maribor.

ABSTRACT

VACCIPLANT™ - a versatile, natural fungicide with a broad spectrum of activity for residue-free plant protection

VACCIPLANT™ fungicide contains the active ingredient laminarin (45 g/L), which is a natural extract obtained from seaweed of the *Laminaria digitata* species. The active ingredient laminarin (=elicitor) has similar structural properties to the degradation products of damaged plant cells or pathogen cells, which stimulate the response of the plant`s own defense mechanism. According to the FRAC classification, laminarin belongs to group P04. The product does not have a direct effect on harmful organisms, but after binding to specific receptors, it indirectly activates plant defense mechanisms (with formation of phytoalexins and PR proteins), strengthens cell walls and prepares the plant for an attack by pathogenic organisms (fungi, bacteria, viruses) before it actually occurs. The effect of induced plant resistance is established within 1-2 days after application and lasts for about 7 to 10 days. The reaction of plants to Vacciplant™ is comparable to vaccination, so the product must be used preventively. It moves systemically throughout the plant, thus also protecting newly grown parts of plants. It has a broad spectrum of action and is well compatible with other PPP and fertilizers. In our country, its use is registered on apple trees, pears, strawberries, tomatoes, eggplants, peppers, zucchini with edible and inedible peels and beans. The application dose of the product ranges from 1 to 3 L/ha. It can be used in combination with other plant protection products, especially when disease pressure is very high. It can be used alternately with other plant protection products or alone at the end of the growing season, when withdrawal periods no longer allow the use of other products. Vacciplant™ enables food production without residues or a significant reduction of them. It belongs to the group of low-risk products, has a very good ecotoxicological and environmental profile, is safe for the user and beneficial organisms and as such suitable for food production while respecting the highest environmental standards, including organic. The product was tested against apple scab (*Venturia inaequalis*) at KGZ Maribor in 2024 and 2025.

Spremljanje sezonske dinamike zlate minice - *Cetonia aurata* (Linnaeus, 1758) [Coleoptera: Scarabaeidae: Cetoniinae] v nasadih češenj v zahodni Sloveniji z uporabo pasti za množični ulov

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Zlata minica (*Cetonia aurata* [L.]), hrošč iz družine Scarabaeidae in poddružine Cetoniinae, je v zadnjih letih v Evropi in Sloveniji vse pomembnejši škodljivec sadnih rastlin. Med tem ko se ličinke v tleh prehranjujejo saprofagno z odmrlo organsko snovjo, pri čemer ne poškodujejo vitalnih rastlinskih struktur, se odrasli hrošči hranijo s pelodom, nektarjem, cvetovi in plodovi številnih samoniklih ter gojenih rastlin. Zlasti na sadnih vrstah lahko povzročajo pomembno gospodarsko škodo. V Sloveniji zaradi napada zlate minice beležimo znatne izgube predvsem v pridelavi češenj in breskev. Ker ta vrsta do nedavnega ni bila obravnavana kot pomemben škodljivec, je o njeni bionomiji in načinih obvladovanja populacij v kmetijski pridelavi še vedno razmeroma malo znanega. V letih 2024–2025 smo preučevali sezonsko dinamiko zlate minice v intenzivnem nasadu češenj v Stomažu v zgornji Vipavski dolini. Pojav in številčnost odraslih minic smo spremljali v obdobju od konca marca do konca oktobra z uporabo pasti za množični ulov VARb3k (Csalomon®), opremljenih s privabilom, ki je vsebovalo hlapno mešanico anetola, 3-metil evgenola, in 1-feniletanola. Preglede pasti in štetje ulovljenih minic smo izvajali tedensko,

privabilo pa smo menjavali vsake štiri tedne. V obeh letih raziskave smo prve ulove odraslih minic zabeležili v začetku druge dekade aprila. Prvi vrh pojavljanja zlate minice, ki je sovpadal z zorenjem večine sort češenj v nasadu, smo zaznali v začetku junija. Drugi vrh pojavljanja je sledil sredi julija, po zaključku obiranja češenj. Od sredine avgusta dalje je začelo število ulovov postopoma upadati. V obeh letih smo zadnje osebke v pasteh zabeležili v začetku oktobra. Poleg zlate minice smo v pasteh evidentirali tudi druge vrste minic. V velikem številu se je pojavljala zlasti *Protaetia* (*Potosia*) *cuprea*, (Fabricius, 1775), v manjšem številu pa tudi *Oxythyrea funesta* (Poda, 1761), *Tropinota* (*Epicometis*) *hirta* (Poda, 1761) in *Tropinota squalida* (Scopoli, 1763). Za vse navedene vrste je znano, da lahko ob prerazmnožitvi povzročajo pomembno škodo v kmetijstvu. V prispevku predstavljamo sezonsko dinamiko zlate minice ter obravnavamo vpliv okoljskih in drugih dejavnikov na njen pojav in velikost populacije v posameznem letu.

ABSTRACT

Seasonal dynamics of the rose chafer, *Cetonia aurata* (Linnaeus, 1758) [Coleoptera: Scarabaeidae: Cetoniinae], in cherry orchard in Western Slovenia using mass trapping

The rose chafer, *Cetonia aurata* Linnaeus, 1758 (Coleoptera: Scarabaeidae: Cetoniinae), has become an increasingly important pest of fruit crops in Europe and Slovenia in recent years. Its saprophagous larvae develop in the soil on decaying organic matter without damaging vital plant structures, while adults feed on pollen, nectar, flowers, and fruits of numerous wild and cultivated plants, causing economically significant damage, particularly in fruit production. In Slovenia, substantial yield losses due to *C. aurata* have been recorded mainly in cherry and peach production. In 2024 and 2025, the seasonal population dynamics of *C. aurata* adults was studied in the commercial cherry orchard in Stomaž, located in the upper Vipava Valley, western Slovenia. Adult occurrence and population abundance were monitored from late March to late October using VARb3k traps (Csalomon®) baited with flower-derived attractant composed of anethole, 3-methyl eugenol and 1-phenylethanol. Traps were inspected weekly, and lures were replaced every four weeks. In both years, the first adults were captured in early April. The first population peak, coinciding with the ripening period of most cherry cultivars grown in the orchard, occurred in early June. A second peak was recorded in mid-July, following the cherry harvest. From mid-August onwards, trap catches gradually declined, with the last individuals recorded in early October. In addition to *C. aurata*, several other Cetoniinae beetles, were captured in the traps. The most abundant of these was *Protaetia* (*Potosia*) *cuprea* (Fabricius, 1775), while less frequently captured species included *Oxythyrea funesta* (Poda, 1761), *Tropinota* (*Epicometis*) *hirta* (Poda, 1761), and *Tropinota squalida* (Scopoli, 1763). All of these species are known to cause significant damage to agricultural crops when they occur in large populations.

Vpliv aplikacije talnih koristnih gliv na členonožce v nadzemnih delih jagodnjaka

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Gojene rastline vrtnega jagodnjaka (*Fragaria* × *ananassa*) napadajo različne bolezni in členonožci, vključno z žuželkami in pršicami. Tekom rastne dobe škodo povzročajo na različnih delih rastlin. Najpogostejši škodljivci so listne uši, resarji, rilčkarji, gosenice, travniške stenice, ščitkarji in pršice. V nasadih jagod pa se zadržujejo tudi koristni organizmi, kot so plenilske pršice, talni plenilci (npr. krešiči in pajki), tenčičarice, opraševalci (npr. čebele in čmrlji), parazitoidi ter muhe trepetavke (plenilci/opraševalci). V terenski raziskavi izvedeni v okviru projekta EXCALIBUR (št. pogodbe 817946) smo spremljali, določali, kategorizirali in kvantificirali glavne škodljive in koristne členonožce v nasadih z integrirano (IPM) in ekološko (ORG) pridelavo jagod v Sloveniji in na Danskem. Glavni cilj je bil ugotoviti, ali talni bioinokuli, osnovani na koristnih glivah, vplivajo na združbo nadzemnih členonožcev. Uporabili smo tri vrste/skupine koristnih gliv: *Clonostachys rosea* (mikoparazit), *Metarhizium brunneum* (entomopatogen) in arbuskularne mikorizne glive (biognojilo). Bioinokuli, vneseni v tla, so imeli omejen vpliv na nadzemne členonožce: le uporaba glive *M. brunneum* je v Sloveniji značilno povečala število plenilcev. V Sloveniji je bila v primerjavi s poskusom na Danskem ugotovljena večja številčnost členonožcev, kar je verjetno posledica razlik v geografski legi, podnebju, zasnovi poskusov ter okoliški vegetaciji in krajini. Način pridelave jagod (IPM vs. ORG) je značilno vplival na nadzemno združbo členonožcev, pri čemer sta bili raznolikost in številčnost členonožcev pri ekološkem načinu pridelave značilno večja v primerjavi z integrirano pridelavo. Opažene razlike v številčnosti in pestrosti členonožcev v nasadih v Sloveniji in na Danskem ter znotraj različnih sistemov pridelave odražajo kompleksnost ekoloških interakcij v agroekosistemih. Večja številčnost in raznolikost členonožcev v ekološki pridelavi kaže na potencialne koristi trajnostnih kmetijskih praks.

ABSTRACT

Effects of soil-deployed fungal bioinocula on strawberry canopy arthropods

Strawberry plants are attacked by various arthropods, including insects and mites. They cause damage to different parts of the plants and at different times of the year. The most common pests are aphids, thrips, weevils, cutworms, sap beetles, tarnished plant bugs, whiteflies and mites. However, strawberry plantations also harbour beneficial arthropods such as predatory mites, epigeal predators (e.g. carabids and spiders), lacewings, pollinators (e.g. honeybees and bumblebees), parasitoids and hoverflies (both predators and pollinators). In the field study performed within the EU project EXCALIBUR (grant agreement 817946) we monitored, identified, quantified and categorized the main pest and beneficial arthropods in both integrated (IPM) and organic (ORG) strawberry production in Slovenia and Denmark. The primary objective was to determine whether soil-deployed bioinocula based on beneficial fungi influence the aboveground arthropod assemblage. We applied three species/groups of beneficial fungi: *Clonostachys rosea* (mycoparasite), *Metarhizium brunneum* (entomopathogen) and arbuscular mycorrhizal fungi (biofertilizer). Soil-deployed bio-inocula had limited impact on aboveground arthropod assemblages; however, in the treatment with *M. brunneum*, the number of predators in Slovenia significantly increased. Higher arthropod abundance was observed in Slovenia compared to Denmark, likely influenced by differences in geography, climate, experimental setup, and surrounding vegetation and landscape. Agricultural management strongly affected arthropods, with organic trials promoting greater diversity and abundance of arthropods compared to integrated trials. The differences in arthropod

abundance and species diversity observed between Slovenia and Denmark, as well as among the different agricultural management systems, highlight the complexity of ecological interactions in agroecosystems. The higher arthropod abundance and diversity in organic fields further suggest the potential benefits of sustainable farming practices.

Pojav nove rje *Aculeastrum americanum* na malinah (*Rubus idaeus*) v Sloveniji

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Jeseni 2024 je bil v nasadu malin sorte Polana v osrednji Sloveniji odvzet vzorec zaradi nedozorevanja malin. Rastlina je kazala znake rje z značilnimi oranžno-rumenimi trosišči (urediniji) na listih, cvetnih čašah in plodovih. Mikroskopski pregled je pokazal za rjo *Aculeastrum americanum (Farl.) M. Scholler & U. Braun (Coleosporiaceae, Pucciniales) (= Pucciniastrum arcticum var. americanum Farl., Pucciniastrum americanum (Farl.) Arthur, Thekopsora americana (Farl.) Aime & McTaggart)* značilne morfološke znake (bodičaste urediniospore, značilni urediniji). Identifikacija patogena je bila potrjena z analizo zaporedja izbranih črtnih kod (ITS, LSU). Patogenost rje je bila preverjena s poskusom umetne inokulacije, pri kateri so se na zdravih rastlinah po dveh tednih razvila enaka trosišča kot na naravno okuženih vzorcih. Prisotnost rje *A. americanum* predstavlja prvo zabeleženo najdbo te bolezni v evropskem pridelovalnem okolju. V jeseni 2025 smo v laboratoriju ponovno potrdili prisotnost te rje na malinah sorte Clarita z jugovzhodne Slovenije, kar nakazuje na to, da je rja širše prisotna v slovenskem pridelovalnem okolju. Rja je sicer razširjena v Severni Ameriki ter tudi v Južni Ameriki. Drugod po svetu je redko zabeležena, kot na primer na Japonskem, Novi Zelandiji in izjemoma v Evropi (botanični vrtovi, posamezne najdbe). Rja napada predvsem vrste rodu *Rubus*, na katerih povzroča bolezen imenovano pozna rja malin. Posledice okužbe s to rjo so zmanjšana fotosintetska učinkovitost, poškodbe tkiv in nižja komercialna vrednost pridelka. Čeprav bolezen v Evropi doslej ni bila razširjena, podnebne razmere v Sloveniji kot so visoka zračna vlaga in zmerne temperature omogočajo njeno potencialno uveljavitev. V območjih, kjer je patogen uveljavljen, lahko povzroča pomembne izgube zaradi zmanjšanega pridelka in kakovosti plodov.

ABSTRACT

Occurrence of *Aculeastrum americanum* rust on raspberry (*Rubus idaeus*) in Slovenia

In autumn 2024, a plant sample of raspberry cv. Polana was collected from a plantation in central Slovenia due to incomplete ripening of fruits. The plant exhibited rust symptoms with characteristic orange-yellow uredinia on leaves, sepals, and fruits. Microscopic examination revealed morphological features typical of *Aculeastrum americanum* (Farl.) M. Scholler & U. Braun (Coleosporiaceae, Pucciniales) (= *Pucciniastrum arcticum* var.

americanum Farl., *Pucciniastrum americanum* (Farl.) Arthur, *Thekopsora americana* (Farl.) Aime & McTaggart), including echinulate urediniospores and diagnostic uredinia. Identification of the pathogen was confirmed by sequencing selected DNA barcodes (ITS, LSU). Pathogenicity was verified through artificial inoculation, in which the same type of uredinia developed on healthy plants two weeks after inoculation, matching those observed on naturally infected samples. The detection of *A. americanum* represents the first documented occurrence of this disease in European commercial production. In autumn 2025, the rust was confirmed again in samples from southeastern Slovenia, indicating that it had spread more widely across Slovenian raspberry-growing areas. The rust is widespread in North America and also occurs in South America. Elsewhere it is rarely reported, with records from Japan, New Zealand, and, exceptionally, isolated findings in Europe (botanical gardens, sporadic cases). It primarily infects species of the genus *Rubus*, on which the disease is known as late leaf rust of raspberry. Infection leads to reduced photosynthetic efficiency, tissue damage, and lower commercial fruit quality. Although the disease has not previously been widespread in Europe, climatic conditions in Slovenia such as high humidity and moderate temperatures are favourable for its establishment. In regions where the pathogen is already present, it can cause significant yield losses and reduce fruit quality.

Problematika glivičnih bolezni v nasadih lesk

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Navadna leska (*Corylus avellana*) je pionirska gozdna vrsta in hkrati zanimiva sadna rastlina, katere pridelava se v Sloveniji v zadnjih letih povečuje ter postaja vse pomembnejša kmetijska kultura. Pridelovalci lešnikov se soočajo z novimi škodljivimi organizmi, ki so posledica uvoza sadilnega materiala iz tujine, vse pogostejših vremenskih ekstremov ter pojava novih tujerodnih bolezni. Ti povzročitelji bolezni izkoriščajo ekološke niše in okoljske stresne razmere za svoj razvoj in širjenje, zato v prihodnje predstavljajo resno tveganje pri pridelavi. Stanje na terenu tako kaže na potrebe po novih poglobljenih raziskavah zdravstvenega varstva leske, predvsem na področju identifikacije in obvladovanja škodljivih gliv, ki povzročajo gospodarsko škodo. S pripravo novih varstvenih strategij bodo pridelovalci lahko konkurenčnejši pri pridelavi lešnikov. V preteklih letih je bila pri nas prvič potrjena prisotnost dveh gospodarsko pomembnih patogenih gliv. To sta leskova pepelasta plesen (*Erysiphe corylacearum*) ter bolezen rjavenja listnih pecljev, ovojev in plodov (*Elsinoë coryli*, sinonim *Sphaceloma coryli*). Od leta 2023 dalje poteka večletna inventarizacija patogenih gliv v slovenskih nasadih leske. Vzporedno smo ovrednotili najpogostejše glivične bolezni, ki lahko predstavljajo potencialno gospodarsko tveganje, ter izvedli teste patogenosti izbranih gliv (*Venturia* sp., *Ramularia* sp. in *Didymella corylicola*). Poseben poudarek smo namenili strategijam obvladovanja nove invazivne leskove pepelovke (*Erysiphe corylacearum*). Izvedeni so bili tudi prvi poskusi učinkovitosti sredstev na osnovi mikroorganizmov ter anorganskih fungicidov. Namen raziskave je bil določiti glivične bolezni leske, ki so prisotne v Sloveniji, ocena razširjenosti, presoja tveganj, ki jih predstavljajo za pridelavo in njihovo obvladovanje.

ABSTRACT

The incidence of fungal diseases in hazelnut plantations

Common hazel (*Corylus avellana*) is a pioneer forest species and an increasingly important fruit crop, with cultivation expanding in Slovenia during recent years. Hazelnut growers are facing new pests due to the import of foreign planting material, increasingly frequent weather extremes, and the emergence of new invasive diseases. These pathogens exploit ecological niches and environmental stressors for their development and distribution, thereby posing a serious risk to future production. Current field observations highlight the need for new in-depth research on hazel health management, particularly the identification and control of harmful fungi that cause economic damage. With the development of new protection strategies, growers will be able to increase their competitiveness in hazelnut production. In recent years, two economically important fungal pathogens have been confirmed in Slovenia for the first time. These are hazel powdery mildew (*Erysiphe corylacearum*) and hazel spot anthracnose, which causes browning of leaf petioles, husks, and nuts (*Elsinoë coryli*, synonym *Sphaceloma coryli*). Since 2023, a multi-year inventory of pathogenic fungi in Slovenian hazelnut orchards has been underway. In parallel, we evaluated the most common fungal diseases that may pose potential economic risks and conducted pathogenicity tests of selected fungi (*Venturia* sp., *Ramularia* sp., and *Didymella corylicola*). Special attention has been devoted to management strategies for the new invasive hazel powdery mildew (*Erysiphe corylacearum*). Initial efficacy trials of microorganism-based products and inorganic fungicides were also carried out. The purpose of the study was to determine the fungal diseases of hazel present in Slovenia, assess their distribution, evaluate the risks they pose to production, and explore their management.

Genomska primerjava fitoplazem skupine 16SrV na trti in leski v Sloveniji

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V vinogradih povzroča velik upad pridelka in krčenje nasadov fitoplazma *Grapevine flavescence dorée* (FDf) iz skupine 16SrV, povzročiteljica zlate trsne rumenice, ki je v EU uvrščena na seznam karantenskih škodljivih organizmov. Trte se lahko okužijo z različnimi izolati fitoplazem skupine 16SrV, med katerimi so nekateri epidemični, saj se zelo učinkovito prenašajo v vinogradih z ameriškim škržatkom (*Scaphoideus titanus*). Tudi v propadajočih nasadih leske v Sloveniji smo ugotovili prisotnost fitoplazem skupine 16SrV. Potrjene so bile tudi v osebkih vzhodnjaškega škržatka (*Orientus ishidae*). Epidemiologija kroženja teh fitoplazem v okolju je bila doslej preučevana zgolj na osnovi nekaj genov, zlasti gena *map*, ki omogoča določitev genotipa *map-FD* in razlikovanje med epidemičnimi ter neepidemičnimi izolati. Ker so fitoplazme obligatorni paraziti in jih ni mogoče gojiti zunaj gostitelja, je raziskovanje njihovih genomov oteženo. Z novo razvito metodo obogatitve in sestavljanja genomov fitoplazem neposredno iz okoljskih vzorcev

(Kogej Zwitter in sod., 2025) smo lahko primerjali genome FDf na trti in sorodnih fitoplazem na leski. Osredotočili smo se na genotipe *map-FD*, ki so bili predhodno zaznani tako v trti kot v leski (Kogej Zwitter in sod., 2023). V prispevku bomo predstavili, kako so si fitoplazme na trti in leski med seboj podobne oziroma različne ter razpravljali o njihovem epidemičnem potencialu in pomenu za varstvo rastlin.

ABSTRACT

Genomic comparison of 16SrV group phytoplasmas from grapevine and hazelnut in Slovenia

Grapevine Flavescence dorée phytoplasma (FDp) from the 16SrV group is a quarantine pest in the EU, causing severe yield losses and vineyard decline. Grapevines can be infected with various isolates of 16SrV phytoplasmas, some of which are epidemic because they are efficiently transmitted in vineyards by the American leafhopper (*Scaphoideus titanus*). In declining hazelnut orchards in Slovenia, we also detected the presence of 16SrV phytoplasmas. Their presence was also confirmed in specimens of the mosaic leafhopper (*Orientus ishidae*). The epidemiology of these phytoplasmas in the environment has so far been studied using only a few genes, particularly the *map* gene, which enables determination of the *map-FD* genotype and differentiation between epidemic and non-epidemic isolates. Because phytoplasmas are obligate parasites and cannot be cultured outside their hosts, genome research is challenging. Using a newly developed protocol for enrichment and assembly of phytoplasma genomes directly from environmental samples (Kogej Zwitter et al., 2025), we were able to compare FDp genomes from grapevine with related phytoplasmas from hazelnut. We focused on *map-FD* genotypes previously detected in both grapevine and hazelnut (Kogej Zwitter et al., 2023). In this contribution, we will present how similar or different phytoplasmas from grapevine and hazelnut are, and discuss their epidemic potential and significance for plant protection.

Spremljanje črne figove muhe (*Silba adipata McAlpine 1956*) v nasadu fig v spodnji Vipavski dolini

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Črno figovo muho (*Silba adipata* McAlpine 1956 [Diptera, Lonchaeidae]) smo v Sloveniji prvič odkrili leta 2001 na Goriškem. Trenutno je zastopana na širšem območju države, kjer uspevajo divje in gojene fige. Je multivoltilna vrsta, letno lahko razvije do šest rodov, v naših podnebnih razmerah navadno dva. Žerke prvega rodu povzročajo škodo od sredine julija do sredine avgusta, ko se hranijo pod kožico še nezrelih fig, zaradi česar te predčasno odpadajo. Žerke drugega rodu se hranijo v mesu zorečih plodov in povzročajo njihovo črvivost od začetka septembra naprej. Gospodarska škoda nastaja v proizvodnih nasadih, z izgubami pridelka pa se soočajo tudi imetniki fig na domačih vrtovih. Čeprav populacijo črne figove muhe v zahodni Sloveniji spremljamo že vrsto let, so podatki o njeni bionomiji še vedno pomanjkljivi. Največ nejasnosti je povezanih s pojavom prvega rodu. Kljub ugotovljeni škodi na plodovih, s trenutno dostopnimi metodami spremljanja njegove

sezonske dinamike doslej še nismo uspeli raziskati. Ker ne obstajajo specifična privabila za figovo muho, za njeno spremljanje uporabljamo prilagojene pasti Tephri Trap s kombinacijo heksanola in 2-odstotnega amonijevega sulfata, ki pa ne zagotavljajo učinkovitega nadzora nad pojavom odraslih muh. V letu 2025 smo v manjšem ekološkem nasadu fig na lokaciji Kromberk preučevali pojavljanje in dinamiko leta črne figove muhe z različnimi tipi pasti opremljenimi s štirimi vrstami privabil: past Tephri Trap s kombinacijo heksanola in 2-odstotnega amonijevega sulfata, rumena lepljiva plošča, past domače izdelave s privabilno raztopino kisa in rdečega vina ter doma izdelano past z v vodi raztopljenim kvasom torula. V pasteh s kvasom torula smo prve osebke ujeli že v začetku julija, kar časovno sovpada s pojavom poškodb na nezrelih plodičih fig in nam prvič omogoča jasno zaznavo in potrditev pojava prvega rodu muhe. V ostalih tipih pasti smo prve muhe ulovili šele v začetku avgusta, podobno kot v preteklih letih spremljanja. Številčnost ulova je bila največja v pasteh s kvasom torula, z njimi smo ujeli skoraj 60% vseh osebkov. Sledile so rumene lepljive plošče, ki so dobro zaznale pojav drugega rodu muhe. V pasti Tephri Trap s kombinacijo heksanola in 2-odstotnega amonijevega sulfata ter v pasti s kisom in vinom smo tekom celotnega poskusa ujeli le posamezne osebke, kar ne odraža dejanske velikosti in dinamike populacije figove muhe, kot tudi ne škode na plodovih. V prispevku bodo natančneje predstavljeni izsledki spremljanja in sezonska dinamika črne figove muhe v letu 2025 ter podatki o biologiji vrste in predlagani ukrepi za zmanjšanje škode.

ABSTRACT

Monitoring of the black fig fly (*Silba adipata* McAlpine 1956) in a fig orchard in the lower Vipava Valley

The black fig fly (*Silba adipata* McAlpine 1956 [Diptera, Lonchaeidae]) was first recorded in Slovenia in 2001 in the Nova Gorica region. It is now widespread in all areas of the country where wild and cultivated figs grow. The species is multivoltine and may develop up to six generations per year, although typically two generations occur under our climatic conditions. Larvae of the first generation cause damage from mid-July to mid-August by feeding beneath the skin of unripe figs, which results in premature fruit drop. Larvae of the second generation feed inside ripening figs from early September onwards. Damage occurs in commercial orchards, and fruit losses also affect fig growers in home gardens. Although the population of the black fig fly has been monitored in western Slovenia for many years, information on its bionomics and seasonal dynamics remains limited. The greatest uncertainty concerns the occurrence of the first generation, which, despite evident damage to unripe fruits, has not yet been confirmed with currently available monitoring methods. Because no species-specific lures are commercially available, our monitoring relies on modified Tephri Trap baits with hexanol and 2% ammonium sulphate, which do not provide sufficiently reliable results. In 2025, we studied the occurrence and flight dynamics of the black fig fly in a small organic fig orchard in Kromberk using four different traps: a Tephri Trap with hexanol and 2% ammonium sulphate, a yellow sticky trap, a homemade trap with a vinegar and red wine solution, and a homemade trap with torula yeast dissolved in water. The first adults were captured in traps with torula at the beginning of July, which matches the timing of damage observed on unripe figs and provides the first clear confirmation of the first generation. In all other trap types, the first adults were recorded only in early August, similar to observations in previous years. Black fig fly captures were highest in traps with torula, which represented nearly 60% of all adults collected. Yellow sticky traps were effective in detecting the second generation. Only individual specimens were captured in the Tephri Trap with hexanol and 2% ammonium sulphate and in the traps with vinegar and wine, which does not reflect the actual size and dynamics of the black fig fly population, nor the level of damage to the

fruit. This paper presents detailed monitoring results, the seasonal dynamics of the black fig fly in 2025, and information on the biology of the species, together with proposed measures for reducing damage.

Razvoj prognostičnega modula za napovedovanje pojava drugega rodu oljčne muhe (*Bactrocera oleae* Gmelin)

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Podobno kot v drugih sredozemskih državah je tudi v slovenskem Primorju oljčna muha (*Bactrocera oleae* Gmelin) najpomembnejši škodljivec oljk. V primeru ugodnih vremenskih razmer in pomanjkljivega varstva lahko vrsta povzroča veliko škodo na pridelku, zlasti na sortah, ki so dovzetne na poškodbe kot je npr. 'Istrska belica'. Glede na rezultate večletnega spremljanja populacijske dinamike škodljivega organizma, ki ga izvaja Javna služba zdravstvenega varstva rastlin lahko povzamemo, da so ob ugodnih klimatskih razmerah odrasle žuželke v Slovenski Istri prisotne celo leto. Škodo na pridelku povzročajo žerke, ki se hranijo z mesom, plod pa onesnažijo z iztrebki kar vpliva na kakovost olja. Najbolj intenziven let oljčne muhe in posledično poškodbe plodov praviloma beležimo od druge polovice avgusta do začetka oktobra. Zaradi dolgega obdobja izpostavljenosti plodov je varstvo zahtevno, ukrepi pa morajo biti skrbno načrtovani. Zaradi tega je izjemno pomembno, da let oljčne muhe v oljčnikih redno spremljamo s pomočjo feromonskih vab ali rumenih lepljivih plošč, smiselno pa je tudi redno spremljanje stanja poškodovanosti plodov. Da bi bilo zatiranje z insekticidnimi pripravki karseda ekološko upravičeno in hkrati učinkovito je poleg spremljanja leta oljčne muhe smiselna tudi uporaba orodij za določanje pojava posameznih stadijev škodljivca. Na podlagi prej omenjenih spremljanj in beleženja meteoroloških parametrov s pomočjo mreže avtomatskih meteoroloških postaj je bil v sklopu projekta POSEIDONE (Program Interreg VI-A Italija–Slovenija 2021–2027) izdelan prognostični modul za spremljanje oljčne muhe in napovedovanje pojava drugega rodu oljčne muhe. Modul je bil integriran v Agrometeorološki portal Slovenije (UVHVVR). S pomočjo orodja bo mogoče natančneje predvideti čas pojava odraslih žuželk drugega rodu kar bo pripomoglo k natančnejši napovedi za uporabo insekticidnih pripravkov.

ABSTRACT

Development of forecasting model for predicting the occurrence of the second generation of the olive fruit fly (*Bactrocera oleae* Gmelin)

Similar to other Mediterranean countries, the olive fruit fly (*Bactrocera oleae* Gmelin) is the most important pest of olives in the western Slovenia. In case of favourable weather conditions and insufficient pest control, the species can cause significant damage to the yield, especially to varieties that are susceptible to damage, such as the 'Istrska belica'. According to the monitoring records of the pest population dynamics of several years carried out by the Public Plant Health Service, we can deduce that under favourable climatic conditions, adult insects are present in Slovenian Istria all year round. The

damage to the crop is caused by larvae, which feed on the fruits and contaminate them with excrements, which affects the quality of the oil. The most intensive flight of adults which lead to fruit damage is usually recorded from the second half of August to the beginning of October. Due to the long period of fruit exposure, crop protection is demanding, and insecticidal treatments must be carefully planned. For this reason, it is extremely important to regularly monitor the insect flight in olive groves using pheromone baits or yellow sticky traps, and it is also important to regularly monitor the fruit damage rate. In order to make pest control with chemical products as ecologically justified as possible and at the same time effective, in addition to insect monitoring, it is also appropriate to use tools for determining the occurrence of individual stages of the pest. Based on the mentioned monitoring and recording of meteorological parameters using a network of automatic meteorological stations, a forecasting model for monitoring the olive fly and predicting the occurrence of the second generation of olive fly was developed as part of the POSEIDONE project (Interreg VI-A Italy-Slovenia Programme 2021–2027). The model was integrated into the Agrometeorological Portal of Slovenia (Administration for Food Safety, Veterinary Sector and Plant Protection). With the help of the developed tool, it will be possible to more accurately predict the time of appearance of adult insects of the second generation, which will contribute to a more accurate forecast for the use of pesticides.

Oljkova vešča (*Palpita unionalis* Hübner): opis vrste in škodljivost

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Oljkova vešča (*Palpita unionalis* Hübner) je polifagni škodljivec iz družine Pyralidae. Prepoznamo jo po belih krilih z bisernim prelivom. Zgornji rob kril je rjavo do oranžno obarvan, telo je svetlo rjavo. Vrsta izvira iz Sredozemlja, vendar jo najdemo tudi v nekaterih tropskih in subtropskih območjih Afrike, Azije, Avstralije in obeh Amerik. Med gostiteljske rastline spadajo predvsem vrste iz družine Oleaceae, zlasti tiste iz rodov *Oleae*, *Jasminum*, *Ligustrum*, *Fraxinus* in *Phillyrea*. V rodnih oljčnih nasadih velja za manj pomembnega škodljivca. Občasno se vrsta prekomerno namnoži, kar privede do gospodarske škode na sadikah in mladih oljčnih drevesih (do 3 leta starosti). Na novo izležene gosenice se hranijo s parenhimom na spodnji strani listov. Zgornja stran (epiderm) se na to posuši in porjavi. Ob zelo močnem napadu se lahko hranijo tudi s plodovi. V Sloveniji se oljkova vešča pojavlja od aprila do decembra in običajno razvije dva rodova na leto. Populacijsko dinamiko spremljamo s pomočjo feromonskih vab. Za zatiranje oljkove vešče sta trenutno registrirana dva pripravka na osnovi mikroorganizmov *Bacillus thuringiensis* subsp. *aizawai* in *Bacillus thuringiensis* subsp. *kurstaki*. Uporabimo ju lahko največ trikrat letno in sicer ob pojavu mladih gosenic.

ABSTRACT

The olive leaf moth (*Palpita unionalis* Hübner): species description and crop damage

The olive leaf moth, also known as the jasmine moth (*Palpita unionalis* Hübner), is a polyphagous pest of the family Pyralidae. It is recognized by white wings with a pearly

sheen, which have a brown to orange margin on the upper edge, while the body is light brown. The species originates from the Mediterranean region, but is also found in some tropical and subtropical areas in Africa, Asia, Australia and the Americas. Its host plants mainly include species from the family Oleaceae, especially those from the genera *Oleae, Jasminum, Ligustrum, Fraxinus* and *Phillyrea*. It is considered a minor pest in productive olive groves. Occasionally, there are severe outbreaks that can cause economic damage, especially on seedlings and young olive trees (up to 3 years old). Newly hatched larvae (caterpillars) feed on the parenchyma of the lower surface of the leaves, causing the upper surface (epidermis) to dry out and turn brown. In very severe attacks, they can also feed on the olive fruits. In Slovenia, the olive leaf moth occurs from April to December and usually develops two generations per year. Population dynamics is monitored with pheromone traps. For control, there are currently two formulations registered based on the microorganisms *Bacillus thuringiensis* subsp. *aizawai* and *Bacillus thuringiensis* subsp. *kurstaki*. They can be applied up to three times per year during pest early larval stage.

Poskus zatiranja pršic šiškaric (Eriophydae) na oljkah (*Olea europaea*) s pripravki na podlagi žvepla

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V letih 2022 in 2023 je bila pri vzorčenju simptomatičnih rastlin oljk na območju Primorske ugotovljena prisotnost vrste *Aculus olearius* Castagnoli. Gre za predstavnika iz družine pršic šiškaric (Eriophydae), ki povzroča poškodbe na mladih poganjkih, cvetnih brstih in cvetovih oljk. Vrsta je bila predhodno opisana tudi v tujini (Španija, Italija in nekatere druge sredozemske države). Razvoj in številčnost vrste je povezana s fenofazo gostiteljske rastline, kar v naših razmerah pomeni od konca aprila do začetka maja. Poškodbe se kažejo kot rjavenje in sušenje cvetnih brstov in mladih plodov, v primeru močnejšega napada pa tudi deformacije listov in mladih poganjkov. Verjetno je s prerazmnožitvijo pršic šiškaric v obdobju pred cvetenjem oljk delno povezano tudi predčasno odpadanje mladih plodičev oljk, ki ga v zadnjih letih opažamo v oljčnikih. V sezonah 2024 in 2025 smo opravili škropilni poskus z registriranimi pripravki na osnovi žvepla. S poskusom smo ugotavljali, če škropljenje v času pred cvetenjem oljk (fenofaza BBCH 30-60) vpliva na pridelek. Dobljene podatke smo ovrednotili s pomočjo analize variance.

ABSTRACT

Attempt to control eriophyds infestation on olive trees (*Olea europaea*) with sulhur-based products

In the seasons 2022 and 2023, sampling of symptomatic olive trees in the Primorska region (western Slovenia) revealed the presence of the species *Aculus Olearius* Castagnoli. It belongs to the family Eriophydae and causes damage to young shoots, flower buds and flowers of olives. The species has also been previously described in Spain, Italy and some other Mediterranean countries. The development and abundance of the species is related to the phenological stage of the host plant. In our conditions, this

means from the end of April to the beginning of May. Damage is manifested as rusting and drying of flower buds and young fruits. In case of a more severe attack, also deformation of leaves and young shoots occurs. The premature drop of young olive fruits, which has been observed in olive groves in recent years, is probably also partly related to the overpopulation of eriophyd mites in the period before olive flowering. In the seasons 2024 and 2025, we conducted a spraying trial with registered sulphur-based products. The experiment was designed to determine whether spraying before olive flowering (BBCH 30-60) affects the yield. The obtained data were evaluated using analysis of variance.

Environmental fate of the bio-derived compound hexyl gallate for citrus canker control

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Citrus canker, caused by *Xanthomonas citri* subsp. *citri*, is a citrus disease characterized by necrotic lesions on above-ground tissues that, in severe cases of infection, result in premature fruit drop. Copper sprays remain the primary management tools for protecting plants from infection. However, the growing concerns about the environmental impact of this toxic metal, combined with regulatory limitations on its use, have prompted calls for a more sustainable alternative to control the pathogen's spread. One such promising candidate could be hexyl gallate, an ester derivative of the natural compound, gallic acid. Our Netherlands-Brazil consortium has previously shown its antibacterial efficacy *in vitro* and evaluated its performance in greenhouse trials. Here, we investigated its environmental fate, with soil considered the primary sink following field application. We conducted soil adsorption and degradation tests, β-glucosidase activity assays, and enrichments for potential soil microbial degraders using two agricultural soils from the Netherlands. To assess the effect of hydrophobicity on environmental behaviour, we compared hexyl gallate with two structurally related alkyl gallates (propyl and octyl gallate), commonly used in the food and cosmetics industries. More hydrophobic alkyl gallates exhibited stronger adsorption to soil, which influenced their initial degradation rates. However, none of the compounds caused long-term changes in soil β-glucosidase activity over 21 days. In addition, two isolated bacterial strains demonstrated potential to degrade alkyl gallates in biodegradation assays. Together, these results indicate that hexyl gallate exhibits low environmental persistence, is biodegradable, and does not adversely affect soil enzyme activity, supporting its potential as a more sustainable alternative to copper-based control of citrus canker and potentially other bacterial plant diseases.

IZVLEČEK

Okoljski vpliv in razgradnja biološko osnovane spojine heksil galata za kontrolo agrumovega bakterijskega raka

Agrumov bakterijski rak je bolezen, za katero so značilne nekrotične lezije na nadzemnih rastlinskih tkivih, ki v hudih primerih okužbe z bakterijo *Xanthomonas citri* subsp. *citri* povzročijo prezgodnje odpadanje plodov. Fungicidi na osnovi bakra predstavljajo glavno orodje za varstvo rastlin, ki pa zaradi naraščajoče zaskrbljenosti glede vpliva na okolje, skupaj z regulativnimi omejitvami njihove uporabe, spodbujajo k razvoju bolj trajnostnih alternativ za zatiranje rastlinskih patogenov. Heksil galat, estrski derivat naravno prisotne galne kisline predstavlja enega od možnih kandidatov. Predhodno smo v okviru nizozemsko-brazilskega konzorcija pokazali njegovo protibakterijsko učinkovitost v pogojih *in vitro* in v rastlinjakih. Potencial za uporabo kot fitofarmacevtsko sredstvo, pa smo razširili v tej raziskavi, kjer smo se osredotočili na okoljki vpliv in razgradnjo heksil galata v zemlji. Testirali smo adsorpcijo in razgradnjo v dveh vzorcih kmetijskih tal iz Nizozemske, analizirali β-glukozidazno aktivnost in izvedli obogatitvene teste za izolacijo potencialnih mikrobnih razgrajevalcev. Za primerjavo vpliva hidrofobnega značaja na obnašanje v okolju smo testirali tudi dva strukturno sorodna alkil galata (propil in oktil galat), ki se pogosto uporabljata v živilski in kozmetični industriji. Bolj hidrofobni galati so pokazali močnejšo adsorpcijo v tleh, kar je vplivalo na začetne stopnje razgradnje. Nobena od spojin pa ni povzročila dolgotrajnih sprememb v β-glukozidazni aktivnosti tekom 21 dni. Poleg tega, dva izolirana bakterijska seva, sta pokazala potencial za njihovo biorazgradnjo. Rezultati naše raziskav kažejo, da ima heksil galat potencial za uporabo kot bolj trajnostna alternativa za varstvo rasltin proti bakterijskim rasltinskim patogenom, saj nakazuje nizko okoljsko obstojnost, potencial za biorazgradljivost in zanemarljiv vpliv na aktivnost talnih mikroorganzimov.

Spremljanje epidemije črne pegavosti citrusov (citrus black spot) v Tuniziji

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Okužba z ascomicetno glivo *Phyllosticta citricarpa* povzroča razvoj bolezni črna pegavost agrumov (citrus black spot disease, CBS), ki vodi v veliko gospodarsko škodo, saj okuženi agrumi niso primerni za prodajo. Bolezen je najbolj razširjena v vlažnih geografskih območjih, to je v Avstraliji, Braziliji, na Kitajskem, v južni Afriki, vendar so pred nekaj leti prisotnost *P. citricarpa* potrdili tudi v Tuniziji. Slednje je zelo zaskrbljujoče za sredozemske države Evropske unije, saj je bilo do sedaj razumljeno, da podnebni pogoji v Sredozemlju niso primerni za širjenje te bolezni. V okviru projekta CBS Epidemiology smo v Tuniziji v nasadih simptomatičnih limonovcev spremljali epidemijo *P. citricarpa*, kjer smo vzorčili zrak in deževnico. Z molekularno analizo vzorcev smo pokazali časovno

variabilnost v relativni količini spor *P. citricarpa*, in sicer smo največjo količino spor zaznali v hladnejših delih leta. Pomembna ugotovitev je bila tudi potrditev klonske populacije z eno idiomorfno različico paritvenega tipa, kar podpira domnevo, da se v Tuniziji *P. citricarpa* razmnožuje nespolno s piknidiosporami. V okviru projekta ETHICS pa nadaljujemo s proučevanjem vloge piknidiospor *P. citricarpa* za epidemijo v Tuniziji. V kontroliranih pogojih smo pokazali pozitiven vpliv višje temperature in daljše omočenosti listov na uspešnost okužbe limonovcev s piknidiosporami. Hkrati pa v okuženih nasadih v Tuniziji nadaljujemo z opazovanjem fenologije okuženih dreves, zbiranjem vremenskih podatkov, kmetijskih praks in vzorčenjem zraka in deževnice. Študija populacijske genomike pa bo podrobneje ocenila genetske značilnosti in strukturo tunizijskih populacij patogena. Z združitvijo vseh podatkov bomo dobili poglobljen vpogled v vlogo okolijskih dejavnikov na širjenje bolezni. V okviru projekta ugotavljamo tudi najprimernejšo časovno razporeditev tretiranja s fungicidi, učinkovitost mikrobnih antagonistov ter rastlinskih izvlečkov/eteričnih olj proti *P. citricarpa*. Rezultati projekta bodo podprli izboljšanje modela za napovedovanje okužb z piknidiosporami, pripravo smernic za integrirano varstvo rastlin v mediteranskih nasadih citrusov in določitev zanesljivih parametrov za oceno tveganja v EU.

ABSTRACT

Investigating the epidemiology of citrus black spot in Tunisia

Infection by the ascomycete fungus *Phyllosticta citricarpa* causes citrus black spot disease (CBS), resulting in major economic losses due to unmarketability of fruit. The disease is most widespread in humid regions of Australia, Brazil, China, and southern Africa, but in 2019 *P. citricarpa* presence was confirmed in Tunisia. This is highly concerning for Mediterranean EU countries, as it had previously been assumed that Mediterranean climatic conditions were unsuitable for the spread of this disease. Within the CBS Epidemiology project, we monitored the epidemic of *P. citricarpa* in symptomatic lemon orchards in Tunisia by sampling air and rainwater. Molecular analysis of samples revealed temporal variability in the relative quantity of *P. citricarpa* propagules, with the highest amounts detected during the colder parts of the year. An important finding was the confirmation of a clonal population with a single mating-type idiomorph, supporting the hypothesis that in Tunisia *P. citricarpa* reproduces asexually. In the ETHICS project, we are continuing to investigate the role of *P. citricarpa* pycnidiospores in the Tunisian epidemic. Under controlled conditions, we demonstrated a positive effect of higher temperature and longer leaf-wetness duration on the success of lemon infection by pycnidiospores. In infected orchards in Tunisia we continue to monitor the phenology of infected trees, collect weather data and information on agronomic practices, and sample air and rainwater. Finally, a population genomics study will further assess the genetic characteristics and structure of the Tunisian populations of the pathogen. The project is also focused on selection of the most appropriate timing of fungicide applications and assessing the efficacy of microbial antagonists as well as plant extracts/essential oils against *P. citricarpa*. The results will support improvement of a model for predicting infections, development of integrated pest management guidelines and definition of robust parameters for EU risk assessment.

Najdbe novih glivičnih povzročiteljev bolezni v Sloveniji

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Pojavljanje novih in nepoznanih glivičnih povzročiteljev bolezni predstavlja vse večji izziv, s katerim se sooča sodobno kmetijstvo. Globalna trgovina, podnebne spremembe in intenzivna pridelava ustvarjajo ugodne pogoje za vnos in uveljavitev novih patogenov, katerih vpliv je pogosto nepredvidljiv. Nekateri patogeni povzročajo hitro širjenje bolezni in pomembne gospodarske izgube, drugi ostanejo latentni, dokler se ne pojavijo primerni pogoji za njihov razvoj. V mikološkem laboratoriju Oddelka za varstvo rastlin Kmetijskega inštituta Slovenije vsako leto analiziramo številne vzorce, na katerih je mogoče opaziti pojavljanje rastlinskih patogenov, ki v našem okolju prej niso bili poznani oziroma do sedaj niso povzročali večjih težav. V prispevku predstavljamo nekatere primere novih potrjenih glivičnih in glivam podobnih povzročiteljev bolezni. Rja *Aculeastrum americanum*, ki smo jo potrdili na malinah, je bila prvič potrjena v Evropi v komercialnih nasadih malin. Za glivo *Didymella corylicola*, ki smo jo izolirali iz leske in je še dokaj nepoznana vrsta, iz Italije poročajo, da povzroča nekroze na lešnikih. Nova vrsta iz rodu *Fusarium*, izolirana iz listov in gomoljev sladkega krompirja, je bila prvič potrjena v Evropi. Glivo *Venturia inequalis*, ki je sicer dobro poznan patogen pri nas, smo prvič identificirali na japonski nešplji. Po literaturi sodeč, je to prva potrjena najdba na tem gostitelju. Oomiceta *Phytophthora pseudocryptogea*, prvič v Sloveniji potrjena na orehu in smilju, ima širok krog gostiteljev. Pri intenzivnem pridelovalcu paradižnika smo potrdili nekaj nam manj poznanih gliv in glivam podobnih organizmov: *Globiosporangium recalcitrans*, *Dactylonectria hispanica* in druge. Zgodnje prepoznavanje in hitro ukrepanje je ključnega pomena za preprečevanje ali vsaj zmanjševanje vpliva novih patogenih organizmov na kmetijsko pridelavo.

ABSTRACT

Findings of new fungal plant pathogens in Slovenia

The emergence of new and unknown fungal pathogens represents an increasing challenge for modern agriculture. Global trade, climate change and intensive production practices create favourable conditions for the introduction and establishment of new pathogens, whose impacts are often unpredictable. Some pathogens cause rapid disease spread and significant economic losses, while others remain latent until suitable conditions for their development are provided. In the Mycology Laboratory of the Plant Protection Department at the Agricultural Institute of Slovenia, we analyse numerous samples each year, from which plant pathogens are detected that were previously unknown in our environment, have not caused major problems until now, or can cause problems on alternative hosts. We present some examples of newly confirmed fungal and oomycete plant pathogens. The rust *Aculeastrum americanum*, which we confirmed on raspberry, was for the first time detected in Europe in commercial raspberry orchards. For the relatively unknown species fungus *Didymella corylicola*, which we isolated from hazelnut, reports from Italy indicate that it causes necrosis on hazelnuts. A new species from the genus *Fusarium*, isolated from the leaves and tubers of sweet potato, was confirmed for the first time in Europe. The fungus *Venturia inaequalis*, although a well-known pathogen in our region, was identified for the first time on *Eriobotrya japonica*.

According to the literature, this is the first confirmed finding on this host. The oomycete *Phytophthora pseudocryptogea*, confirmed for the first time in Slovenia on walnut and immortelle, has a wide range of hosts. *Globiosporangium recalcitrans*, *Dactylonectria hispanica*, and others were confirmed from plants from an intensive tomato production system. Early detection and rapid response are crucial for preventing or at least mitigating the impact of emerging pathogenic organisms on agricultural production.

Varstvo poljščin, krmnih in okrasnih rastlin

Prvi rezultati učinkovitosti metode motenja parjenja skladiščnih moljev v Sloveniji

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V raziskavi predstavljamo rezultate preučevanja delovanja metodike motenja parjenja močne vešče (*Anagasta kuehniella*) in krhljevega molja (*Plodia interpunctella*) v dveh podjetjih v Sloveniji, ki se ukvarjata s predelavo moke. V raziskavi smo na obeh lokacijah uporabljali feromonske nosilce in pripravek za motenje parjenja italijanskega proizvajalca inPEST (Milano, Italy). Vse feromonske nosilce smo pritrdili na kartonasto past (tip pasti: EASY TRAP, proizvajalec: inPEST), ki vsebuje lepljivo notranjo površino. Na prvi lokaciji v zahodni Sloveniji smo poskus zasnovali v pekarni objekta ter v zunanjem skladišču odpadne embalaže. Poskus je v pekarni objekta potekal od 7.11.2024, v zunanjem skladišču pa smo poskus postavili 20.3.2025. V poskusu na zahodu Slovenije smo v pasti najpogosteje ujeli močno veščo. V notranjosti objekta v zahodni Sloveniji je poskus potekal v dveh obravnavanjih, in sicer kontrolno obravnavanje ter obravnavanje, kjer smo uporabiI pripravek za motenje parjenja. V kontrolnem obravnavanju smo uporabili lepljive pasti v kombinacijami s feromonskimi nosilci klasične koncentracije feromona. Prve molje močne vešče smo v kontrolnem obravnavanju zaznali 20. marca 2025, najvišji ulov pa smo ugotovili v sredini septembra. V obravnavanju, kjer smo uporabili pripravek za motenje parjenja, smo prve molje v pasteh s klasičnim feromonom zaznali 5. marca 2025, najvišji ulov pa smo ugotovili 17. marca 2025. Poleg feromonov s klasično koncentracijo in pripravka MD, smo v omenjenem obravnavanju postavili tudi feromonske pasti s povišano koncentracijo feromona. V omenjenih pasteh smo samce močne vešče zaznali v vseh terminih štetja, najvišji ulov pa smo zgotovili konec maja 2025, ko smo v omenjenem časovnem intervalu (9.5.-28.5.) zaznali skoraj 1 metulja močne vešče na past na dan. Feromonske nosilce in pripravek MD (v obliki vrvic) smo menjali v dvomesečnih intervalih, medtem ko smo pregled pasti izvajali v 21 – dnevnih intervalih. Poskus v zunanjem skladišču smo zasnovali tako, da smo prav tako uporabili feromone s klasično koncentracijo, feromone s povišano koncentracijo ter pripravek za motenje parjenja v obliki vrvic. Zunanje skladišče je prav tako vsebovalo kontrolno obravnavanje, kjer smo uporabili pasti v kombinaciji s feromoni klasične koncentracije. V kontrolnem obravnavanju smo najvišji ulov metuljev močne vešče zaznali 21. avgusta (29.7.-21.8.), ob 0.3 metulja močne vešče (past na dan). V obravnavanju, kjer smo preučevali delovanje MD pripravka pa smo najvišji ulov v pasteh z povišano koncentracijo feromona, najvišji ulov metuljev zaznali v časovnem intervalu 9.5.-28.5.2025, ko smo zaznali 1 samca močne vešče na vabo. V pasteh s klasično koncentracijo feromona smo ulov spremljali vse od sredine maja pa do sredine septembra. Medtem, ko smo v pasteh v zahodnih Sloveniji v pasteh v večini primerov zaznali osebke močne vešče, pa smo v severovzhodni Sloveniji v pasteh lovili osebke krhljevega molja. Poskus smo zasnovali 8.11.2024, v skladišču in mlinu obrata. Skladišče in mlin smo razdelili na dva dela, in sicer smo povsod postavili kontrolno obravnavanje ter obravnavanje, kjer smo preučevali delovanje MD pripravka. V skladišču, kjer smo postavili kontrolno obravnavanje s pastmi, ki so vsebovale feromon klasične koncentracije smo ulov metuljev spremljali od konca maja 2025 (28.5.), pa vse do 17.11. 2025. Najvišji ulov smo ugotovili v obdobju 30.7.-22.8., ko smo v pasteh zaznali več kot 8 osebkov krhljevega molja na past/dan. V obravnavanju z MD pripravkom v skladišču, smo v ulov krhljevega molja v pasteh s feromonom višje koncentracije beležili

od 19.6. pa vse do 10.10.2025. Več kot 1 metulja na past/dan nismo ujeli. V pasteh z navadno koncentracijo feromona smo metulje ujeli v istem časovnem intervalu, vendar so bili ulovi višji. V kontrolnem obravnavanju v mlinu smo metulje v pasteh lovili od 7.5.2025, pa vse do 27.10. Več kot 4 osebke na past/dan smo ujeli v časovnem intervalu od 29.5 do 19.6., ter od 23.8. do 18.9. V pasteh s klasično koncentracijo feromona, ki so bile postavljene v MD obravnavanju smo v omenjenem časovnem intervalu prav tako zaznali najvišje ulove. V feromonskih pasteh s višjo koncentracijo feromona smo najvišji številčni ulov metuljev spremljali v časovnem intervalu od 29.5. do 18.9.2025. Ugotavljamo, da se je uporabljena metoda v naših poskusih (predvsem v zahodni Sloveniji) izkazala za učinkovito, saj glede na podatke iz preteklih let govorimo o bistvenem zmanjšanju ulova. Med pomembne dejavnike učinkovitosti spada tudi lokacija feromonskih pasti v prostoru spremljanja, zato bomo v nadaljevanju poskusa metodiko še nadgradili z dodatnimi pastmi.

ABSTRACT

First results on the effectiveness of the mating disruption method against storage moths in Slovenia

In this study, we present the results of investigating the effectiveness of the mating disruption method against the Mediterranean flour moth (*Anagasta kuehniella*) and the Indian meal moth (*Plodia interpunctella*) in two flour processing companies in Slovenia. At both locations, pheromone dispensers and a mating disruption product from the Italian manufacturer inPEST (Milan, Italy) were utilized. All pheromone dispensers were attached to a cardboard trap (trap type: EASY TRAP, manufacturer: inPEST), which features an adhesive inner surface. At the first location in western Slovenia, the experiment was set up in the facility's bakery and in an outdoor waste packaging warehouse. The trial in the bakery began on 7th November, 2024, while the experiment in the outdoor warehouse was established on 20th March, 2025. In the study conducted in western Slovenia, the Mediterranean flour moth was the most frequently captured species in the traps. Inside the facility in western Slovenia, the experiment consisted of two treatments: a control treatment and a mating disruption treatment. In the control treatment, adhesive traps were used in combination with pheromone dispensers of standard concentration. The first Mediterranean flour moths in the control treatment were detected on 20th March, 2025, with the highest catch recorded in mid-September. In the mating disruption treatment, the first moths in the standard pheromone traps were detected on 5th March, 2025, while the highest catch was observed on 17th March, 2025. In addition to the standard concentration pheromones and the MD (mating disruption) product, pheromone traps with an increased pheromone concentration were also deployed in the aforementioned treatment. In these traps, male Mediterranean flour moths were detected during all sampling intervals, with the highest catch recorded at the end of May 2025; during this period (9th-28th May), nearly 1 moth per trap per day was recorded. The pheromone dispensers and the MD product (in the form of strings) were replaced at two-month intervals, while monitoring of traps was performed every 21 days. The experiment in the outdoor warehouse was similarly designed, utilizing standard concentration pheromones, high-concentration pheromones, and the mating disruption product in the form of strings. The outdoor warehouse also included a control treatment using traps combined with standard concentration pheromones. In the control treatment, the peak catch of Mediterranean flour moths was recorded on 21st August (period 29th July – 21st August), with 0.3 moths per trap per day. In the treatment where the effectiveness of the MD product was studied, the highest catch in the high-concentration pheromone traps was recorded during the interval from 9th May to 28th May, 2025, with 1 male Mediterranean flour moth detected per trap. In the traps with the standard pheromone concentration, the catch was monitored from mid-May until mid-September. While traps in western Slovenia primarily captured individuals of

the Mediterranean flour moth, the traps in northeastern Slovenia captured the Indian meal moth (*Plodia interpunctella*). The experiment was established on 8th November, 2024, in the facility's warehouse and mill. Both the warehouse and the mill were divided into two sections: a control treatment and a treatment for studying the effectiveness of the MD product. In the warehouse control treatment, where traps with standard concentration pheromones were used, moth catches were monitored from late May 2025 (28th May) until 17th November, 2025. The highest catch was recorded between 30th July and 22nd August, with more than 8 Indian meal moths per trap per day. In the warehouse MD treatment, catches of the Indian meal moth in high-concentration pheromone traps were recorded from 19th June to 10th October, 2025. During this period, the catch never exceeded 1 moth per trap per day. In the traps with standard pheromone concentrations, moths were captured within the same time interval, but the catch rates were higher. In the control treatment within the mill, moths were captured in traps from 7th May, 2025, until 27th October. Catches exceeding 4 individuals per trap per day were recorded during the intervals from 29th May to 19th June and from 23rd August to 18th September. Similarly, the highest catches in the MD treatment were recorded during the same periods in the traps with standard pheromone concentrations. In the pheromone traps with higher concentrations, the peak moth abundance was monitored between 29th May and 18th September, 2025. We conclude that the method used in our study proved to be effective, particularly in western Slovenia, as the data indicate a substantial reduction in catches compared to previous years. A key factor in the method's effectiveness is the strategic placement of pheromone traps within the monitored area; therefore, in the next phase of the study, the methodology will be further upgraded with additional traps.

Potivirusi na sladkem krompirju v Sloveniji

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Sladki krompir (*Ipomoea batatas*) je rastlina iz družine slakovk (Convolvulaceae), ki izvira iz Južne in Srednje Amerike. V svetovnem merilu predstavlja eno najpomembnejših prehranskih kultur, virusi pa veljajo za enega ključnih omejitvenih dejavnikov njegove pridelave. Virusi sladkega krompirja se prenašajo z vegetativnim razmnoževanjem in s prenašalci. Znano je, da sladki krompir okužuje več kot 30 različnih virusov, med katerimi je tudi šest potivirusov. V raziskavi smo se osredotočili na ugotavljanje okuženosti rastlin s potivirusi, saj je v Sloveniji zaradi prisotnosti njihovih prenašalcev, kot so bombaževčeva uš (*Aphis gossypii*), siva breskova uš (*Myzus persicae*) in *A. craccivora*, verjetnost za njihovo širjenje največja. V okviru strokovnih nalog s področja zdravstvenega varstva rastlin smo v letih od 2022 do 2024 vzorčili liste rastočih rastlin sladkega krompirja na 16 lokacijah po Sloveniji. Skupno smo odvzeli 197 vzorcev, pri čemer je bila prisotnost bolezenskih znamenj kriterij za odvzem vzorca. Vzorce smo analizirali z metodo reverzne transkripcije in verižne reakcije s polimerazo (RT-PCR) z uporabo dveh parov začetnih oligonukleotidov, specifičnih za gena *NIb* in *CI*, ki pomnožujeta del dveh genomskih regij številnih potivirusov. Prisotne viruse smo identificirali s sekvenciranjem PCR-produktov. Rezultati analiz so pokazali, da je bilo 60,4 % (119) vzorcev pozitivnih na potiviruse. Identificirali smo štiri različne viruse: virus G sladkega krompirja (SPVG, sweet potato

virus G), virus peresaste lisavosti sladkega krompirja (SPFMV, sweet potato feathery mottle virus), virus C sladkega krompirja (SPVC, sweet potato virus C) in virus 2 sladkega krompirja (SPV2, sweet potato virus 2). Ugotovili smo, da je večino opaženih simptomov mogoče pripisati virusnim okužbam. Z analizo nukleotidnih zaporedij posameznih vzorcev smo virusne izolate med seboj primerjali in razvrstili v skupine po sorodnosti.

ABSTRACT

Potyviruses on sweet potato in Slovenia

Sweet potato (*Ipomoea batatas*), a member of the Convolvulaceae family, originates from South and Central America. Globally, it ranks among the top 10 most important food crops, with viral diseases considered one of the key limiting factors in its production. Sweet potato viruses are transmitted through vegetative propagation and by vectors. It is known that sweet potato can be infected by more than 30 viruses, including six potyvirus species. This study focused on the detection of potyviruses, as the presence of their vectors in Slovenia, such as the cotton aphid (*Aphis gossypii*), the green peach aphid (*Myzus persicae*), and the cowpea aphid (*A. craccivora*), suggests a high potential for their spread. Leaves of growing sweet potato plants were sampled between 2022 and 2024 on 16 locations across Slovenia. A total of 197 samples were collected, with the presence of virus-like symptoms serving as the criterion for sampling. The samples were analysed using reverse transcription polymerase chain reaction (RT-PCR). Two different primer pairs targeting the *NIb* and *CI* genes of potyviruses were used to amplify parts of these two genomic regions of potyviruses. The results showed that 60.4% (119) of the samples were positive for potyviruses. The detected viruses were identified by sequencing of obtained amplicons. Four potyvirus species were identified: sweet potato virus G (SPVG), sweet potato feathery mottle virus (SPFMV), sweet potato virus C (SPVC), and sweet potato virus 2 (SPV2). Most of the observed symptoms could be attributed to viral infections. Furthermore, sequence analysis enabled comparison of individual isolates and their grouping according to similarity.

Potencial naravnih snovi, hlapnih organskih spojin in entomopatogenih gliv za odvračanje strun (Coleoptera: Elateridae) v tleh

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Strune so talni škodljivci, ki povzročajo veliko škodo na številnih kulturah, med drugim na koruzi, žitih, krompirju in zelenjadnicah. Zaradi njihovega skritega podzemnega načina življenja in dolgega življenjskega cikla je njihovo zatiranje izjemno zahtevno. Ob postopnem zmanjševanju uporabe klasičnih insekticidov ter z uvedbo celostnega pristopa k obvladovanju škodljivih organizmov na podlagi smernic integriranega varstva rastlin (IVR) se povečuje potreba po alternativnih rešitvah, ki so hkrati učinkovite in okolju

prijazne. V tej raziskavi smo preučevali, kako različni naravni in sintetični pripravki – dva kompostna čaja (CT16, CT19), sintetična hlapna organska spojina 3-oktanon in entomopatogena gliva *Metarhizium brunneum* (sev 1868) – vplivajo na premikanje strun, njihovo vedenje ter na čas, ki ga preživijo v bližini tretiranega območja. Z uporabo talnih olfaktometrov in rizotronov smo spremljali odzive dveh v Evropi pogostih in gospodarsko pomembnih vrst strun (*Agriotes lineatus* in *A. litigiosus*) na posamezno obravnavanje. Rezultati so pokazali jasne vedenjske vzorce, in sicer je kompostni čaj (CT16) deloval kot privabilo, saj je bilo število strun v delu talnega olfaktometra s tem obravnavanjem večje kot v kontrolnem delu. CT19 ni značilno vplival na obnašanje strun. Nasprotno pa sta bila število strun in čas, ki so ga le-te preživele v bližini tretiranega območja, ob prisotnosti 3-oktanona in glive *M. brunneum* manjša, kar kaže na izrazit odganjalni učinek. Podobne vedenjske vzorce smo opazili pri obeh preizkušenih vrstah strun. Prav tako so bili rezultati olfaktometrov in rizotronov med seboj primerljivi, kar potrjuje odganjalni učinek 3-oktanona in glive *M. brunneum* v dveh neodvisnih eksperimentalnih sistemih. Ti rezultati nakazujejo potencial takšnih pripravkov za vključitev v trajnostne strategije varstva rastlin, zlasti v t. i. odvrni in privabi (angl. "push-pull") strategijah, ki ličinke usmerjajo stran od posevkov. Za potrditev praktične uporabnosti teh pristopov pri zmanjševanju škode na okolju prijazen način pa bodo ključne terenske raziskave.

ABSTRACT

Potential of natural substances, synthetic volatile organic compounds and entomopathogenic fungi for repelling wireworms (Coleoptera: Elateridae) in soil

Wireworms are persistent soil-dwelling pests that cause substantial damage to many crops, including maize, cereals, potatoes and vegetables. Their hidden underground lifestyle and long lifecycle make them difficult to control. As the use of conventional insecticides is decreasing and Integrated Pest Management (IPM) has become mandatory, there is an increasing need for alternative solutions that are both effective and environmentally acceptable. In this study, we investigated how different natural and synthetic agents–two types of compost teas (CT16, CT19), the synthetic volatile organic compound 3-octanone, and the entomopathogenic fungus *Metarhizium brunneum* (strain 1868)–affect wireworm movement, behaviour within dual-choice soil selection tests and the time they spend near the treated area. Using dual-choice soil olfactometers and rhizotron assays, we examined how two common and economically important wireworm species in Europe (*Agriotes lineatus* and *A. litigiosus*) responded to these treatments. Our results showed clear and consistent behavioural effects. Compost tea CT16 acted as an attractant, increasing the number of wireworms moving toward the treated soil, whereas CT19 did not affect wireworm behaviour significantly. In contrast, both 3-octanone and *M. brunneum* reduced wireworm numbers and the time they spent in the treated zones, showing a significant repellent effect. This behaviour was similar in both tested species. Both olfactometer and rhizotron assays gave similar results, confirming the repellence of 3-octanone and *M. brunneum* in two independent experimental setups. These findings indicate that such products could be incorporated into sustainable control strategies, especially in push–pull systems that aim to direct larvae away from crops and towards attractant or trap crops. However, field trials will be essential to confirm the practical usefulness of these approaches in reducing damage in an environmentally friendly way.

Glivni lektini kot selektivni bioinsekticidi: mehanizem delovanja *Marasmius oreades* aglutinina (MOA) proti koloradskemu hrošču

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Glivni lektini so zaradi specifične vezave na ogljikove hidrate obetavni kandidati za razvoj selektivnih biopesticidov. V raziskavi smo ovrednotili insekticidni potencial izbranih rekombinantnih glivnih lektinov proti ličinkam koloradskega hrošča *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae), enega najpomembnejših škodljivcev krompirja. V prehranskih poskusih na listnih diskih je le *Marasmius oreades* aglutinin (MOA) povzročil izrazit porast smrtnosti ličink, medtem ko sta *Aleuria aurantia* lektin (AAL) in *Coprinopsis cinerea* lektin 2 (CCL2) predvsem zavirala prirast telesne mase. Za MOA je bila določena LC50 vrednost 0,67 mg/mL. Funkcionalna analiza mutantov MOA je pokazala, da sta za insekticidno delovanje nujni tako aktivna lektinska domena za vezavo na celične receptorje kot tudi aktivna proteazna domena. MOA se veže na glikoproteine srednjega črevesa ličink, pri čemer je bil kot verjetna primarna tarča identificiran membranski glikoprotein aminopeptidaza. Histološke in ultrastrukturne analize so razkrile popolno dezorganizacijo epitela srednjega črevesa ličink koloradskega hrošča; namesto enoslojnega visokoprizmatskega epitela je bilo vidnih več slojev celic, večinoma brez celičnih stikov in s porušeno ultrastrukturo. Nasprotno pa pri odraslih čebelah in ličinkah medonosne čebele *Apis mellifera* Linnaeus, 1758 (Hymenoptera: Apidae) pri testiranih koncentracijah nismo ugotovili akutne toksičnosti, zaznani so bili le neznačilni subletalni učinki na razvoj ličink. Rezultati kažejo, da je MOA učinkovit in razmeroma selektiven kandidat za trajnostno varstvo krompirja pred koloradskim hroščem z neznatnimi učinki na neciljne organizme.

ABSTRACT

Fungal lectins as selective bioinsecticides: mode of action of *Marasmius oreades* agglutinin against the Colorado potato beetle

Fungal lectins, due to their specific glycan-binding properties, are promising candidates for the development of selective biopesticides. We evaluated the insecticidal potential of six recombinant fungal lectins against larvae of the Colorado potato beetle *Leptinotarsa*

decemlineata Say (Coleoptera: Chrysomelidae), one of the most destructive pests of potato crops. Leaf-disc feeding assays showed that *Marasmius oreades* agglutinin (MOA) caused the highest larval mortality, while *Aleuria aurantia* lectin (AAL) and *Coprinopsis cinerea* lectin 2 (CCL2) primarily inhibited larval weight gain. The median lethal concentration (LC50) of MOA was determined to be 0.67 mg/mL. Functional analysis of MOA mutants demonstrated that both the active lectin domain, which binds to cell receptors, and the active protease domain are essential for its entomotoxicity. MOA binds to glycoproteins in the larval midgut, with a membrane-bound aminopeptidase identified as a likely primary target. Histological and ultrastructural analyses revealed complete disorganization of the midgut epithelium of Colorado beetle larvae; instead of one-layered columnar epithelium, several layers of cells were visible, mostly without cell contacts and with severely disrupted ultrastructure. In contrast, no acute oral toxicity was observed in adult honeybees or honeybee larvae, *Apis mellifera* Linnaeus, 1758 (Hymenoptera: Apidae). Only insignificant sublethal effects on larval weight gain were detected. These findings indicate that MOA is an effective and selective bioinsecticide candidate for sustainable control of the Colorado potato beetle with negligible impact on non-target organisms.

Pojav karantenske bakterije *Pantoea stewartii* subsp. *stewartii* na koruzi v Vipavski dolini

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Pantoea stewartii subsp. *stewartii* je karantenski škodljivi organizem EU, uvrščen v prilogo II.A Izvedbene uredbe Komisije (EU) 2019/2072, kjer so navedeni škodljivi organizmi, za katerega ni znano, da bi se pojavljal v EU. Z gospodarskega vidika sta njeni najpomembnejši gostiteljski rastlini koruza in sladka koruza, ki je na okužbo z bakterijo najbolj občutljiva, lahko pa se okužijo tudi nekatere vrste trav. Značilni znaki okužbe koruze so bledo zelene do rumene proge na listih, ki sčasoma nekrotizirajo in se razširijo po večjem delu listne površine. V zgodnejših razvojnih fazah okužba pogosto povzroči pritlikavost, sistemsko uvelost in propad cele rastline. Bakterija je razširjena v Severni in Južni Ameriki, kjer jo učinkovito prenaša koruzni bolhač (*Chaetocnema pulicaria*), ki v Evropi doslej ni bil potrjen. V druge dele sveta se je najverjetneje prenesla z okuženim semenom koruze. V EU so bile najdbe bakterije *P. stewartii* subsp. *stewartii* potrjene le v Italiji in Sloveniji, pri čemer so bili ob vsaki potrjeni najdbi odrejeni ukrepi izkoreninjenja. V Sloveniji v okviru programov preiskav spremljamo pojav bakterije od leta 2017. Prvič je bila ugotovljena v letu 2018 v Vipavski dolini in se od tedaj redno pojavlja v posevkih koruze. Na območju Slovenije, kjer je pridelava koruze največja (Štajerska, Prekmurje), bakterija do sedaj ni bila ugotovljena. Vzorčenje opravljamo na podlagi vizualnih pregledov rastlin s tipičnimi simptomi, za vsak vzorec odvzamemo do 20 listov iz posameznih rastlin. Od leta 2023 vzorčimo tudi možne gostiteljske rastline kot so *Setaria*

viridis (zeleni muhvič), *Echinochloa crus-galli* (navadna kostreba), *Digitaria sanguinalis* (krvavordeča srakonja), *Sorghum halepense* (divji sirek) ter potencialne vektorje iz vrst bolhačev (*Chrysomelidae*) in malih škržatkov (*Cicadellidae*), ki se pojavljajo v posevkih koruze. Vse vzorce analizira Nacionalni inštitut za biologijo v Ljubljani. Do sedaj so analize potrdile, da se bakterija pojavlja v koruzi, v letu 2024 je bila v enem vzorcu potrjena tudi na plevelu *Digitaria sanguinalis*. V letu 2025 smo odvzeli tudi 3 vzorce sladke koruze, ki so bili pozitivni. Iz večletnih vzorčenj in analiz ugotavljamo, da se število pozitivnih lokacij povečuje, saj je bilo v letu 2025 od 24 uradnih vzorcev kar 19 pozitivnih. Da bi ugotovili izvor okužb, smo v okviru projekta MAPQUEST - Napredne strategije upravljanja karantenske bakterijske uvelosti koruze v Sloveniji, ki se je začel v 2024, poleg koruze dodatno vzorčili krmne rastline (sudansko travo - *Sorghum sudanense* in krmni sirek - *Sorghum bicolor*) ter žuželke koruznega hrošča (*Diabrotica v. virgifera* LeConte), ki je glavni škodljivec koruze. V prispevku bodo predstavljeni podatki o pojavu bakterije *P. stewartii* subsp. *stewartii* na koruzi v Vipavski dolini ter njeni prisotnosti v alternativnih gostiteljskih rastlinah in potencialnih prenašalcih.

ABSTRACT

Occurrence of the quarantine bacterium *Pantoea stewartii* subsp. *stewartii* on maize in the Vipava Valley (Slovenia)

Pantoea stewartii subsp. *stewartii* is an EU quarantine pest listed in Annex II.A of Commission Implementing Regulation (EU) 2019/2072 as a pest not known to occur in the EU. From an economic perspective, its most important host plants are maize and sweet maize, the latter being the most susceptible to infection, although some grass species may also become infected. Typical symptoms of infection on maize include pale-green to yellow streaks on the leaves, which gradually become necrotic and spread over a large part of the leaf surface. In earlier developmental stages of maize, the disease often causes stunting, systemic wilting, and the collapse of entire plants. The bacterium is widespread in North and South America, where it is efficiently transmitted by the corn flea beetle (*Chaetocnema pulicaria*), a vector that has not been confirmed in Europe to date. The pathogen is considered to have been introduced into other parts of the world via infected maize seed. Within the EU, detections of *P. stewartii* subsp. *stewartii* have been reported only in Italy and Slovenia, where eradication measures have been ordered following each confirmed detection. In Slovenia, the occurrence of the bacterium has been monitored within national survey programmes since 2017. It was first detected in 2018 in the Vipava Valley and has since regularly occurred in maize fields there. In regions of Slovenia where maize production is most extensive (Štajerska and Prekmurje), the bacterium has not yet been detected. Sampling is carried out based on visual inspections of plants showing typical symptoms; for each sample, up to 20 leaves are collected from individual plants. Since 2023, potential host plants such as *Setaria viridis* (green foxtail), *Echinochloa crus-galli* (barnyard grass), *Digitaria sanguinalis* (large crabgrass), *Sorghum halepense* (Johnsongrass), as well as potential vectors from flea beetles (Chrysomelidae) and leafhoppers (Cicadellidae) occurring in maize fields, have also been sampled. All samples are analysed by the National Institute of Biology in Ljubljana. To date, analyses have confirmed the presence of the bacterium in maize, and in 2024 it was also confirmed in one sample of the weed *Digitaria sanguinalis*. In 2025, three samples of sweet maize were also collected and tested positive. Based on multi-year sampling and analyses, we observe an increasing number of positive findings; in 2025, 19 out of 24 official samples were positive. To determine the source of infections, within the project MAPQUEST – Advanced management strategies for quarantine bacterial wilt of maize in Slovenia, which started in 2024, additional sampling was conducted, in addition to maize, on forage crops (Sudan grass – *Sorghum sudanense* and forage sorghum – *Sorghum bicolor*) and on

insects of the western corn rootworm (*Diabrotica virgifera virgifera* LeConte), the main pest of maize. This paper presents data on the occurrence of *P. stewartii* subsp. *stewartii* in maize in the Vipava Valley and its presence in alternative host plants and potential vectors.

Preliminarni rezultati identifikacije potencialnih prenašalcev bakterije *Pantoea stewartii* subsp. *stewartii* na koruzi v Sloveniji

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Bakterija *Pantoea stewartii* subsp. *stewartii* (ERWIST) je karantenski povzročitelj bakterijske uvelosti koruze. Medtem ko je v Severni Ameriki glavni prenašalec bakterije koruzni bolhač (*Chaetocnema pulicaria*), ta v Evropi ni potrjen. Prav tako v evropskem prostoru ni podatkov o drugih prenašalcih. V okviru rednih programov preiskav, ki jih koordinira Uprava za varno hrano, veterinarstvo in varstvo rastlin, ter projekta CRP V4-2415 MapQuest smo v letu 2025 na koruznih poljih z značilnimi bolezenskimi znamenji bakterijske uvelosti v Vipavski dolini izvedli vzorčenje žuželk potencialnih prenašalcev bakterije z lovilnimi mrežami. Sledila je njihova morfološka in molekularna analiza. V preliminarnih analizah smo morfološko določili več deset osebkov vrst iz rodu *Chaetocnema*, med katerimi je bila *C. conducta* daleč najpogostejša, sledila je *Phyllotreta vittula*, medtem ko so bile druge vrste prisotne le posamično, kar odraža visoko pojavnost vrste *C. conducta* na pregledanih poljih. Zbrali smo tudi osebke škržatkov, ki jih bomo dodatno identificirali z uporabo črtnih kod DNA. Ker standardiziranega protokola za pripravo žuželk za diagnostiko ERWIST ni bilo, smo razvili in optimizirali postopek analize vzorcev, ki vključuje ločeno analizo glave za izolacijo DNA ter trupa za izolacijo na gojiščih. Z metodo PCR v realnem času smo v nizkih koncentracijah zaznali prisotnost ERWIST v štirih osebkih *C. conducta*, medtem ko so bili ostali testirani primerki negativni. Pozitivni signali, kakršne smo opazili, so lahko posledica hranjenja hroščev na okuženih rastlinah. To je skladno z možnostjo prenosa bolezni preko kontaminacije z izločki, vendar ne potrjuje preživetja bakterije v žuželki preko zime, ki bi bilo potrebno za epidemiološko pomembno vlogo prenašalca. Trenutni delež pozitivnih žuželk je nizek, zato opažanje obravnavamo kot potencialno zanimivo, ne pa kot dokaz obstoja prenašalca ali grožnje za večje izgube pridelka. Za zanesljivo oceno vloge različnih žuželk bomo nadaljevali z razširjenim vzorčenjem, izolacijami bakterije na gojiščih ter integracijo morfološke in molekularne identifikacije potencialnih prenašalcev.

ABSTRACT

Preliminary results on the identification of potential vectors of *Pantoea stewartii* subsp. *stewartii* in maize crops in Slovenia

Pantoea stewartii subsp. *stewartii* (ERWIST) is a quarantine pathogen causing Stewart's bacterial wilt of maize. In North America, the main vector is the corn flea beetle (*Chaetocnema pulicaria*). This species has not been recorded in Europe, where any vector of the pathogen remains unknown. In 2025, as part of national survey programmes, coordinated by the Administration for Food Safety, Veterinary Sector and Plant Protection of Republic of Slovenia, and the CRP V4-2415 MapQuest project, we sampled insects from maize fields showing typical bacterial wilt symptoms in the Vipava Valley. Insects, considered potential bacterial vectors, were collected using sweep nets and subjected to morphological and molecular analyses. In preliminary analysis, morphological identification showed that *Chaetocnema conducta* was by far the most abundant flea beetle species in the surveyed fields, followed by *Phyllotreta vittula*, while other species were only occasionally detected. We also collected leafhopper specimens, which will be further identified using DNA barcoding. In the absence of a standardised protocol for insect preparation in ERWIST diagnostics, we established and optimised a workflow where heads are processed for DNA extraction and thoraces for culture-based isolation. Using real-time PCR, we detected low levels of ERWIST DNA in four *C. conducta* individuals, while all other tested specimens were negative. These positive signals may result from feeding on infected plants and are consistent with potential transmission via contamination with excreta. However, these findings do not demonstrate bacterial survival in the insect over winter, a prerequisite for an epidemiologically important vector. Given the low proportion of positive insects, the observation is intriguing but not evidence of an established vector or a significant yield threat. To obtain a robust assessment of the role of different insects, we will continue with expanded sampling, bacterial isolation, and combined morphological and molecular identification of potential vectors.

Sistematično podvzorčenje kot pristop za izboljšanje izolacije *Pantoea stewartii* subsp. *stewartii* v Sloveniji

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Bakterija *Pantoea stewartii* subsp. *stewartii* (ERWIST) povzroča bakterijsko uvelost koruze (*Zea mays* L.) in lahko ob prisotnosti učinkovitega prenašalca povzroči znatne gospodarske izgube. V Sloveniji smo bakterijo prvič potrdili leta 2018 v dveh vzorcih koruze, v obdobju do konca leta 2024 pa še v dodatnih 19 vzorcih koruze. Vse razen ene najdbe izvirajo iz Vipavske doline. V tem obdobju je bilo dodatnih 19 vzorcev pozitivnih z dvema molekularnima testoma, vendar bakterije ni bilo mogoče potrditi z izolacijo na gojiščih. V večini teh primerov so bili prisotni številni saprofiti ali druge bakterije, od katerih so nekatere morfološko podobne ERWIST, kar je oteževalo zanesljivo prepoznavanje kolonij. V letu 2025 smo v okviru programa preiskav, ki jih koordinira Uprava za varno hrano, veterinarstvo in varstvo rastlin, ter projekta CRP V4-2415 MapQuest uvedli sistematičen pristop podvzorčenja, osredotočen na različna opažena bolezenska znamenja. Kombinacija vzporednega molekularnega testiranja in izolacije na gojiščih nam je omogočila hitrejše pridobivanje izkušenj pri prepoznavanju diagnostično najbolj informativnih znamenj in boljši vpogled v povezavo med koncentracijo bakterij in številčnostjo kolonij na gojiščih. Pristop je izboljšal uspešnost izolacije ERWIST: leta 2025 smo bakterijo potrdili v vseh vzorcih koruze, kjer sta bila pozitivna oba molekularna testa. Uspeh je verjetno povezan s ciljno izbiro najbolj značilnih bolezenskih znamenj, saj

je tak način podvzorčenja zmanjšal prisotnost spremljajoče mikrobiote in povečal verjetnost zajema tkiva z dejansko višjo koncentracijo ERWIST. Metoda poveča obseg dela predvsem v začetnih fazah, vendar omogoča hitrejši razvoj diagnostične strokovnosti in postopno zmanjševanje potrebe po intenzivnem podvzorčenju v prihodnjih letih. Uvedeni pristop tako pomembno krepi uspešnost izolacije ERWIST v primeru pozitivnih presejalnih testov in podpira zanesljivejšo diagnostiko te bakterije v Sloveniji.

ABSTRACT

Systematic subsampling as an approach to improve the isolation of *Pantoea stewartii* subsp. *stewartii* in Slovenia

The bacterium *Pantoea stewartii* subsp. *stewartii* (ERWIST) causes Stewart's wilt of maize (*Zea mays* L.). When an efficient vector is present, it can result in significant economic losses. In Slovenia, the bacterium was detected for the first time in 2018 in two maize samples, and by the end of 2024 it had been confirmed in an additional 19 samples through molecular testing and culture-based isolation, with all but one finding originating from the Vipava Valley. During this period, 19 further samples tested positive with two molecular assays, but the bacterium could not be confirmed by isolation. In many of these cases, abundant saprophytes or other bacteria were present, some of which were morphologically similar to ERWIST, complicating reliable colony selection. To improve recovery rates, in 2025 we introduced a systematic subsampling strategy for maize samples within national survey programme, coordinated by the Administration for Food Safety, Veterinary Sector and Plant Protection of Republic of Slovenia, and the CRP V4-2415 MapQuest project. The approach focused on separate testing of different types of observed disease symptoms. Parallel molecular testing and isolation on media enabled us to evaluate which symptoms were most informative and link bacterial concentration with colony abundance on culture media. This strategy improved the success of ERWIST isolation: in 2025, the bacterium was confirmed in all maize samples in which both molecular tests were positive. The improvement is likely linked to the targeted selection of the most characteristic symptom types, as this subsampling strategy reduced the presence of accompanying microbiota and increased the likelihood of capturing tissue with a genuinely higher concentration of ERWIST. While the method increases workload, particularly during early implementation, it supports faster accumulation of diagnostic expertise and is expected to reduce the need for extensive subsampling in subsequent years. The introduced approach therefore substantially enhances the reliability of ERWIST isolation and represents an investment in more effective long-term diagnostics in Slovenia.

Izkušnje z zatiranjem žitnega strgača (*Oulema* spp.) na strnih žitih

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Žitni strgači so pomembni škodljivci strnih žit. V Sloveniji so bile prve obsežnejše škode povzročene v začetku sedemdesetih let prejšnjega stoletja. V zadnjih letih se žitni strgač redno pojavlja, številčnost populacije pa med leti precej niha. Vedno pogosteje poškodbe povzroča tudi na koruzi. Med žitnimi strgači je v Sloveniji najštevilčnejši rdeči žitni strgač

(*Oulema melanopus*), modrega žitnega strgača (*Oulema lichenis*) je številčno manj. V letu 2024 smo v posevku pšenice preverili delovanje insekticidov, registriranih za zatiranje rdečega žitnega strgača (*Oulema melanopus*). V obravnavanjih smo preizkusili insekticide ter insekticide v kombinaciji z različnimi močili. Cilj prvega leta raziskave je bil ugotoviti učinkovitost posameznih pripravkov ob uporabi uravnanega pH vode ter rezultate primerjati z učinkovitostjo istih insekticidov. V letu 2025 nadaljevali s preskušanjem učinkovitosti vseh dovoljenih insekticidov proti žitnemu strgaču in pripravek na osnovi acetamiprida z uravnavanjem pH-ja. Uporabo uravnanega pH vode smo ohranili pri pripravkih, kjer je to bilo potrebno za zagotovitev stabilnosti ali optimalnega delovanja.

ABSTRACT

Experiences with the control of cereal leaf beetles (*Oulema* spp.) in small grain cereals

Cereal leaf beetles are important pests of small grain cereals. In Slovenia, the first significant damage was recorded in the early 1970s. In recent years, cereal leaf beetles have appeared regularly, although population levels fluctuate considerably between years. Increasingly, they also cause damage in maize. Among the cereal leaf beetles present in Slovenia, the most abundant species is the cereal leaf beetle (*Oulema melanopus*), while the blue cereal leaf beetle (*Oulema lichenis*) occurs in lower numbers. In 2024, we assessed the performance of insecticides registered for the control of the cereal leaf beetle (*Oulema melanopus*) in a wheat crop. The aim of the first year of the study was to determine the efficacy of individual insecticides when applied with adjusted water pH and to compare the results with the efficacy of the same insecticides used without pH adjustment. In 2025, we continued by testing the efficacy of all authorised insecticides for controlling the cereal leaf beetle, and the acetamiprid-based product was applied with pH adjustment. The adjustment of water pH was maintained for those insecticides for which it was necessary to ensure stability or optimal performance.

Stanje populacij pelinolistne ambrozije (*Ambrosia artemisiifolia* L.) na kmetijskih zemljiščih Slovenije v zadnjem desetletju

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Pelinolistna ambrozija je invazivna vrsta s splošno znanimi negativnimi učinki v kmetijski pridelavi in z negativnim delovanjem na zdravje ljudi in živali (povzročanje alergijskih učinkov na dihalih). Zaradi velikega pomena je bila razvita zakonodaja, ki narekuje ustrezno ukrepanje za omejevanje velikosti populacij. V okviru dolgoletne strokovne naloge izvajamo monitoring velikosti populacij in monitoring uspešnosti zatiranja. V prispevku so predstavljeni podatki poenostavljenega monitoringa za zadnjih 10 let. Rezultati monitoringa kažejo, da smo hitro povečevanje populacij zajezili. Delež kmetijskih površin, kjer se ambrozija pojavlja se počasi povečuje, ne povečuje pa se delež površin, kjer imamo razvite velike populacije in so kmetje pri zatiranju neuspešni. Kljub pomanjkanju nekaterih učinkovitih herbicidov ocenjujemo, da se je znanje kmetov za obvladovanje ambrozije in uspešnost zatiranja v zadnjem desetletju izboljšala. Povečujejo

se populacije naravnih regulatorjev populacij ambrozije; obseg glivičnih okužb in uničenja od herbivorov (npr. *Ophraella communa* Le Sage). Pri monitoringu nismo ugotovili razširjanja drugih pomembnih invazivnih vrst kot so *A. psilostachya*, *A. trifida*, *A. tenuifolia* in *A. confertiflora*, ki se sicer širijo po Evropi.

ABSTRACT

Status of ragweed (*Ambrosia artemisiifolia* L.) populations on agricultural lands in Slovenia in the last decade

Ragweed is an invasive plant species with generally known adverse effects on agricultural production and with negative effects on human and animal health (causing allergic effects on the respiratory tract). Due to its great importance, legislation has been developed that dictates appropriate action to limit population size. As part of a long-term research project, we monitor population sizes and the effectiveness of control measures. The paper presents simplified monitoring data for the past decade. The monitoring results show that we have curbed the rapid increase in population. The share of agricultural plots where ragweed occurs is slowly increasing, but the share of plots with large populations and where farmers are unsuccessful in controlling it is not growing. Despite the lack of certain effective herbicides, we estimate that farmers' knowledge of ragweed control and the success of their control efforts have improved over the last decade. Populations of natural regulators of ragweed populations are increasing (the extent of fungal infections and destruction by herbivores, e.g., *Ophraella communa* Le Sage). During monitoring, we did not detect the spread of other important invasive species such as *A. psilostachya*, *A. trifida*, *A. tenuifolia,* and *A. confertiflora*, which are otherwise spreading across Europe.

Dominance of invasive Johnsongrass in roadside vegetation of Serbia

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Roads, railways and watercourses represent major terrestrial invasion corridors, which enable long-distance dispersal and transport of invasive alien plants between previously isolated regions. Johnsongrass (*Sorghum halepense* (L.) Pers.) is a highly invasive perennial weed species of cosmopolitan distribution. It forms dense, monodominant stands, which can crowd out native vegetation. Given its importance in agricultural production, especially in light of its multiple herbicide resistance, and the recognition of roads as major non-agricultural areas for Johnsongrass spread, our aim was to evaluate the role of roads as linear corridors facilitating its spread in Serbia. Field research was carried out in July-September of 2018-2020, at a total of 205 field sites. These field sites were distributed along highways and major state roads in Serbia, with 100 m^2 belt transects set up parallel to the road, in every section of the roadside terrain. Cover values of the roadside vegetation were expressed in % of the transect area. Correlation between the Johnsongrass invasion (presence and cover) and selected characteristics of the field site were analyzed using

linear regression analysis in Statistica software. Johnosongrass was recorded at 57% of field sites (55% of relevés). In the majority of field sites (64%), its cover ranged between 5% and 50% of the transect. However, more than 10% of transects contained dense stands: 15 with 51–75% cover and five fully dominated (>75%). Records of its presence and dominance were concentrated in the northern, low-lying part of Serbia, where at two field sites it formed nearly monodominant stands (>90% cover). While its presence and cover were negatively correlated with altitude of the field site, both were positively correlated with the number of other aliens plants in the transect.
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Novi pristopi k obvladovanju verticilijske uvelosti hmelja z uporabo koristnih mikroorganizmov

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Verticilijska uvelost, ki jo povzroča letalni patotip glive *Verticillium nonalfalfae*, je ena najpomembnejših bolezni hmelja. Uspešno obvladovanje bolezni v veliki meri temelji na integriranih pristopih, ki vključujejo fitosanitarne ukrepe, sajenje odpornih sort ter tehnologije za izboljšanje zdravstvenega stanja tal. V raziskavi smo se osredotočili na vrednotenje potenciala koristnih mikroorganizmov, izoliranih iz rizosfere in ksilema hmelja, za preprečevanje razvoja glive *V. nonalfalfae*. Na osnovi selekcije, ki je vključevala *in vitro* teste dvojnih kultur ter *in planta* testiranja učinkovitosti proti glivi *V. nonalfalfae* v kontroliranih pogojih rastne komore, smo izbrali tri mikroorganizme: *Pseudomonas* sp. HX1, *Streptomyces luteogriseus* HR40 in *S. flavofungini* HR77. Izbrane mikroorganizme smo v obliki mešanice uporabili za obogatitev dveh hmeljnih kompostov, ki smo ju nato vnesli v izbrane poljine kontaminiranih hmeljišč sort Celeia in Aurora. Vnos kompostov je potekal dve leti, in sicer spomladi po strojni odgrnitvi tal od rastlin, s čimer smo zagotovili aplikacijo v neposredno bližino koreninskega sistema. V prispevku predstavljamo prve rezultate pojava verticilijske uvelosti v poljinah z uporabljenim kompostom v primerjavi s kontrolnimi parcelami. Raziskava je bila izvedena v okviru projekta PRIMA SUSTEMICROP (https://sustemicrop.eu/) in financirana s strani Javne agencije za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije (ARIS), št. pogodb N4-0270 in P4-0077.

ABSTRACT

New approaches to the management of verticillium wilt of hop using beneficial microorganisms

Verticillium wilt caused by the lethal pathotype of *Verticillium nonalfalfae* is one of the most damaging diseases of hop. Current disease management largely depends on phytosanitary measures, the cultivation of resistant varieties, and soil sanitation practices. In this study, we evaluated the potential of microbial biological control agents (BCAs) isolated from the hop rhizosphere and xylem for suppressing *V. nonalfalfae*. A strain selection process, comprising an in vitro dual-culture assay and in planta efficacy testing under controlled growth-chamber conditions, identified three promising BCAs: *Pseudomonas* sp. HX1, *Streptomyces luteogriseus* HR40, and *S. flavofungini* HR77. These BCAs were applied as a mixture to enrich hop composts, and their suppressive activity was assessed in naturally contaminated field trials established with the highly susceptible variety Celeia and the moderately susceptible Aurora. The trials were designed as a minimum two-year experiment, with BCA-enriched compost applied in spring after soil was plowed away from the plants to enable placement near the root zone. In this presentation, we will show initial results of disease assessments comparing BCA-compost-treated and untreated plots. This work was carried out within the PRIMA project SUSTEMICROP (https://sustemicrop.eu/) and was funded by the Slovenian Research and Innovation Agency (ARIS), grant numbers N4-0270 and P4-0077.

Izzivi pri razvoju CRISPR/Cas diagnostične metode za določanje CBCVd v hmelju

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Viroidne bolezni svetovnem kmetijstvu predstavljajo velik izziv, saj ti majhni in strukturno preprosti patogeni lahko okužijo številne gospodarsko pomembne rastlinske vrste. Učinkovito preprečevanje in obvladovanje viroidnih bolezni temelji na pravočasnem odkrivanju žarišč in diagnostičnih metodah, ki omogočajo zanesljivo identifikacijo viroidov. *Cocadviroid rimocitri* (viroid razpokanosti skorje agrumov, CBCVd) na hmelju povzroča agresivno obolenje imenovano »huda viroidna zakrnelost hmelja«, ki je v Sloveniji že povzročilo veliko gospodarsko škodo in še naprej ogroža pridelavo hmelja. Razvoj molekularne biologije je močno izboljšal občutljivost in specifičnost diagnostičnih metod pri rastlinah. Med najobetavnejšimi inovacijami je uporaba metod na osnovi CRISPR/Cas sistema, ki so bile zaradi enostavne uporabe in široke prilagodljivosti razvite za identifikacijo številnih rastlinskih patogenov. V kombinaciji s hitrimi testi CRISPR/Cas omogoča enostavno, občutljivo in zelo hitro detekcijo viroidov v manj kot eni uri. Ker je naš glavni cilj razviti hitro CRISPR/Cas metodo, razvijamo protokol, ki omogoča detekcijo brez predhodne izolacije RNA. Preizkusili smo več načinov homogenizacije rastlinskega tkiva z uporabo različnih pufrov in homogenizatorjev ter prisotnost CBCVd v rastlinskem soku uspešno potrdili z RT-PCR in RT-qPCR. Nato smo CRISPR/Cas reakcijo optimizirali z uporabo fluorescenčno označenih ssDNA sond v qPCR inštrumentu. Za zagotavljanje praktične uporabnosti in možnosti za prilagoditev za detekcijo na terenu, smo preizkusili tudi različne hitre teste, pri čemer smo dobili obetavne rezultate. Zaradi določenih omejitev metode, bomo v prihodnje raziskali dodatne protokole, s katerimi bi lahko še skrajšali čas analize. Razvoj občutljive in hitre metode brez izolacije RNA bo predstavljal pomemben napredek v raziskavah hmelja, metoda pa se kaže tudi potencial za detekcijo na terenu.

ABSTRACT

Challenges in Developing a CRISPR/Cas Diagnostic Method for Detection of CBCVd in Hop

Viroid diseases represent a persistent challenge in global agriculture, as these small, structurally simple pathogens can infect many economically important plant species. Effective prevention and control therefore depend on the timely detection of infection hotspots and on diagnostic tools capable of reliably identifying the causal viroids. *Cocadviroid rimocitri* (formerly citrus bark cracking viroid, CBCVd) causes an aggressive disease called “severe hop stunt disease” that has already resulted in major economic losses in Slovenia and continues to threaten hop production. Advances in molecular biology have greatly improved the sensitivity and specificity of plant diagnostic methods. Among the most promising innovations is the application of CRISPR/Cas-based detection, which has been successfully adapted for the identification of numerous plant pathogens due to its simplicity and versatility. When coupled with lateral flow assays, CRISPR/Cas enables simple, sensitive, and very fast detection of viroids in less than one hour. With the primary aim of developing a fast CRISPR/Cas method, we are developing a protocol that enables detection without prior RNA isolation. We evaluated multiple plant tissue homogenization approaches using different buffers and homogenization tools, and the presence of CBCVd in crude extracts was successfully confirmed by RT-PCR and RT-qPCR. We further optimized the CRISPR/Cas reaction using fluorescently labeled ssDNA probes in a qPCR platform. To ensure practical applicability and potential adaptation for field detection, we also tested several lateral flow assays, obtaining encouraging preliminary results. Due to certain limitations of the current method, we plan to explore additional protocols that could further reduce the analysis time. Developing a sensitive, rapid, and RNA-extraction-free will represent a significant advancement in hop research and holds string potential for future on-site detection.

Predstavitev rezultatov spremljanja in prvih ukrepov zatiranja japonskega hrošča (*Popillia japonica*) v Sloveniji na napadenih območjih v letu 2025

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V okviru Programa preiskav smo japonskega hrošča (*Popillia japonica* Newman) (Coleoptera: Scarabaeoidea) na območju Slovenije prvič ugotovili poleti 2024, in sicer na avtocestnih počivališčih Lukovica jug in Barje jug v Osrednji Sloveniji. Na obeh lokacijah se je tekom sezone v pasteh skupaj ujelo osem hroščev (Lukovica: 6, Barje: 2). Kljub dodatno postavljenim feromonskim pastem na širšem območju prvih najdb, hrošča v letu 2024 izven počivališč nismo potrdili. V letu 2025 smo pasti postavili bliže obema počivališčema, kjer so se prvi hrošči v začetku julija tudi ujeli. Poleg tega se je en hrošč v začetku julija ujel tudi na počivališču Dul pri Trebnjem na Dolenjskem, kjer kljub dodatno postavljenim pastem v sezoni ni bilo več ulova. Za preprečevanje širjenja je UVHVVR julija 2025 vzpostavila dve razmejeni območji, ki vključujeta napadeno območje in varovalni pas, v katerih so se izvajali dodatni ukrepi in preiskave. Do konca sezone je bilo

na širšem območju Lukovice postavljenih 60 pasti, na območju Barja 54 pasti z namenom spremljanja navzočnosti, velikosti populacije ter omejevanja širjenja oziroma zatiranja hrošča z metodo masovnega ulova. V letu 2025 se je v feromonske pasti na območju Lukovice ujelo skupaj 418, na Barju 78 hroščev. Največji nalet hroščev je bil v drugi polovici julija, lovili pa so se do konca septembra. Na Lukovici smo hrošče opazili tudi na leskah. Skupno je bilo izven pasti najdenih 10 hroščev v neposredni bližini pasti z največjim sezonskim ulovom. Kot ukrep zatiranja ogrcev smo septembra 2025 na travniških površinah, ob katerih se je v pasteh ulovilo največ japonskih hroščev, izvedli tretiranje z entomopatogenimi ogorčicami (EPO) vrste *Heterorhabditis bacteriophora*. V letu 2026 bomo nadaljevali s spremljanjem in zatiranjem japonskega hrošča na napadenih območjih ter ugotavljanjem morebitne razširjenosti v varovalnih pasovih.

ABSTRACT

Presentation of monitoring results and initial control measures against the Japanese beetle (*Popillia japonica*) in infested areas of Slovenia in 2025

Within the official survey programme, the Japanese beetle (*Popillia japonica* Newman) (Coleoptera: Scarabaeoidea) was detected for the first time in Slovenia in summer 2024 at the Lukovica South and Barje South motorway service stations in central Slovenia. Across both sites, a total of eight adults were captured during the season (six at Lukovica and two at Barje). Despite the installation of additional pheromone traps in the wider surroundings of the initial detection sites, the species was not confirmed outside the rest areas in 2024. In 2025, traps were positioned closer to both rest areas, where the first adults were again captured in early July. Additionally, a single specimen was trapped in early July at the Dul motorway service station near Trebnje (Dolenjska region), but no further captures were recorded there despite intensified trapping. To prevent further spread, the Administration for Food Safety, Veterinary Sector and Plant Protection established two demarcated zones in July 2025, comprising the infested zone and the buffer zone, where additional measures and surveys were implemented. By the end of the season, 60 traps were deployed in the broader Lukovica area and 54 in the Barje area to monitor pest presence, estimate population density, and limit its spread and reduce the pest population through mass trapping. In 2025, pheromone traps captured a total of 418 beetles at Lukovica and 78 at Barje. The highest beetle flight activity occurred in the second half of July, with captures continuing until the end of September. At Lukovica, adults were also observed feeding on hazel. In total, ten beetles were found outside traps in the immediate vicinity of the trap with the highest seasonal catches. As a larval eradication measure, entomopathogenic nematodes (EPN) of the species *Heterorhabditis bacteriophora* were applied in September 2025 to grassland areas adjacent to the trap with the highest capture rates. In 2026, monitoring and eradication efforts in the infested zones will continue, alongside assessments of possible spread into the buffer zones to enable early detection.

Škropljenje z brezpilotnimi letalniki za trajnostno in natančno varstvo rastlin - Fly4IPM (CRP V4-2428)

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V zadnjih letih se v kmetijski pridelavi intenzivno razvijajo nove tehnologije za natančno in ciljno nanašanje fitofarmacevtskih sredstev (FFS), kar odpira vprašanja o njihovi dejanski učinkovitosti, varnosti ter možnosti vključitve v integrirano varstvo rastlin. V okviru projekta CRP V4-2428 Fly4IPM zato pripravljamo znanstvene podlage za nanašanje FFS sredstev z nizkim tveganjem in koristnih organizmov z brezpilotnimi zrakoplovi (UAV). Tovrsten pristop ima pomembne prednosti pred klasično mehanizacijo, saj omogoča obdelavo težje dostopnih površin, zmanjšuje zbijanje tal, ter manjša mehanske poškodbe posevkov in zanašanje škropilne brozge. Dodatno odpira možnosti za prostorsko ciljno aplikacijo, ki temelji na dejanskem zdravstvenem stanju rastlin in prisotnosti škodljivcev. Glavni cilj projekta je ovrednotiti smiselnost in učinkovitost uporabe UAV za škropljenje ter razviti priporočila, ki bodo omogočila varno, trajnostno in zakonito vključitev te tehnologije v kmetijske prakse. Na tehnični ravni projekta poteka razvoj tehničnih smernic za škropilne UAV-sisteme, ki vključujejo razumevanje optimalnih konfiguracij, nastavitev šob, višine in hitrosti leta ter vpliva vremenskih pogojev na kakovost in varnost aplikacije. Ključni del predstavljajo tudi eksperimentalne analize zanašanja škropilne brozge, izvedene v različnih kulturah in razmerah, s katerimi projekt gradi temelje za zmanjšanje tveganj za netarčne organizme in okolje. Efektivnost nanašanja FFS z UAV bomo testirali s poskusi. Poseben poudarek je na pilotnih poskusih nanašanja biostimulantov in sredstev z nizkim tveganjem, kjer natančnost UAV sistemov predstavlja pomembno prednost. Rezultati bodo omogočili pripravo smernic, tehničnih specifikacij in programov usposabljanja za pilote UAV ter predloge za izboljšave zakonodaje. Fly4IPM tako vzpostavlja temelje za znanstveno podprt in okoljsko odgovoren prehod k natančnemu škropljenju z UAV v slovenskem kmetijstvu.

ABSTRACT

Spraying with unmanned aerial vehicles for sustainable and precision plant protection – Fly4IPM (CRP V4-2428)

In recent years, new technologies for the precise and targeted application of plant protection products (PPP) have been rapidly developing in agricultural practices, raising questions about actual effectiveness, safety, and their role in integrated pest management. Within the Fly4IPM project (CRP V4-2428), a scientific basis is being established for the use of unmanned aerial vehicles (UAVs) for the precise application of PPPs, and low-risk and biotic management products. Such advanced technologies offer significant advantages over conventional mechanization, as they enable access to difficult-to-treat areas, reduce soil compaction, mechanical damage to crops, and spray drift. In addition, they offer possibilities for spatially targeted applications based on actual plant health status or pest presence. The main objective of the project is to evaluate the feasibility and effectiveness of UAV-based spraying and to develop recommendations that will enable safe, sustainable, and legal integration of this technology into agricultural practice. At the technical level, the project includes development of technical guidelines for UAV spraying systems, including an understanding of optimal configurations, nozzle

settings, flight height and speed, and the influence of weather conditions on application quality and safety. A key component also consists of experimental analyses of spray drift conducted in various crops and conditions, through which the project establishes a basis for reducing risks to non-target organisms and the environment. The effectiveness of UAV-based PPP application will be evaluated through comparative field trials, with a particular emphasis on pilot experiments involving biostimulants and low-risk products, where the precision of UAV systems represents a significant advantage. The outcomes of the study will enable the preparation of guidelines, technical specifications, and training programs for UAV pilots, as well as proposals for improvements to legal policies. In this way, Fly4IPM is laying the foundations for a science-based and environmentally responsible transition to precise UAV-based spraying in Slovenian agriculture.

Genomska identifikacija bakterije *Agrobacterium rosae* v vzorcih tumoroznih izrastkov vrtnic

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Bakterije iz rodu *Agrobacterium* so znane povzročiteljice tumoroznih izrastkov pri rastlinah. Patogenost teh bakterij je povezana s prisotnostjo tumor-inducirajočega (Ti) plazmida, ki omogoča vključitev dela bakterijske DNA v genom rastline in s tem povezanega nastanka izrastkov. Med gostitelje sodijo tudi okrasne rastline, npr. vrtnice (*Rosa* spp.). Ena izmed opisanih vrst bakterij, *Agrobacterium rosae*, je bila poimenovana prav po pogostih najdbah na vrtnicah, vendar lahko okužuje tudi druge gostitelje. V okviru diagnostične dejavnosti smo analizirali vzorec vrtnice (hibrid 'Yann Arthus Bertrand'), pri katerem je bil zaradi tumoroznih izrastkov na steblu podan sum na okužbo z bakterijami iz rodu *Agrobacterium*. Iz vzorca smo na gojiščih (manitol-kvasni ekstrakt) izolirali več bakterijskih kolonij, ki jih je dendrogramska analiza na podlagi spektrov, pridobljenih z MALDI-TOF masno spektrometrijo, uvrstila v rod *Agrobacterium*. Z molekularnima testoma (Sawada in sod. 1995; Haas in sod. 1995) smo pri dveh izolatih potrdili prisotnost Ti plazmida. Ker testa ne omogočata identifikacije na nivoju vrste, smo enega od izolatov izbrali za sekvenciranje celotnega genoma. Analiza pridobljenega genoma je pokazala, da gre za vrsto *Agrobacterium rosae,* ob čemer je bila ugotovljena prisotnost še ene bakterijske vrste, ki je bila identificirana kot *Rhizobium smilacinae*. Sledeči rezultati fenotipske karakterizacije s sistemom BIOLOG GEN III so bili netipični, kar se sklada s prisotnostjo mešane kulture. Kljub temu, je bilo mogoče izolirati sestavljena zaporedja, ki pripadajo *A. rosae*, kar je omogočilo njeno taksonomsko klasifikacijo in potrdilo prisotnost Ti plazmida v genomu. Oba dejavnika močno podpirata vlogo *A. rosae* kot povzročitelja tumoroznih izrastkov v analiziranem vzorcu vrtnic, medtem ko je sočasna prisotnost *R. smilacinae* verjetno odraz kompleksne mikrobne združbe. Ob tem je bila genomska analiza ključna pri razločevanju med dejanskim povzročiteljem bolezni in oportunističnimi spremljevalnimi mikroorganizmi. Vse to poudarja robustnost sekvenciranja celotnega genoma, ki omogoča zanesljivo identifikacijo povzročiteljev bolezni tudi pri mešanih

kulturah ter predstavlja pomembno dopolnitev diagnostičnim metodam na področju bakterijskih bolezni rastlin.

ABSTRACT

Genomic identification of bacterium *Agrobacterium rosae* from galls on roses

Bacteria of the genus *Agrobacterium* are well known as causative agents of plant galls. Their pathogenicity is associated with a tumour-inducing (Ti) plasmid, which enables the transfer and integration of bacterial DNA into the plant genome and triggers the formation of gall tissues. Ornamental plants like roses are among recognised hosts. One described species, *Agrobacterium rosae*, was named after its frequent isolation from roses, although it is not restricted to this host. As part of our diagnostic activities, we analysed a rose sample (hybrid 'Yann Arthus Bertrand') showing gall formation on the stem, which raised suspicion of infection with bacteria from the genus *Agrobacterium*. Several bacterial colonies were isolated on yeast extract–mannitol medium and were assigned to the genus *Agrobacterium* based on dendrogram analysis of MALDI-TOF mass spectra. Molecular assays targeting the Ti plasmid (Sawada et al. 1995; Haas et al. 1995) confirmed its presence in two isolates. As these assays do not provide species-level identification, one isolate was selected for whole-genome sequencing (WGS). Genome analysis identified *Agrobacterium rosae*, but also revealed the presence of a second bacterial species, *Rhizobium smilacinae*, which indicated that the culture was mixed. This finding was consistent with atypical phenotypic profiles obtained using the BIOLOG GEN III system, which in retrospect reflected the mixed nature of the isolate. WGS enabled not only the confirmation that the isolate was mixed but also enabled genome-resolved separation of the two bacterial species and identification of the Ti plasmid–harbouring genome. These findings strongly support the role of *A. rosae* as the causative agent of galls in the analysed rose sample, while the simultaneous presence of *R. smilacinae* is likely a reflection of the complex microbial community in galls. The genomic analysis played a crucial role in distinguishing between the bacterium causing the disease and opportunistic microflora. This case highlights the diagnostic value and robustness of WGS, which enables reliable identification of plant pathogenic bacteria and resolution of mixed cultures, and represents an important addition to diagnostic methods in the field of bacterial plant diseases.

Prva najdba virusa klorotične lisavosti srobota *(Clematis chlorotic mottle virus,* ClCMV) v Sloveniji

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Leta 2009 smo v Ljubljani na listih drena (*Cornus* sp.) opazili klorotične linijske vzorce in obročkaste pege. Rezultati testiranja s serološko metodo DAS-ELISA za trinajst virusov (ArMV, TRSV, ToRSV, TBRV, CLRV, SLRSV, RRSV, ApMV, RBDV, TSWV, INSV, CMV in AMV) so bili negativni, zato smo se odločili, da vzorce analiziramo z tehniko visokozmogljivega sekvenciranja (HTS). Simptomatične liste iz iste rastline smo ponovno vzorčili leta 2020. Skupno RNA smo izolirali s kompletom reagentov MagMAX-96 Total RNA Isolation Kit (Thermo Fisher Scientific) ter jo po odstranitvi ribosomske RNA in

pripravi knjižnice cDNA analizirali s platformo Illumina (Macrogen Europe BV, Nizozemska). Z bioinformatskimi orodji smo sestavili skoraj celotni genom virusa, primerjava z zaporedji v bazi GenBank pa je pokazala najvišjo nukleotidno podobnost (82,4–82,5 %) z virusom klorotične lisavosti srobota (*Clematis chlorotic mottle virus* oz. ClCMV oz. *Pelarspovirus clematis*). Drugega virusa ali viroida v vzorcu nismo zaznali. Glede na dobljeno zaporedje smo dizajnirali nove začetne oligonukleotide, s katerimi smo z metodo RT-PCR virus uspešno potrdili v istem vzorcu. Za nadaljnjo raziskavo razširjenosti virusa na drenu smo v letih 2024 in 2025 izvedli vzorčenje drenov v Ljubljani in njeni okolici. Vzorce smo analizirali z RT-PCR in dobljene PCR produkte sekvencirali (Macrogen Europe BV, Nizozemska). V vseh 12 simptomatičnih vzorcih smo okužbo z virusom potrdili. Poleg tega smo testirali tudi 11 nesimptomatičnih vzorcev drena iz nasada v okolici Ljubljane, kjer so bili vsi rezultati negativni. Nukleotidna zaporedja do sedaj analiziranih slovenskih izolatov so si med seboj podobna najmanj 89,4 %, kar kaže na genetsko raznolikost tega virusa znotraj majhnega geografskega območja. Naše odkritje predstavlja prvo potrditev prisotnosti ClCMV v Sloveniji in prvi znani primer okužbe gostitelja, ki ne pripada rodu *Clematis*. Poleg tega gre tudi za prvo zabeleženo prisotnost tega virusa v Evropski uniji. Nadaljnje raziskave bodo usmerjene v ugotavljanje njegove razširjenosti ter pomena za gojene in samonikle rastline v Sloveniji.

ABSTRACT

First detection of *Clematis chlorotic mottle virus* (ClCMV) in Slovenia

In 2009, chlorotic line patterns and ringspots were observed on leaves of *Cornus* sp. in Ljubljana. Samples were tested by DAS-ELISA for thirteen viruses (ArMV, TRSV, ToRSV, TBRV, CLRV, SLRSV, RRSV, ApMV, RBDV, TSWV, INSV, CMV, and AMV). The results were negative, so we decided to analyze the samples using high-throughput sequencing (HTS). Symptomatic leaves from the same plant were re-sampled in 2020. Total RNA was extracted using the MagMAX-96 Total RNA Isolation Kit (Thermo Fisher Scientific) and after rRNA depletion and cDNA library preparation, analysed on the Illumina platform (Macrogen Europe BV, the Netherlands). Using bioinformatic tools, a near-complete viral genome was assembled. Comparison with sequences in the GenBank database showed the highest nucleotide identity (82.4–82.5%) with Clematis chlorotic mottle virus (ClCMV, *Pelarspovirus clematis*). No other viruses or viroids were detected. Based on the obtained sequence, new detection primers were designed, and the virus was successfully confirmed in the same sample by RT-PCR. To further investigate the distribution of the virus in dogwood, sampling of dogwood plants was carried out in Ljubljana and its surroundings in 2024 and 2025. The samples were analyzed by RT-PCR, and the resulting PCR products were sequenced (Macrogen Europe BV, the Netherlands). All 12 symptomatic samples tested were positive for ClCMV. In addition, 11 non-symptomatic dogwood samples from a plantation near Ljubljana were also tested and they were all negative. The nucleotide sequences of the Slovenian isolates share at least 89.4% nucleotide sequence identity, which indicates a considerable genetic diversity of this virus in a small geographical area. Our discovery represents the first finding of ClCMV in Slovenia and the first known finding in a non-Clematis host. It is also the first recorded occurrence of this virus in the European Union. Further studies will focus on determining its distribution and relevance for cultivated and wild plants in Slovenia.

Optimizacija in učinkovitost strategij uničenja krompirjeve cime v pridelavi semenskega krompirja

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Uničenje krompirjeve cime je eden pomembnejših tehnoloških postopkov v pridelavi krompirja. Še posebej to velja za semenski krompir, kjer predstavlja ključen ukrep za omejevanje prenosa virusnih in glivičnih bolezni ter za zagotavljanje ustrezne velikosti in zrelosti gomoljev. Z uvedbo prepovedi aktivne snovi dikvat je v Sloveniji nabor kemičnih sredstev za sušenje krompirjeve cime zelo omejen. Namen te raziskave je bil zato preizkusiti širši nabor strategij, ki vključujejo znižane odmerke herbicidov in uporabo mehanskih postopkov. V letu 2025 je bil na Spodnjem Brniku zasnovan poljski poskus v semenskem krompirju sorte Sora kot naključni bločni poskus z desetimi obravnavanji in štirimi ponovitvami. V poskusu smo uporabili aktivne snovi piraflufen-etil, karfentrazon-etil in pelargonsko kislino ter metilirano olje oljne ogrščice kot močilo. Herbicide smo aplicirali v začetku avgusta, en dan po mulčenju s specialnim mulčerjem za krompir. Preizkušeni postopki so vključevali uporabo polnih in polovičnih odmerkov, deljeno aplikacijo ter uporabo karfentrazon-etila samo v 25 cm široki vrsti grebena. Vizualna ocenjevanja smo opravili 14 in 25 dni po škropljenju. V prvem terminu ocenjevanja smo pri obravnavanjih s pelargonsko kislino ugotovili zelo nizko učinkovitost (45 %). Učinkovitost karfentrazon-etila 14 dni po škropljenju se je gibala med 91 in 97 % in je bila značilno večja kot pri piraflufen-etilu (76–82 %). Vpliva močila pri teh dveh sredstvih nismo ugotovili, medtem ko so bile deljene aplikacije in uporaba karfentrazon-etila v vrsti pri polnih odmerkih primerljive z njegovo uporabo po celi površini. Z uporabo polovičnih odmerkov so se učinkovitosti do drugega termina ocenjevanja značilno znižale, razen pri uporabi deljenih odmerkov. Naši podatki kažejo, da je kombinacija mulčenja in uporabe karfentrazon-etila učinkovita strategija za preprečevanje ponovne rasti cime. Porabo karfentrazon-etila je pri tem pristopu mogoče zmanjšati z uporabo v vrsti ali z deljeno uporabo polovičnih odmerkov tega sredstva.

ABSTRACT

Optimisation and performance of potato haulm destruction strategies in seed potato production

Potato haulm destruction is one of the most important technological operations in potato production. This is particularly true for seed potato production, where it represents a key measure for limiting the transmission of viral and fungal diseases and for ensuring appropriate tuber size and physiological maturity. Following the ban of the active substance diquat, the range of chemical products available for potato haulm desiccation in Slovenia has become very limited. The objective of this study was therefore to evaluate a broader range of strategies, including reduced herbicide application rates and the integration of mechanical methods. In 2025, a field experiment was established in Slovenia, at Spodnji Brnik in seed potatoes of the cultivar Sora as a randomized complete block design with ten treatments and four replications. The tested active ingredients were pyraflufen-ethyl, carfentrazone-ethyl, and pelargonic acid, with methylated rapeseed oil used as an adjuvant. Herbicides were applied in early August, one day after mechanical

haulm mulching using a specialized potato flail mower. The evaluated treatments included full and reduced application rates, split applications, and banded application of carfentrazone-ethyl confined to a 25 cm ridge row.Visual assessments were conducted 14 and 25 days after spraying. At the first assessment, treatments with pelargonic acid showed very low efficacy (45%). The efficacy of carfentrazone-ethyl 14 days after application ranged from 91 to 97% and was significantly higher than that of pyraflufen-ethyl (76–82%). No significant adjuvant effect was observed for either of these two products, whereas split applications and banded application of carfentrazone-ethyl at full rates were comparable to broadcast application. When reduced rates were applied, efficacy declined significantly by the second assessment, except in the case of split applications. Our results indicate that the combination of mechanical mulching and carfentrazone-ethyl application is an effective strategy for preventing haulm regrowth. Moreover, the overall use of carfentrazone-ethyl can be reduced by adopting banded applications or split applications at reduced rates.

Varstvo vrtnin

Inertni prahovi kot alternativna sredstva za varstvo zelja pred pisano stenico (*Eurydema ventralis*) in nekaterimi drugimi škodljivci: rezultati laboratorijskih in poljskih poskusov

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Pisana stenica (*Eurydema ventralis* Kolenati) v zadnjih letih povzroča vse več gospodarske škode v pridelavi zelja in drugih križnic (Brassicaceae), hkrati pa narašča potreba po zmanjšanju rabe kemičnih fitofarmacevtskih sredstev. Prispevek predstavlja rezultate laboratorijskih in poljskih raziskav, v katerih smo ovrednotili učinkovitost lokalno pridobljenih inertnih in rastlinskih prahov kot alternativnih oziroma dopolnilnih sredstev v varstvu rastlin. V laboratorijskem poskusu smo preučevali vpliv petih prahov (diatomejska zemlja, zeolit, kremenčev pesek, lesni pepel navadne smreke in prah listov velikega pajesena (*Ailanthus altissima*)) na smrtnost in prehranjevalno aktivnost odraslih osebkov in nimf pisane stenice. Diatomejska zemlja je dosegla najvišjo učinkovitost, saj je povzročila 78,3 % smrtnost odraslih osebkov in 55,2 % smrtnost nimf ter zmanjšala indeks poškodb listov na 3,5. Zeolit in lesni pepel sta izkazala zmerno učinkovitost, medtem ko je prah listov *A. altissima* povzročil nizko smrtnost (≤14,5 %), vendar izrazito zmanjšal prehranjevalno aktivnost, kar kaže na antifeedantni oziroma odvračalni učinek. Poljski poskusi v dveh rastnih sezonah so pokazali, da je bila učinkovitost inertnih prahov v naravnih razmerah nižja kot v laboratorijskih pogojih, predvsem zaradi vpliva padavin in povečane zračne vlage. V sušnih razmerah so bili inertni prahovi učinkovitejši kot v razmerah z večjo količino dežja. Učinkovitost smo spremljali tudi proti drugim pomembnim škodljivcem zelja, vključno z bolhači (*Phyllotreta* spp.), gosenicami metuljev, resarji ter s pisanimi stenicami (*Eurydema* spp.). V sušni sezoni sta diatomejska zemlja in lesni pepel zmanjšala indeks poškodb pisane stenice na 1,5–1,7 ter povečala neto pridelek zelja do 1055 g na glavo, medtem ko se je v deževni sezoni učinkovitost vseh inertnih prahov izrazito zmanjšala. Rezultati potrjujejo, da imajo inertni prahovi, zlasti diatomejska zemlja, pomemben potencial za vključitev v integrirano varstvo zelja, pri čemer je njihova uspešna uporaba močno odvisna od vremenskih razmer.

ABSTRACT

Inert dusts as alternative control agents in cabbage and Brassica pest management: laboratory and field results against the cabbage stink bug and other pests

The cabbage stink bug (*Eurydema ventralis* Kolenati) has recently caused increasing economic damage in cabbage and other Brassica crops (Brassicaceae), while the need to reduce the use of chemical plant protection products is growing. This contribution presents the results of laboratory and field studies evaluating the efficacy of locally sourced inert and plant-derived dusts as an alternative or a complementary pest management measure. Under laboratory conditions, five dusts (diatomaceous earth, zeolite, quartz sand, wood ash of Norway spruce, and leaf dust of tree of heaven (*Ailanthus altissima*)) were evaluated for their effects on mortality and feeding activity of adult and nymphal stages of the cabbage stink bug. Diatomaceous earth showed the highest efficacy, causing 78.3% mortality in adults and 55.2% in nymphs and reducing the feeding damage index to 3.5. Zeolite and wood ash exhibited moderate efficacy, whereas *A. altissima* leaf dust caused low mortality (≤14.5%) but significantly reduced feeding

activity, indicating a deterrent or antifeedant effect. Field trials conducted over two growing seasons demonstrated that the efficacy of inert dusts under natural conditions was lower than under laboratory conditions, primarily due to the effects of rainfall and increased air humidity. Under dry conditions, inert dusts were more effective than during periods with frequent precipitation. Their efficacy was also assessed against other major cabbage pests, including, flea beetles (*Phyllotreta* spp.), lepidopteran larvae, thrips and of course cabbage stink bugs (*Eurydema* spp.). In the dry season, diatomaceous earth and wood ash reduced cabbage stink bug damage indices to 1.5–1.7 and increased net cabbage yield up to 1055 g per head, whereas the efficacy of all inert dusts was reduced during the rainy season. Overall, the results indicate that inert dusts, particularly diatomaceous earth, have considerable potential for integration into Integrated Pest Management programs for cabbage, with successful application being strongly dependent on weather conditions.

Okolju prijazne metode za obvladovanje črne žilavke kapusnic

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Črna žilavka kapusnic, ki jo povzroča bakterija *Xanthomonas campestris* pv. *campestris* (Xcc), velja za eno najpomembnejših bolezni pri pridelavi kapusnic. Bakterija povzroča največ težav v pridelavi zelja, zlasti pri občutljivih sortah, kot sta Varaždinsko in Ljubljansko. Kljub temu se bolezen pojavlja tudi pri številnih drugih vrstah kapusnic. V Sloveniji je bolezen prisotna že dalj časa, a so se težave v zadnjih izrazito povečale, predvsem zaradi pogostih visokih temperatur in močnih deževij v poletnem času. Glavni vir okužbe je okuženo seme. Bakterija Xcc ni na seznamu nadzorovanih nekarantenskih škodljivih organizmov (NNŠO), zato se semen ne testira na prisotnost patogena. Bolezenska znamenja na sadikah pogosto niso izražena, a patogen je lahko vseeno prisoten kot epifit in se v fazi vzgoje sadik učinkovito razširja na sosednje rastline. Na polju se prvi znaki bolezni pojavijo na robovih listov, nato pa se ob ugodnih razmerah hitro širijo proti centralnemu prevodnemu sistemu rastline. Kljub uporabi različnih preventivnih ukrepov so pridelovalci še vedno močno odvisni od vremenskih razmer posameznega pridelovalnega leta. Pridelavo dodatno otežuje pomanjkanje učinkovitih zaščitnih sredstev, saj za zatiranje te bolezni na kapusnicah ni registriranega nobenega fitofarmacevtskega sredstva. V okviru strokovne naloge iz Integriranega varstva rastlin smo naslovili to težavo in izvedli številne poskuse, kjer smo preverjali učinkovitost različnih alternativnih sredstev. Uporabili smo različna sredstva; večina je temeljila na delovanju mikroorganizmov ali drugih organskih snovi, nekatera pa so bila kemičnega izvora. Vsa testirana sredstva so bila primerna za okolju prijazen pristop k varstvu rastlin, uporabljena pa so bila v različnih fazah razvoja rastline. Rezultati kažejo, da je mogoče v vseh fazah rasti uporabiti določeno sredstvo, ki lahko prispeva k boljši zaščiti rastlin v primerjavi z rastlinami, pri katerih tretiranja nismo izvedli.

ABSTRACT

Environmentally friendly methods for controlling black rot of brassicas

Black rot of brassicas, caused by the bacterium *Xanthomonas campestris* pv. *campestris* (Xcc), is considered one of the most important diseases in brassica production. The most severe damage is typically observed in cabbage, particularly in susceptible cultivars such as Varaždinsko and Ljubljansko. However, the disease also occurs in many other brassica species. Even though the pathogen has been present in Slovenia for many years, the incidence and severity of black rot have increased in recent seasons. This is primarily due to more frequent summer heatwaves and intense rainfall. The main source of infection is contaminated seed. Since Xcc is not listed as a regulated non-quarantine pest (RNQP), seed lots are not routinely tested for the presence of the pathogen. Infection is often latent, with the pathogen present epiphytically and capable of spreading efficiently to neighbouring plants during the propagation phase. In the field, the first symptoms appear along the leaf margins, and, under favourable conditions, rapidly spread towards the central vascular system of the plant. Despite the use of various preventive measures, growers remain highly dependent on weather conditions throughout the growing season. The situation is further aggravated by the lack of effective control agents, as no plant protection products are currently registered for the control of this disease in brassica crops. As a part of Integrated pest management assignments, we addressed this issue by conducting a series of trials to evaluate the effectiveness of various alternative control agents. A range of products was tested, most based on microorganisms or other organic compounds, while some were of chemical origin. All selected treatments were compatible with environmentally friendly crop protection strategies and were applied at different growth stages. The results indicate that suitable treatments can be applied throughout all growth stages and may contribute to improve plant protection compared to untreated controls.

Determinacija glivičnih patogenov pri pridelavi paradižnika v zavarovanih prostorih

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Na Primorskem se paradižnik prideluje na prostem in v zavarovanih prostorih. V slednjih zaradi ozkega kolobarja in intenzivne proizvodnje, ki med drugim privede tudi do nizkih vrednosti organske snovi ter viškov hranil v tleh, redno spremljamo pojav glivičnih bolezni koreninskega sistema paradižnika. Bolezenska znamenja se pogosto pojavljajo že kmalu po presajanju rastlin, izrazitejša pa so v fenofazi razvoja plodov torej od BBCH701 dalje. Najznačilnejši simptomi bolezni so venenje poganjkov in rumenenje listov. Opisanim bolezenskim znamenjem sledijo še nekroze tkiv, kar povzroča odmiranje rastlinskih organov ali propadanje celotnih rastlin. Glede na podatke pridobljene iz različnih virov škodo na gojenih rastlinah povzročajo predvsem glivične bolezni, ki jih povzročajo vrste *Verticillium dahliae*, *Fusarium* sp. in *Phytophthora* sp. Da bi ugotovili oz. potrdili prisotnost prej imenovanih vrst gliv smo v pridelovalni sezoni 2025 v zavarovanem prostoru na območju Slovenske Istre opravili podrobne morfološke in molekularne analize povzročiteljev bolezni na paradižniku. Vzorčenje je bilo izvedeno na simptomatičnih rastlinah indeterminantnih hibridov paradižnika Grifone F1 in Aurea F1. Poleg patogenih gliv so bile najdene tudi vrste, ki so v literaturi opisane kot antagonistični organizmi. V prispevku je podrobno predstavljen nabor najdenih vrst gliv.

ABSTRACT

Determination of fungal pathogens in tomato indoor production

In Primorska region (Western part of Slovenia) tomatoes are grown outdoors and in greenhouses as well. Indoor tomato production is intensive, avoids crop rotation and uses low organic matter but increased fertilization. As a consequence of fungal diseases of the tomato root system are regularly observed. Symptoms of the plant diseases often appear soon after transplanting, and they are more pronounced in the phenological growth stage of fruit development, i.e. at stage BBCH701 and onwards. The most characteristic symptoms of the disease are wilting of shoots and yellowing of leaves. The described symptoms are followed by tissue necrosis, which causes partial or complete plant collapse or gradual decline. According to data obtained from various sources the damage to cultivated tomato is attributed primarily to fungal diseases caused by *Verticillium dahliae*, *Fusarium* sp. and *Phytophthora* sp. In order to confirm the presence of these pathogens, detailed morphological and molecular analyses were carried out in a covered production facility in the Slovene Istria region in 2025. Sampling was conducted on symptomatic tomato hybrids Grifone F1 and Aurea F1. In addition to pathogenic fungi, also potentially antagonistic fungal species were also identified. The manuscript presents the list of encountered fungal species.

Ali lahko ogorčica *Phasmarhabditis papillosa* ustavi pohod španskega lazarja (*Arion vulgaris*) po Sloveniji?

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Polži predstavljajo pomembne škodljivce v kmetijstvu, zato so učinkovite alternative kemičnim limacidom ključne, zlasti zaradi omejene uporabe nekaterih aktivnih snovi v ekološki pridelavi. V Sloveniji smo v zadnjih letih odkrili tri nove vrste parazitskih ogorčic polžev, med njimi *Phasmarhabditis papillosa*, katere potencial v biotičnem varstvu še ni bil raziskan. V polterenskih poskusih smo preučili učinkovitost *P. papillosa* pri zatiranju španskega lazarja (*Arion vulgaris*) in mrežastega slinarja (*Deroceras reticulatum*) pri dveh koncentracijah (100.000 in 250.000 IL/m^2). Ugotovili smo zmerno smrtnost pri *A. vulgaris* (do ~55 %) ter nižjo pri *D. reticulatum* (10–15 %), medtem ko je metaldehid ostal najuspešnejša primerjava. Kljub nižji smrtnosti je uporaba ogorčic zmanjšala škodo na solati v primerjavi s kontrolo. Rezultati kažejo, da ima *P. papillosa* potencial kot naravni antagonist polžev, zlasti pri zmanjševanju škodljivega delovanja, vendar so za izboljšanje terenske učinkovitosti potrebne dodatne raziskave.

ABSTRACT

Can the nematode *Phasmarhabditis papillosa* stop the march of the Spanish slug (*Arion vulgaris*) across Slovenia?

Slugs represent important agricultural pests, making effective alternatives to chemical molluscicides essential, especially due to restrictions on certain active substances in organic farming. In recent years, three new species of slug parasitic nematodes have been identified in Slovenia, including *Phasmarhabditis papillosa*, whose potential for

biocontrol has not yet been investigated. In semi-field experiments, we evaluated the efficacy of *P. papillosa* against the Spanish slug (*Arion vulgaris*) and the grey field slug (*Deroceras reticulatum*) at two concentrations (100,000 and 250,000 IJ/m²). We observed moderate mortality in *A. vulgaris* (up to ~55%) and lower mortality in *D. reticulatum* (10–15%), while metaldehyde remained the most effective reference treatment. Despite lower mortality, the use of nematodes reduced lettuce damage compared to the control. The results indicate that *P. papillosa* has potential as a natural antagonist of pest slugs, particularly in reducing plant damage, although further research is needed to optimise application methods and improve field efficacy.

Ralstonia pseudosolanacearum **filotip I v Evropi: spregledane poti vnosa in zgodnje odkrivanje**

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Ralstonia pseudosolanacearum filotip I je rastlinska patogena bakterija s širokim krogom gostiteljskih rastlin, ki vključuje razhudnikovke, stročnice, začimbne in številne okrasne rastline. Kljub temu jo v Evropi pogosto še vedno dojemamo kot »eksotični patogen eksotičnih rastlin«, zaradi česar se nadzor osredotoča predvsem na tropski sadilni material in uvožene korenike. Vendar pa najdbe v zadnjem desetletju kažejo, da je takšno razumevanje nepopolno: bakterija je bila ugotovljena ne le na uvoženem ingverju, temveč tudi na okrasnih rastlinah ter v površinskih vodah na Nizozemskem in Madžarskem. Obstojnost bakterije v okolju, širok nabor gostiteljev in podnebna primernost velikega dela Evrope, vključno s Slovenijo, kažejo, da je tveganje širše, kot ga v skladu z zakonodajo trenutno naslavlja rutinski nadzor. Slovenija je leta 2023 zabeležila najdbo na ingverju, ki je v postopku izkoreninjenja brez dokazov širjenja. Celogenomsko sekvenciranje je izolirano bakterijo uvrstilo v ingverjev klad, enega od treh trenutno prepoznanih evropskih kladov (ingver, okrasne rastline, razhudnikovke), ki odražajo več neodvisnih vnosov in raznolike trgovinske poti. Diagnostika vrste je zahtevna zaradi njene izrazite raznolikosti. Morfologija kolonij na selektivnih gojiščih je lahko spremenljiva, starejši molekularni testi pa pri nekaterih izolatih delujejo manj optimalno. Ingver in kurkuma vsebujeta veliko inhibitorjev pomnoževanja, zato je klasični PCR pogosto zanesljivejši od PCR v realnem času. Ker se vnosi v Evropo pojavljajo, je največji izziv prepoznati zgodnje in latentne okužbe pri gostiteljskih rastlinah, ki s to bakterijo še niso povezani, a bi lahko predstavljali prve rastline za ustalitev bakterije. Zaradi potrjene sposobnosti preživetja v vodi je pomembno tudi spremljanje vodotokov. Dodatno tveganje predstavlja procesiranje vse večjega obsega uvoženega ingverja in kurkume za pridelavo in prehrano. Odpadni material iz takšne obdelave ter gospodinjski odpadki lahko vstopijo v kompost, biološke odpadke ali kanalizacijo brez toplotne obdelave. Ker bakterija lahko preživi v vodi in okolju, te poti predstavljajo verjetne, a premalo raziskane poti nenamernega vnosa.

ABSTRACT

Ralstonia pseudosolanacearum **Phylotype I in Europe: overlooked entry pathways and early detection**

Ralstonia pseudosolanacearum Phylotype I is a plant pathogen with a broad host range, including solanaceous crops and legumes. Nonetheless, it is often still viewed in Europe as an "exotic pathogen on exotic hosts", and surveillance has therefore focused mainly on tropical planting material and imported rhizomes. However, detections over the past decade show that this perspective is incomplete: the pathogen has been found not only on imported ginger but also in ornamental plants and in surface water in the Netherlands and Hungary. Its environmental persistence, wide host range and climatic suitability across much of Europe, including Slovenia, indicate that the true risk extends beyond current routine surveillance. Slovenia recorded a single finding on ginger in 2023, which is under eradication with no evidence of spread. Whole-genome sequencing placed the isolate within the ginger-associated clade, one of three phylogenetic clusters currently recognised in Europe (ginger, ornamentals, solanaceous hosts), reflecting independent introductions and diverse trade pathways. Diagnosis is challenging due to substantial intraspecies diversity. Colony morphology on semi-selective media can vary, and some legacy molecular assays show reduced performance with certain isolates. Ginger and turmeric frequently contain strong PCR inhibitors, with conventional PCR more reliable than real-time PCR. Because introductions appear to occur sporadically, the main difficulty lies in detecting early and latent infections across a wide range of hosts not routinely associated with the pathogen under existing surveillance frameworks. Monitoring of watercourses is also relevant, given the bacterium's ability to survive in water. A further consideration is the increasing volume of ginger and turmeric imported for consumption and processed. Waste from such processing, together with household peelings, may enter compost, biowaste or sewage without heat treatment, representing plausible but still underexplored pathways for unintentional release.

Obvladovanje tulipanove pršice (*Aceria tulipae* Keifer) na česnu (*Allium sativum*) s pripravki na podlagi žvepla

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Tulipanova pršica je polifag, ki je lahko prisoten na vseh rastlinskih vrstah iz rodu *Allium*. V naših pridelovalnih razmerah največ škode povzroča na česnu (*Allium sativum*) v času med skladiščenjem. Fitofag spada v družino pršic šiškaric (Eriophydae) in je razširjen v Evropi kot v drugih delih sveta. Organizem parazitira različne vrste čebulnic med njimi tudi nekatere okrasne čebulnice. Za škodo so bolj dovzetne bele sorte česna kot je 'Gardos'. Zaradi hranjenja odraslih pršic in nimf prvega in drugega stadija prihaja do poškodb na povrhnjici strokov. Poškodbe se kažejo kot rumenenje oziroma rjavenje strokov česna. Pri hranjenju nastanejo rane, ki lahko služijo kot vstopna mesta za nekatere patogene glive in bakterije, kar lahko še dodatno zmanjša kakovost pridelka. Pri pregledu semenskega materiala občasno opažamo, da so pršice prisotne že na samih strokih. Z namenom, da ugotovimo učinkovitost uporabe pripravkov na osnovi žvepla pri zatiranju pršice, smo izvedli škropilni poskus z več obravnavanji. Učinkovitost tretiranj smo ugotavljali s pregledom strokov česna po kratkotrajnem skladiščenju. V prispevku so podrobno predstavljeni rezultati omejevanja škode pridobljeni v sezoni 2024.

ABSTRACT

Control of tulip mite (*Aceria tulipae* Keifer) on garlic (*Allium sativum*) with sulphur-based products

The tulip mite is a polyphagous species that can be present on all plant species of the genus *Allium*. In our growing conditions, it causes the main damage to garlic (*Allium sativum*) during storage. This phytophagous mite belongs to the family of eriophyd mites and is widespread in Europe as well as in other parts of the world. The organism feeds on various species of bulbous plants, including some ornamental bulbs. White garlic varieties such as 'Gardos' are more susceptible to damage. Feeding by adult mites and nymphs causes damage to the skin of the cloves. The damage is manifested as yellowing or browning of the garlic cloves. Feeding causes wounds that can serve as entry points for certain pathogenic fungi and bacteria, which can further reduce crop quality. When inspecting seed material, we occasionally notice that mites are already present on the cloves themselves. In order to determine the effectiveness of sulphur-based products in controlling mites, we conducted a spraying experiment with several treatments. The effectiveness of the treatments was determined by examining the garlic cloves after storage for a short period of time. The manuscript presents the results of pest control treatments in the season 2024.

Control of root-knot nematodes (*Meloidogyne incognita*) with eco product Benkal (plus)

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Root-knot nematodes *Meloidogyne* spp. are one of the most economically significant plant-parasitic nematodes in the world and a highly damaging pest. *Meloidogyne incognita* stands out among the most harmful and widespread polyphagous endoparasites that cause serious damage to plants. It is control is very demanding andcombination of various methods nematicides, biocontrol agents, botanicals essential oils, resistant cultivars and physical measures are applied. Nematicides are restricted by ban in many parts of the world because of environmental hazards and toxicity to humans and other organisms. That's why many researches are focus on finding alternative solutions. In our research, we wanted to verify the effectiveness of the Benkal (plus) product and examine its mechanism of action against *M. incognita*. The study of efectivnes of the product had three parts. In the first part, we examined the emergence of nematodes from *Meloidogyne incognita* egg clutches treated with the product. We tested 2 different types of products and a negative control. Here we already recognized a significant effect of these preparations. In the second part, we examined the penetration of nematodes into host plant tomato roots. It turned out that there was initially a delay in root-boring in the control plants compared to the treated plants. In the third part, we examined the multiplication of the nematodes in host plants in treated on nontreated growing substrate. The results revealed a significant effect of Benkal on the abundance of nematodes and on the plants themselves.

IZVLEČEK

Zatiranje ogorčic koreninskih šišk (*Meloidogyne incognita*) z eko izdelkom Benkal (plus)

Ogorčice koreninskih šišk *Meloidogyne* spp. so ene gospodarsko najpomembnejših rastlinskih parazitskih ogorčic na svetu in zelo škodljiv škodljivec. *Meloidogyne incognita* izstopa med najškodljivejšimi in najbolj razširjenimi polifagnimi endoparaziti, ki povzročajo resno škodo rastlinam. Njihovo zatiranje je zelo zahtevno in uporabljajo se kombinacije različnih metod: nematicidi, biološki kontrolni agensi, rastlinski izvlečki, eterična olja, odporne sorte in fizikalni ukrepi. Uporaba nematicidov je v mnogih delih sveta omejena zaradi nevarnosti za okolje in toksičnosti za ljudi in druge organizme. Zato se številne raziskave osredotočajo na iskanje alternativnih rešitev. V naši raziskavi smo želeli preveriti učinkovitost izdelka Benkal (plus) in preučiti njegov mehanizem delovanja proti M. incognita. Študija učinkovitosti izdelka je imela tri dele. V prvem delu smo preučevali pojav ogorčic iz jajčnih mas *Meloidogyne incognita*, obdelanih z izdelkom. Testirali smo 2 različni vrsti izdelkov in negativno kontrolo. Že tukaj smo prepoznali pomemben učinek teh pripravkov. V drugem delu smo preučevali vstop ogorčic v korenine gostiteljske rastline paradižnika. Izkazalo se je, da je sprva prišlo do zamude pri vrtanju v korenine pri kontrolnih rastlinah v primerjavi z obdelanimi rastlinami. V tretjem delu smo preučevali razmnoževanje ogorčic v gostiteljskih rastlinah v obdelanem in neobdelanem gojitvenem substratu. Rezultati so pokazali učinek Benkala na številčnost ogorčic in na same rastline.

Testiranje biostimulantov v pridelavi čebule; količina in kakovost pridelka v letu 2025

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Čebula zahteva intenzivno varstvo pred boleznimi in škodljivci. Posledično se pri pridelavi čebule uporablja veliko fitofarmacevtskih sredstev. Uporaba biostimulantov pri pridelavi čebule v Sloveniji je na srednje intenzivni ravni, pridelovalci pa največkrat nimajo dovolj znanja o uporabi le-teh. V poskusu smo želeli primerjati vpliv nekaterih biostimulantov na pridelek čebule in njihovo delovanje oz. učinek ob sočasni uporabi izbranih fitofarmacevtskih sredstev. Raziskava je bila izvedena na sorti čebule „Ptujski lük“. Testirali smo hipotezo, da lahko zaradi uporabe biostimulantov zmanjšamo količino apliciranih fitofarmacevtskih sredstev. Primerjali smo 7 različnih programov škropljenja. Preučili smo efektivnost biostimulantov na količino in kvaliteto pridelka čebule na pojavnost glivičnih bolezni. Stopnjo bolezni smo analizirali večkrat, po obiranju smo čebulo shranili. Naša študija kaže, da uporaba pripravka Amalgerol (šestkrat, pri odmerku 2 L/ha) pomembno poveča pridelek čebule. Glede na učinkovitost povečanja pridelka delujeta oba preizkusna pripravka (A. essence in A. PB) podobno, ko ju vključimo v škropilni program. Nekatere razlike med pripravki so bile opažene pri dodajanju Amalgerola, hkrati z mikrobiološkimi pripravki, ob 40 % zmanjšanju količine fungicidov. V primeru dodajanja A. essence v program fitofarmacevtskih sredstev z zmanjšanim odmerkom smo dosegli enako raven zatiranja bolezni kot pri tretmaju s polnim odmerkom fitofarmacevtskih sredstev. V primeru dodajanja A. PB v program z zmanjšanim odmerkom fitofarmacevtskih sredstev smo opazili zmanjšan nadzor bolezni, kar je vodilo do nižjega pridelka. Naša raziskava kaže, da lahko pogosta uporaba pripravkov Amalgerol

(v kombinaciji z mikrobiotičnimi pripravki) omogoči zmanjšanje intenzivnosti uporabe nekaterih FFS v čebuli. Menimo, da lahko Amalgerol služi kot podporni vir hrane za mikroorganizme, ki se uporabljajo kot biotični fungicidi za preprečevanje bolezni pri biotičnem varstvu.

ABSTRACT

Testing biostimulants in onion production: results on yield and quality in 2025

Onion is a vegetable that requires intensive protection against diseases and pests. For this reason, a lot of pesticides are used in onion production. The use of biostimulants in onion production in Slovenia is at a medium-intensity level, and growers often lack knowledge about their use. In the experiment, we aimed to compare the effect of various biostimulants on onion yield and their interactive effect with pesticides. The experiment was carried out on the onion variety “Ptujski lük”. We tested the hypothesis that, due to the use of biostimulants, we can reduce the amount of pesticides applied to control diseases and pests. We compared seven different spraying programs. We tested the effect of biostimulants on onion yield formation and on the control of fungal diseases. We analysed the disease rate in the field several times, and after harvest, the onions were stored. Our study shows that the application of Amalgerol preparations six times at a dose of 2 L/ha significantly increases the yield of onions. In terms of yield increase, both tested preparations (A. essence and A. PB) are equal when added to the complete pesticide program. Some differences were noticed between preparations when adding Amalgerol and microbial preparations to a 40% reduced pesticide spray program. In the case of adding A. essence to the reduced-dose pesticide program, we achieved the same level of disease control as in the V1 full pesticide dose treatment. In the case of adding A. PB to the pesticide-reduced dose program, we observed reduced disease control, which resulted in a lower yield. We believe that the frequent application of Amalgerol products in conjunction with microbial products can lead to a specific reduction in the intensity of pesticide application. We think that Amalgerol can serve as a supporting food source for microbes applied as fungicides for biological control.

Zatiranje čebulne plesni (*Peronospora destructor*) na čebuli

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Čebulna plesen (*Peronospora destructor*) predstavlja eno najpomembnejših bolezni čebule *(Allium cepa* L.), zlasti v letih z nadpovprečnimi padavinami in daljšimi obdobji visoke zračne vlage. Namen poskusa je bil ovrednotiti učinkovitost različnih škropilnih programov za zatiranje čebulne plesni v ekološki in integrirani pridelavi ter preveriti vpliv dodatka močila na učinkovitost varstva v razmerah povečanega infekcijskega pritiska. Poljski poskus je bil izveden v letih 2024 in 2025 na območju Ptuja po bločni zasnovi s štirimi ponovitvami in neškropljeno kontrolo, pri sorti Ptujska rdeča. V letu 2024 je poskus vključeval šest obravnavanj, v letu 2025 pa pet obravnavanj. V letu 2024 smo preučevali učinkovitost različnih močil, v letu 2025 pa smo se zaradi izrazitega pojava bolezni

osredotočili na primerjavo fungicidov, dovoljenih v Sloveniji, in izbranih pripravkov, dovoljenih tudi v sosednjih državah, z in brez dodatka močila, ki se je v prejšnjem letu izkazalo kot najučinkovitejše. Okuženost rastlin je bila ocenjevana v več terminih med rastno dobo z vizualno oceno deleža okuženih listov oziroma okužene listne površine. Zaradi zelo ugodnih vremenskih razmer za razvoj bolezni v letu 2025 je prišlo do zgodnje primarne okužbe in hitrega širjenja čebulne plesni v vseh obravnavanjih. V letu 2025 smo spremljali tudi vpliv obravnavanj na skladiščno sposobnost čebule.

ABSTRACT

Control of onion downy mildew (*Peronospora destructor*)

Downy mildew (*Peronospora destructor*) is one of the most important diseases affecting onions (*Allium cepa* L.), especially in years with above-average rainfall and prolonged periods of high air humidity. The aim of the experiment was to evaluate the effectiveness of different spraying programs for controlling onion downy mildew in organic and integrated production and to test the effect of wetting agent addition on the effectiveness of protection under conditions of increased infection pressure. The field trial was conducted in 2024 and 2025 in the Ptuj area using a block design with four replicates and an unsprayed control, using the Ptujska rdeča variety. In 2024, the trial included six treatments, and in 2025, five treatments. In 2024, we studied the effectiveness of different fungicides, while in 2025, due to the pronounced occurrence of the disease, we focused on comparing fungicides authorised in Slovenia and selected preparations also authorised in neighbouring countries, with and without the addition of a wetting agent, which proved to be the most effective in the previous year. Plant infection was assessed at several times during the growing season by visually assessing the proportion of infected leaves or infected leaf area. Due to very favourable weather conditions for disease development in 2025, there was early primary infection and rapid spread of onion mold in all treatments. In 2025, we also monitored the effect of treatments on the storage capacity of onions.

Splošna sekcija

ACIES BIO – zanesljiv partner za razvoj in proizvodnjo bioloških pripravkov v kmetijstvu

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Kmetijstvo išče vedno nove načine okolju prijazne pridelave. Eden od stebrov za prehod na bolj trajnostno, sonaravno kmetijstvo so tudi mikroorganizmi in njihovi produkti. Glavni izziv, pri njihovi uveljavitvi je razpoložljivost dovolj učinkovitih in cenovno dostopnih biopesticidov in biostimulantov ter ponovljivo delovanje v različnih podnebnih razmerah. ACIES BIO je slovensko podjetje s sedežem v Tehnološkem parku Brdo, ki se s svojimi 19-letnimi izkušnjami in več kot 100 zaposlenimi raziskovalci in inženirji uveljavlja kot vodilni evropski partner za razvoj in proizvodnjo mikrobioloških preparatov za kmetijstvo. Dejavnosti podjetja obsegajo postopke od zgodnjih faz raziskav in razvoja do učinkovite industrijske proizvodnje s preverjeno kakovostjo. ACIES BIO razvija učinkovite platforme za izražanje proteinov, peptidov in mRNA ter obvladuje postopke za gojenje raznolikih mikroorganizmov in zmanjšanje stroškov proizvodnje. Poleg več kot 20 doktorjev znanosti ključne prednosti ACIES BIO obsegajo sodobno infrastrukturo in fermentacijske kapacitete v obsegu 35 m^3. Razvoj bioloških preparatov poteka v partnerstvu z drugimi podjetji ali raziskovalnimi ustanovami po strukturiranem pristopu – od zgodnjih raziskav in razvoja, kjer pripravimo manjše količine materiala za testiranje učinkovitost v kontroliranih pogojih. Temu sledi laboratorijski razvoj in optimizacija proizvodnih procesov, do industrijske validacije in komercialne proizvodnje. Podjetje zagotavlja visoko kakovost proizvedenih bioproduktov s strogo kontrolo kvalitete in rednimi izboljšavami na podlagi povratnih informacij.. Sodelujemo tudi v številnih konzorcijskih evropskih projektih kot so TOPCAPI, Whey2Value, BIOVEXO, SUSFERT in ProPlant.

ABSTRACT

ACIES BIO – a reliable partner for the development and production of biological preparations in agriculture

Agriculture is constantly seeking new ways to produce in an environmentally friendly manner. One of the pillars supporting the transition towards more sustainable, nature-friendly farming are microorganisms and their products. The main challenge for their wider adoption is the availability of sufficiently effective and affordable biopesticides and biostimulants, as well as consistent performance under diverse climatic conditions. ACIES BIO is a Slovenian company based in the Brdo Technology Park which, with its 19 years of experience and more than 100 employed researchers and engineers, is establishing itself as a leading European partner for the development and production of microbiological preparations for agriculture. The company's activities cover the entire process from early-stage research and development to efficient industrial production with proven quality. ACIES BIO develops efficient platforms for the expression of proteins, peptides and mRNA and has strong expertise in cultivating diverse microorganisms and reducing production costs. In addition to more than 20 PhD-level scientists, the key strengths of ACIES BIO include state-of-the-art infrastructure and fermentation capacities totalling 35 m^3. The development of biological preparations is carried out in partnership with other companies or research institutions through a structured approach – from early research and development, where smaller quantities of material are prepared for efficacy testing under controlled conditions, followed by laboratory-scale development and optimisation of

production processes, to industrial validation and commercial manufacturing. The company ensures high quality of the produced bioproducts through strict quality control and continuous improvements based on feedback from partners and customers. ACIES BIO also participates in numerous European consortia projects such as TOPCAPI, Whey2Value, BIOVEXO, SUSFERT and ProPlant.

Potencial melaninskih gliv v kmetijstvu: od stresne odpornosti do naprednih biostimulantnih formulacij

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Melanin, kompleksen fenolni ali indolni biopolimer, ki ga številne glive sintetizirajo po DHN, DOPA ali piomelanin poti, je eden ključnih zaščitnih mehanizmov mikroorganizmov pred okoljskimi stresorji. Glive z melaninsko celično steno izkazujejo izjemno odpornost na UV-sevanje, sušo, temperaturne ekstreme, oksidativni stres ter prisotnost težkih kovin, kar pomembno prispeva k njihovi ekološki uspešnosti v ekstremnih habitatih. Njegove strukturne in fizikalno-kemijske lastnosti, kot so multispektralna absorpcija svetlobe, radikalsko ujemanje, ionska izmenjava ter visoka stabilnost omogočajo uporabo melanina kot naravnega fotoprotektivnega in antioksidativnega biopolimera. V zadnjih letih narašča zanimanje za uporabo mikrobnega melanina v kmetijstvu, kjer pigment deluje kot večfunkcionalna komponenta za (i) izboljšanje rastlinske tolerance na abiotske strese, (ii) razvoj biotičnih sredstev ter (iii) pripravo naprednih biostimulantnih formulacij. Mikrobni melanin, pridobljen predvsem iz gliv rodov *Aureobasidium*, *Aspergillus*, *Cladosporium* in *Verticillium*, je industrijsko zanimiv zaradi stabilnosti, netoksičnosti in fotoprotektivnih lastnosti. V pridelavi rastlin se izkazuje kot sredstvo za zmanjšanje poškodb zaradi UV sevanja, omejevanje oksidativnega stresa, izboljšanje zadrževanja vode v rizosferi ter povečanje učinkovitosti mikrobnih inokulantov. Poleg bioloških funkcij melanin omogoča razvoj naprednih formulacij, kot so UV-odporni biofungicidi in bioinsekticidi, biomelaninom ojačane mikro- in nanoenkapsulacije ter fotoprotektivni polimerni premazi za bolj stabilno dostavo mikrobnih biostimulantov na list. Sodobne študije poudarjajo, da piomelanin in DHN-melanin izkazujeta specifične redoks lastnosti ter izjemno odpornost proti oksidaciji, zaradi česar sta posebej primerna za formulacijske tehnologije pri katerih je ključna dolgotrajna fotostabilnost bioaktivnih snovi. Prispevek pregleda najnovejša spoznanja o strukturi, biosintezi in ekologiji melaninskih gliv ter ocenjuje njihov tehnološki potencial za trajnostno kmetijstvo. Poseben poudarek je na vključevanju melanina v razvoj biostimulantov nove generacije, ki lahko povečajo odpornost rastlin, zmanjšajo potrebo po kemičnih fitofarmacevtskih sredstvih ter prispevajo k uresničevanju podnebnih ciljev sodobne rastlinske pridelave.

ABSTRACT

The potential of melanised fungi in agriculture: from stress resilience to advanced biostimulant formulations

Melanin, a complex phenolic or indolic biopolymer synthesised by numerous fungi via the DHN, DOPA, or pyomelanin pathways, is a key protective mechanism enabling microorganisms to withstand environmental stressors. Fungi with a melanised cell wall show remarkable resistance to UV radiation, drought, temperature extremes, oxidative stress, and heavy metals, all of which contribute substantially to their ecological success in extreme habitats. Its structural and physicochemical properties including multispectral light absorption, radical scavenging, ion-exchange capacity, and high stability enable the use of melanin as a natural photoprotective and antioxidative biopolymer. In recent years, interest in the agricultural use of microbial melanin has increased, as the pigment serves as a multifunctional component for (i) enhancing plant tolerance to abiotic stresses, (ii) supporting the development of biocontrol strategies, and (iii) designing advanced biostimulant formulations. Microbial melanin, produced mainly by fungal genera such as *Aureobasidium*, *Aspergillus*, *Cladosporium*, and *Verticillium*, is attractive for industrial applications due to its stability, non-toxicity, and photoprotective properties. In crop production, it shows potential for reducing UV-induced damage, limiting oxidative stress in leaf tissues, improving water retention in the rhizosphere, and enhancing the effectivness of microbial inoculants. Beyond its biological functions, melanin enables the development of advanced formulations such as UV-resistant biofungicides and bioinsecticides, biomelanin-enhanced micro- and nanoencapsulation systems, and photoprotective polymer coatings for more stable foliar delivery of microbial biostimulants. Recent studies highlight that pyomelanin and DHN-melanin exhibit distinct redox characteristics and exceptional resistance to oxidative degradation, making them particularly suitable for formulation technologies where long-term photostability of bioactive compounds is essential. This contribution reviews recent insights into the structure, biosynthesis, and ecology of melanised fungi and evaluates their technological potential for sustainable agriculture. Special emphasis is placed on integrating melanin into next-generation biostimulant formulations to enhance plant resilience, reduce reliance on chemical plant protection products, and support the climate objectives of modern crop production.

15 let avtomatskega spremljanja žuželk - glavni mejniki

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Kratek opis: Na predstavitvi bomo spoznali napredek tehnologije avtomatskega spremljanja žuželk od prvih začetkov vgrajene kamere v vabo za žuželke, do danes. Pri tem bomo izpostavili ključne mejnike, ki so bili pomembni za doseganje čim večje avtonomnosti vab za spremljanje. Predstavljeni bodo tudi ključni dosežki, ki so bili potrebni za boljše razumevanje populacijske dinamike in za pomembno izboljšanje napovednih modelov.

Varstvo vinske trte

Preverjanje učinkovitosti jesenskega tretiranja vinogradov z žveplom za zmanjšanje izbruhov erinoze

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Erinoza je pojav, ki jo na trti povzroča trsna listna pršica šiškarica *Colomerus vitis* (Pagenstecher). Ob napadu se na mladih listih v spomladanskem času razvijejo značilne deformacije, ki se gubajo na zgornjo stran lista. Na spodn
ji strani se v šiškah razvijejo številne dlačice, med katerimi se pršice zadržujejo in prehranjujejo tekom rastne dobe trte. Zaradi deformacije listne površine je lahko znižana fotosintetska aktivnost, kar pa izrazito ne vpliva na rast in razvoj trte. Kljub temu pa pršica predstavlja tveganje, saj je prenašalka virusa vinske trte Sivi pinot (GPGV), ki je v slovenskih vinogradih precej razširjen in lahko na nekaterih sortah povzroči večjo škodo v pridelavi. Za zatiranje fitofagnih pršic se v praksi najpogosteje uporabljajo pripravki na osnovi žvepla, ki delujejo ob neposrednem stiku s pršicami. Njihova učinkovitost je tako močno odvisna od časa uporabe, saj so pršice večino časa dobro zavarovane v šiškah, učinkovitost žveplenih pripravkov pa je odvisna od zunanje temperature ob aplikaciji. Tretiranje se zato priporoča v spomladanskem času, ko se pršice selijo iz prezimovališč (brsti) do mladih listov, kjer se prehranjujejo v nadaljevanju rastne dobe. Prav tako so pršice bolj izpostavljene jeseni, ko se iz šišk premikajo proti brstom, kjer prezimijo pod luskolisti. Na osnovi tega smo testirali tako spomladansko kot jesensko tretiranje z žveplenimi pripravki v vinogradih z izrazitim izbruhom erinoz v prejšnjih letih. Rezultati potrjujejo, da je tretiranje v vsakem od terminov bistveno znižalo pojav erinoze v primerjavi s kontrolo. Iz objavljene literature je razvidno, da so avtorji preučili tudi druge vidike zatiranja pršic na trti in nekaterih drugih gospodarsko pomembnih vrstah. Kot ključen dejavnik je ponovno izpostavljen primeren čas tretiranja in sicer, ko so pršice najbolj izpostavljene nanosu sredstva, torej v spomladanskem in jesenskem času, ko se premikajo po rastlini. V posameznih poskusih so bili poleg žveplenih testirani tudi nekateri drugi pripravki, pogosto pa je bila spremljana tudi številčnost populacije. Poleg učinkovitosti pri zatiranju fitofagnih pršic nekatere študije navajajo tudi vpliv uporabljenih pripravkov na koristne plenilske pršice, kar je pomembno upoštevati pri načrtovanju tretiranj.

ABSTRACT

Evaluation of autumn sulfur applications in vineyards for reducing erinose outbreaks

Erinose is a disorder of grapevine caused by the grape erineum mite *Colomerus vitis* (Pagenstecher). Following infestation, characteristic galls develop on young leaves in spring, forming blister-like swellings on the upper leaf surface. Within these galls, dense hairs develop on the lower side of the leaf, providing a sheltered environment in which mites reside and feed throughout the growing season. Although leaf surface deformation

may reduce photosynthetic activity, this typically has little impact on overall plant growth and development. However, mite represents a significant concern because it serves as a vector of Grapevine Pinot Gris virus (GPGV), which is widespread in Slovenian vineyards and can cause substantial yield losses in certain cultivars. In practice, sulfur-based products are most commonly used to control erineum mites, as they act primarily through direct contact. Their efficacy depends strongly on timing of application, since the mites are protected within the galls for most of the season, as well as on the temperature at the time of the treatment. For this reason, treatments are recommended in the spring, when mites migrate from overwintering sites in the buds to young leaves where they feed throughout the season. Mites are also more exposed in autumn, when they move back from galls toward the buds, where they overwinter beneath the bud scales. Based on this, we evaluated both spring and autumn sulfur treatments in vineyards that had experienced severe erinose outbreaks in previous years. The results showed that treatments applied at either timing significantly reduced the incidence of erinose compared with the untreated control. Published studies have also examined additional aspects of mite control on grapevine and other economically relevant crops. The timing of application is consistently highlighted as a key factor, with treatments proving most effective in spring and autumn, when mites are exposed during active movement across the plant. Apart from evaluating sulfur-based and other products for mite control, several studies also monitored mite population dynamics. Importantly, the effect of various treatments on beneficial predatory mites should not be overlooked and should be carefully considered when planning management strategies.

Fytosave, a low-risk PPP in the vinegrower's tool box : a versatile biosolution against powdery and downy mildew on grape

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The increasing demand for sustainable viticulture in Europe requires new solutions that reduce the dependence on conventional plant-protection products while safeguarding yield and grape quality. COS-OGA, the patented active substance in FytoSave®, represents an advanced biocontrol approach based on the activation of plant innate immunity. COS-OGA is a defined complex of chitosan oligomers (COS) and oligogalacturonides (OGA), two natural elicitors recognized by plant receptors. Their synergistic combination triggers early defense signaling at very low application doses, priming the plant for a faster and stronger response to pathogen attacks. In viticulture, FytoSave® has shown consistent performance against key foliar pathogens, particularly *Erysiphe necator* (powdery mildew) and *Plasmopara viticola* (downy mildew). Its mode of action is purely physiological: COS-OGA induces systemic acquired resistance (SAR), promotes the accumulation of PR-proteins and phytoalexins, and strengthens structural barriers, reducing pathogen penetration and sporulation. Multi-year field trials across several European wine-growing regions demonstrate that FytoSave® contributes to a measurable reduction in disease incidence and severity while preserving plant vigor and yield. When integrated into

standard protection programs, it helps reduce fungicide inputs and supports a more balanced disease-management strategy.

From a regulatory and environmental standpoint, COS-OGA offers additional advantages: absence of residues, an excellent ecotoxicological profile, and a minimal risk of resistance development. These characteristics make FytoSave® a suitable tool for integrated pest management (IPM) and for meeting increasingly strict sustainability requirements in European vineyards. This contribution will present an overview of COS-OGA's mode of action, recent field trial results, and practical recommendations for optimizing its use within IPM programs. The results highlight the relevance of elicitor-based technologies as reliable components of modern, sustainable plant protection in viticulture."

IZVLEČEK

FytoSave®, fitofarmacevtsko sredstvo z nizkim tveganjem za vinogradništvo: vsestranski okolju prijazen način zatiranja oidija in peronospore vinske trte

Naraščajoče povpraševanje po trajnostnem vinogradništvu v Evropi zahteva nove rešitve za zmanjšanje odvisnosti od konvencionalnih fitofarmacevtskih sredstev brez zmanjšanja pridelka in kakovost grozdja. COS-OGA, patentirana aktivna snov v FytoSave®, predstavlja napreden pristop biotičnega varstva, ki temelji na aktivaciji rastlinskega imunskega sistema. COS-OGA je definiran kompleks hitosanovih oligomerov (COS) in oligogalakturonidov (OGA), dveh naravnih spodbujevalcev obrambe rastlin (elicitorjev), ki jih prepoznajo rastlinski receptorji. Sinergističen učinek pri zelo nizkih odmerkih sproži zgodnje obrambno signaliziranje, kar rastlino pripravi na hitrejši in močnejši odziv na napade patogenov. V vinogradništvu je FytoSave® pokazal zanesljivo učinkovitost proti ključnim listnim patogenom, zlasti *Plasmopara viticola* (peronospora vinske trte) in *Erysiphe necator* (pepelasta plesen). Njegov način delovanja je povsem fiziološki: COS-OGA povzroča sistemsko pridobljeno odpornost (SAR), spodbuja kopičenje obrambnih proteinov in fitoaleksenov ter krepi strukturne ovire, kar zmanjšuje prodiranje patogenov in njihovo sporulacijo. Večletni terenski poskusi v več evropskih vinorodnih regijah kažejo, da FytoSave® prispeva k merljivemu zmanjšanju pojavnosti in resnosti bolezni, hkrati pa ohranja vitalnost rastlin in pridelek. Ko je vključen v standardne programe zaščite, zmanjšuje potrebo po uporabi fungicidov in omogoča bolj uravnoteženo strategijo zatiranja bolezni. Z regulativnega in okoljskega vidika COS-OGA ponuja dodatne prednosti: odsotnost ostankov, odličen ekotoksikološki profil in minimalno tveganje za razvoj odpornosti. Zaradi teh lastnosti je FytoSave® odlično orodje za integrirano zatiranje škodljivcev (IPM) in za izpolnjevanje vse strožjih zahtev glede trajnostne pridelave v evropskih vinogradih. Ta prispevek bo predstavil pregled načina delovanja COS-OGA, nedavne rezultate terenskih poskusov in praktična priporočila za optimizacijo njegove uporabe v programih IPM. Rezultati poudarjajo pomen tehnologij, ki temeljijo na spodbujevalcih obrambe rastlin (elicitorjih), kot zanesljivih komponent sodobnega in trajnostnega varstva rastlin v vinogradništvu.

Pojav in razširjenost novega listnega zavrtača vinske trte (*Aspilanta oinophylla* van Nieukerken & Wagner, 2012) v zahodni Sloveniji

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Julija 2021 smo v vinogradu v kraju Ustje v Vipavski dolini na listih vinske trte opazili izvrtine, ki jih ni bilo mogoče pripisati nobeni od do sedaj znanih vrst listnih zavrtačev: evropski vrsti *Holocacista rivillei* Stainton, 1855 [Lepidoptera, Heliozelidae], in severnoameriški vrsti *Phyllocnistis vitegenella* Clemens [Lepidoptera, Gracillariidae], ki se pojavljata v slovenskih vinogradih. Na podlagi oblike izvrtin in morfološke analize imaga, smo v zahodni Sloveniji prvič potrdili pojav neevropske vrste *Aspilanta oinophylla* van Nieukerken & Wagner, 2012 [Lepidoptera, Heliozelidae]. Vrsta *A. oinophylla* izvira iz Severne Amerike in je bila v Evropi prvič dokumentirana leta 2007 v vinogradih province Trentino v severni Italiji, od koder se je razširila na širše območje dežel Tridentinsko-Zgornje Poadižje, Benečija in Furlanija–Julijska krajina. Predvidevamo, da se je od tam najverjetneje priselila tudi v Slovenijo. Čeprav, ne velja za izrazito nevarnega škodljivca vinske trte, se lahko občasno zelo namnoži ter povzroči poškodbe, ki zajamejo večji del listne površine. V letih 2021–2023 smo zastopanost vrste *A. oinophylla* potrdili v vseh štirih vinorodnih okoliših primorske vinorodne dežele. V večini primerov se je pojavljala v zelo omejenem obsegu, največkrat je bilo napadenih le nekaj listov na posameznih trsih v vinogradu. V letu 2025 pa smo na nekaterih lokacijah zabeležili obsežnejše napade škodljivca. V vinogradih v okolici Vipolž v Brdih, pri Komnu na Krasu in v okolici Dekanov v Slovenski Istri je bilo napadeno večje število listov. Na posameznih listih je bilo prisotnih tudi več kot 20 rovov in ovalnih luknjic, nastalih zaradi izpada kamric – majhnih delčkov listne ploskve, znotraj katerih se zabubijo odrasle gosenice. V prispevku predstavljamo podatke o trenutni razširjenosti vrste *A. oinophylla* v zahodni Sloveniji, morfoloških in bioloških značilnostih ter gospodarskem pomenu.

ABSTRACT

Occurrence and distribution of the new grapevine leafminer (*Aspilanta oinophylla* van Nieukerken & Wagner, 2012) in western Slovenia

In July 2021, characteristic mines were observed on grapevine leaves in a vineyard located in Ustje in the Vipava Valley. The symptoms differed from those caused by the two lepidopteran leafminers of grapevine already recorded in the Slovenian vineyards: the European species *Holocacista rivillei* Stainton, 1855 [Lepidoptera, Heliozelidae] and the invasive North American species *Phyllocnistis vitegenella* Clemens [Lepidoptera, Gracillariidae]. Based on the shape of the leafmines, the host plant, and the morphological characteristics of the adult reared in the laboratory, the first occurrence of the non-European microlepidopteran species *Aspilanta oinophylla* van Nieukerken & Wagner, 2012 [Lepidoptera, Heliozelidae] was confirmed in western Slovenia. *Aspilanta oinophylla* originates from North America and was first recorded in Europe in 2007 in vineyards of the Trentino province in northern Italy, from where it spread across the wider regions of Trentino–Alto Adige, Veneto and Friuli Venezia Giulia. We therefore presume that its occurrence in western Slovenia is associated with continued spread from the neighbouring Italian region. Although the species is not considered a serious pest for vineyards, it can occasionally reach high population densities when numerous mines may cover a large portion of the leaf surface. During 2021–2023, the presence of *A. oinophylla* was confirmed in all four wine-growing districts of the Primorska wine region. In most cases, population levels were low, with only a few mines on individual leaves. However, in 2025, more extensive infestations were recorded at some locations. In vineyards near Vipolže in Goriška Brda, in Komen on the Kras, and in the area of Dekani in Slovenian Istria, a larger number of leaves were affected. On a single leaf, more than 20 mines were

counted, and oval holes were often present where the larva had already cut out an oval pupal case in which it pupates. This article presents data on the current distribution of *A. oinophylla* in western Slovenia, its potential impact, and its morphological and biological characteristics.

Primerjava metod izolacije RNA za detekcijo virusa pahljačavosti listov vinske trte (GFLV) v ogorčicah prenašalkah (*Xiphinema index*)

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Prvi dokaz o prenosu rastlinskega virusa z rastlinsko-parazitskimi ogorčicami pripisujejo talni ektoparazitski vrsti ogorčic *Xiphinema index* (*X. index*), ki prenaša virus pahljačavosti listov vinske trte (GFLV), enega glavnih povzročiteljev bolezni kužne izrojenosti vinske trte. Bolezen velja za eno najpomembnejših virusnih bolezni vinske trte, saj lahko povzroči do 80 % izpada pridelka, slabšo kakovost grozdja, krajšo življenjsko dobo trt ter večjo občutljivost na okoljske vplive. Okužbo trte z GFLV lahko prepoznamo po rumenenju in deformacijah listov (t. i. peteršiljavost), nepravilnem izraščanju rozg (bifurkacije), oslabelosti trsov in neenakomerno razvitih grozdnih jagodah. Cilj raziskave je bil izbrati najprimernejšo metodo za rutinsko detekcijo GFLV v *X. index*, kar je posebej pomembno na zemljiščih pred zasaditvijo vinograda (zemljišče v prahi ali vinogradi pred ponovno zasaditvijo), saj zgodnja okužba trt z virusom še močneje vpliva na rastline, njihovo preživetje, razvoj in pridelek. Hitra in zanesljiva metoda detekcije virusa namreč omogoča oceno prisotnosti virulentnih ogorčic v tleh in tveganje za prenos virusa v na novo zasajene ali že obstoječe vinograde. V raziskavi smo preverjali učinkovitost štirih metod izolacije RNA za detekcijo GFLV v ogorčicah. Vzorčili smo vinogradniška tla na treh lokacijah na Primorskem, virus pa smo detektirali v vzorcih z 1, 2 ali 5 osebkov *X. index*, ki smo jih predhodno morfološko določili. Rezultati raziskave so pokazali, da izbira metode izolacije RNA pomembno vpliva na verjetnost detekcije GFLV z RT-PCR. Kot najučinkovitejša se je izkazala uporaba komercialnega kompleta za izolacijo RNA (RNeasy Plant Mini Kit, Qiagen), pri kateri je bila zanesljivost detekcije GFLV pri enem osebku 87,2 %, pri dveh osebkih pa 94,0 %. Ugotovili smo, da je pri izolaciji RNA ključna mehanska poškodba tkiva ogorčic, kar omogoči sprostitev virusnih delcev. Rezultati potrjujejo, da tako metoda izolacije kot tudi število analiziranih ogorčic statistično značilno vplivata na detekcijo GFLV s PCR.

ABSTRACT

Comparison of RNA extraction methods for the detection of grapevine fanleaf virus (GFLV) in vector nematodes (*Xiphinema index*)

The first report of plant virus transmission by plant-parasitic nematodes is attributed to the soil ectoparasitic nematode *Xiphinema index* (*X. index*), which transmits grapevine fanleaf virus (GFLV), one of the main causal agents of grapevine degeneration disease. The disease is considered one of the most important viral diseases of grapevine, as it can cause up to 80% yield loss, reduce grape quality, shorten vine lifespan and increase

sensitivity to environmental stress. GFLV infection of vines can be recognized by yellowing and deformation of leaves (parsley-like leaf shape), irregular shoot growth (bifurcation), weak vine growth and unevenly developed grape berries. The aim of the study was to select the most suitable method for routine detection of GFLV in *X. index*, which is particularly important on land before planting vines (fallow land or vineyards before replanting), as early infection of vines with the virus can have a greater impact on plant survival, development and yield. A fast and reliable method of virus detection allows assessment of the presence of virulent nematodes in the soil and the risk of virus transmission to newly planted or existing vineyards. In this study, the effectiveness of four RNA extraction methods for detecting GFLV in nematodes was tested. Vineyard soil was sampled at three locations in the Primorska region and the virus was detected in samples containing 1, 2, or 5 individuals of *X. index*, which were identified morphologically. The results of the study showed that the choice of RNA extraction method significantly affects the probability of GFLV detection by RT-PCR. The use of a commercial RNA isolation kit (RNeasy Plant Mini Kit, Qiagen) proved to be the most effective, with a GFLV detection reliability of 87.2% for a single individual and 94.0% for two individuals. Physical disruption of nematode tissue is crucial for RNA extraction, as it allows the release of viral particles. The results confirm that both the isolation method and the number of analysed nematodes have a statistically significant effect on GFLV detection by PCR.
Zahvala: Aktivnosti mlade raziskovalke (MR 60036) potekajo v sklopu programske skupine Agrobiodiverziteta (P4-0072), ki jo financira Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije (ARIS), del raziskav je potekal v sklopu projekta ResenseVitis (L7-50153).

Izkušnje z zatiranjem peronospore in oidija vinske trte

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Peronospora vinske trte je v severovzhodni Sloveniji v večini let najbolj nevarna glivična bolezen na vinski trti. Po podatkih javne službe zdravstvenega varstva rastlin Slovenije lahko v večini let v severovzhodnem delu Slovenije pričakujemo srednjo do močno okužbo s peronosporo vinske trte. V letih 2023 in 2024 smo v poskusih preizkušali učinkovitost delovanja različnih škropilnih programov (integrirana in ekološka pridelava grozdja) prosi peronospori vinske trte. Učinkovitost delovanja škropilnih programov v letu 2023, je bila, ob ocenitvi na listih, v »integriranem varstvu« 77,74 in 84,84 %, v »ekološkem varstvu« med 54,65 in 76,07%. Stopnja okužbe s peronosporo, (zadnja ocenitev na listih) v kontroli – neškropljeno je bila v letu 2023 7,47%. Slaba učinkovitost delovanja škropilnih programov je bila posledica predolgih razmikov med škropljenji glede na veliko količina padavin v mesecih maj, junij in julij. V letu 2024 (zadnja ocenitev) je bila stopnja okužbe v kontroli – neškropljeno, na listih, zelo nizka (0,81%), učinkovitost škropilnih programov je bila v ekološke varstvu dosti nižja (19,75-30,86%) kot v integriranem (86,42-98,77%). V letu 2025 smo v poskusu preizkušali učinkovitost delovanja škropilnih programov proti oidiju vinske trte. Delež okuženih grozdov (zadnja ocenitev – 28.8.2025) v kontroli – neškropljeno je bil 96 %, učinkovitost škropilnih programov pa je bila med 39,93 in

84,86%. Največja učinkovitost je bila pri škropilnem programu - integrirano varstvo vinske trte (84,86%).

ABSTRACT

Experiences with control of grapevine downy mildew and powdery mildew

Grapevine downy mildew is the most dangerous fungal disease, in most years, of grapevines in northeastern part of Slovenia. According to the data of the Public Plant Health Service of Slovenia, in most years in the northeastern part of Slovenia, we can expect a medium to heavy infection with downy mildew of grapevines. In 2023 and 2024, we tested the efficacy of various spraying programs (integrated and organic grape production) in trials. The efficacy of the spraying programs in year 2023 (assessment on the leaves) was between 77.74 and 84.84% in "integrated production", and between 54.65 and 76.07% in "organic production". The infection rate with downy mildew (last assessment on the leaves) in the check - unsprayed was in the year 2023 7.47%. The low efficacy of the tested spraying programs was a result of too long intervals between sprayings given the high amount of precipitation in the months of May, June and July. In the year 2024, the infection rate in the check - unsprayed, on the leaves, was very low (0.81%), in the spraying programs was rate between 0.01 and 0.65% - the efficiency of the "organic production" was lower (19.75-30.86%) then the efficiency of the "integrated program" (86.42-98.77%). In 2025, we tested the efficacy of various spraying programs against grapevine powdery mildew in trial. The proportion of infected bunches (last assessment – 28th of august 2025) in the check - unsprayed was 96%, the efficacy of spraying programs was between 39.93 and 84.86%. The highest efficacy was at the spraying program - integrated production (84.86%).

Dveletne izkušnje s sredstvom Fytosave za varstvo vinske trte pred peronosporo *(Plasmopara viticola)* **in oidijem** *(Uncinula necator)* **v slovenski praksi**

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Ob krčenju nabora razpoložljivih konvencionalnih aktivnih snovi ter ob naraščajoči globalni zahtevi po trajnostni in ekološko naravnani pridelavi postajajo novi proizvodi, ki ustrezajo tem kriterijem, dobrodošla dopolnitev naboru tudi za slovenske pridelovalce. Za vinogradnike je ključnega pomena primerljivost biološke učinkovitosti ter ekonomska upravičenost, ki ne sme odstopati od konvencionalnih praks, hkrati pa mora zagotavljati vsaj enakovredno kakovost in količino končnega pridelka. Iz navedenega smo v letih 2024 in 2025 sredstvo Fytosave z aktivno snovjo COS-OGA, vključenega v celoleten program varstva vinske trte, preverjali v praktičnem poskusu na lokaciji Višnjevik v Goriških Brdih. Kljub kompatibilnosti Fytosave z vsemi uveljavljenimi doktrinami varstva, je bil program zasnovan izključno z uporabo sredstev, dovoljenih za ekološko certificirano pridelavo. Učinkovitost Fytosave je bila v obeh letih primerjana z netretiranimi in konvencionalno tretiranimi variantami, pri čemer je bilo število aplikacij enako. Posebej omejujoče pridelovalne razmere v letu 2024 potrjujejo visoko učinkovitost Fytosave v kombinaciji z biološko sprejemljivimi sredstvi, kot so žveplo, kalijev bikarbonat ($KHCO_3$) in zmanjšanimi odmerki bakra. Povišan tržni pridelek za 12,7 % v primerjavi z integrirano

varianto v letu 2024 ter približno 1 % v letu 2025 dodatno potrjujeta ekonomsko upravičenost zamenjave konvencionalnih sredstev z ekološko sprejemljivimi alternativami.

ABSTRACT

Two-year experience with product Fytosave for the protection of grapevine against downy mildew (*Plasmopara viticola*) **and powdery mildew** (*Uncinula necator*) **in Slovenian practice**

With the reduction of available conventional active substances and the increasing global demand for sustainable and ecologically oriented production, new products that meet these criteria have become a welcome addition to the range available to Slovenian growers. For winegrowers, it is crucial that the biological efficacy and economic viability are comparable to conventional practices, while ensuring at least equivalent quality and quantity of the final yield. Based on this, in 2024 and 2025, the product Fytosave, containing the active substance COS-OGA and integrated into a year-round grapevine protection program, was evaluated in a field trial at the Višnjevik site in the Goriška Brda region. Despite Fytosave's compatibility with all established protection doctrines, the program was designed exclusively using products permitted for ecologically certified production. The efficacy of Fytosave was compared in both years with untreated and conventionally treated variants, with an equal number of applications. Particularly challenging growing conditions in 2024 confirmed the high efficacy of Fytosave in combination with biologically acceptable products such as sulfur, potassium bicarbonate ($KHCO_3$), and reduced copper doses. The increase in marketable yield by 12,7 % compared to the integrated variant in 2024 and approximately 1 % in 2025 further confirms the economic justification for replacing conventional products with ecologically acceptable alternatives.

Napredni pristopi za zgodnje zaznavanje bolezni vinske trte – project Resens-Vitis (L7-50153)

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Zgodnje zaznavanje bolezni vinske trte je eden izmed ključnih izzivov sodobnega vinogradništva, saj številni patogeni ob nepravočasnem ukrepanju povzročajo znatne izgube in vplivajo na kakovost pridelka ter dolgoročno slabšanje vitalnosti vinogradov. Projekt L7-50153 RESENS-VITIS naslavlja to problematiko z razvojem integriranega sistema, ki združuje snemanje iz brezpilotnih zrakoplovov (UAV) in letala, vizualno ocenjevanje, fiziološke meritve ter molekularno diagnostiko za zgodnje in zanesljivo odkrivanje treh ključnih bolezni vinske trte: zlate trsne rumenice (FD), virusa pahljačavosti

vinske trte (GFLV) ter kapi vinske trte (eska). V izbranih vinogradih dveh slovenskih vinorodnih regij poteka večletni zajem podatkov z UAV hiperspektralnim sistemom Mjolnir VS-620 in senzorji Hyspex VNIR/SWIR na letalu. Podatke integriramo z RGB posnetki, terenskimi ocenjevanji bolezenskih znakov ter meritvami fiziologije. Spektralne podpise trt analiziramo v treh spektralnih regijah. Spremembe pigmentov se odražajo v vidnem delu spektra, spremembe v strukturi listnega mezofila v bližnjeinfrardeči sveltobi, medtem ko biokemijske spremembe vplivajo na svetlobni odboj v kratkovalovni infrardeči svetlobi. S sodobnimi pristopi segmentacije (npr. SAM2) pridobimo natančne maske listne površine, kar omogoča zanesljivo ekstrakcijo spektralnih informacij brez vpliva ozadja. Na osnovi tega vzpostavljamo spektralno knjižnico, povezano z vizualnimi ocenami, laboratorijsko potrjeno okuženostjo in destruktivnimi analizami lesa. Pri analizi podatkov združujemo metode manjšanja dimenzionalnosti podatkov (PCA, PLS-DA, UMAP), izračun spektralnih indeksov ter razvoj modelov strojnega učenja z različnimi algoritmi (npr. SVM, XGBoost in konvolucijske nevronske mreže). Interpretabilnost modelov zagotavljamo z izračunom vrednosti SHAP, kar omogoča preverjanje obnašanja algoritma in kako oziroma zakaj je sprejemal določene odločitve. Prvi rezultati kažejo, da lahko s hiperspektralnimi podatki z visoko prostorsko ločljivostjo bolj ali manj uspešno (natančnost 60–80%) identificiramo spektralne odklone, povezane s FD, ter ločujemo fenološke in okoljske vplive od pravih bolezenskih signalov. Projekt tako vzpostavlja temelje za operativne diagnostične sisteme v preciznem vinogradništvu, ki bodo prispevali k pravočasni detekciji okužb, učinkovitejšemu ukrepanju ter podpori pri upravljanju in obnovi vinogradov.

ABSTRACT

Advanced approaches for early detection of grapevine diseases – Resens-Vitis project (L7-50153)

Early detection of grapevine diseases is a major challenge in modern viticulture, as many pathogens cause substantial yield and quality losses, as well as long-term decline in vineyard productivity when early control measures are not implemented. The project L7-50153 RESENS-VITIS addresses this challenge by developing an integrated diagnostic system that combines UAV- and aircraft-based hyperspectral imaging, visual symptom assessments, physiological measurements, and molecular diagnostics to enable early and reliable detection of three major disease groups: Flavescence dorée (FD), Grapevine fanleaf virus (GFLV), and Esca-complex grapevine trunk diseases. Multi-year data acquisition is being carried out in selected vineyards across two Slovenian wine-growing regions using the UAV hyperspectral system Mjolnir VS-620 and Hyspex VNIR/SWIR sensors mounted on an aircraft. These data are integrated with RGB imagery, visual disease assessments, and plant physiology measurements in the vineyards. Spectral signatures are interpreted through underlying physiological mechanisms. Changes in pigments are reflected in the visible part of the spectrum, alterations in the structure of the leaf mesophyll in near-infrared, while leaf biochemistry in short-wave infrared. Advanced segmentation methods (SAM2) provide accurate leaf-surface masks, enabling extraction of canopy-only spectra without background interference. A comprehensive spectral library is being established, linking hyperspectral signatures with visual ratings, laboratory-confirmed infection status, and destructive wood analyses. The analytical workflow includes dimensionality reduction (PCA, PLS-DA, UMAP), computation of spectral indices, and the development of machine-learning models such as SVM, XGBoost, and convolutional neural networks. Model interpretability is ensured through SHAP values. Preliminary results show that high-resolution hyperspectral data can identify spectral deviations associated with FD with moderate success (accuracy 60–80%) and help separate phenological and environmental variability from true disease-related signals. The

project establishes the foundation for operational diagnostic systems in precision viticulture, enabling earlier detection of infections, more effective intervention, and decision support in vineyard management and restoration.

Nameščanje različnih vrst mrež v vinogradih za zmanjšanje zanašanja fitofarmacevtskih sredstev

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Tudi v vinogradih smo pričeli uporabljati protitočne mreže in mreže nameščene na robu nasadov za zmanjševanje znašanja – drifta FFS (fitofarmacevtskih sredstev). Odprtih imamo veliko strokovnih vprašanja glede njihove učinkovitosti ter načinov nameščanja. Dodatno vinogradnike pogosto zanima učinkovitost elektrostatske podpore pri nanosu FFS, ob uporabi mrežnih sistemov v pridelavi. Izvedeli smo dve ločeni raziskavi. V prvi nas je zanimala učinkovitost na robu vinograda nameščene proti-insektne mreže za zmanjšanje zanašanja FFS. V drugi raziskavi nas je zanimal interaktivni učinek med namestitvijo robne protitočne mreže in uporabo elektrostatske podpore pri nanosu FFS na obseg zanašanja FFS izven območja tretiranja. Učinkovitost prestrezanja zanosa FFS je bila merjena na 4 različnih razdaljah in 4 višinah od roba vinograda. Pri prvi raziskavi smo na tleh na razdalji 2 m od vira škropljenja izmerili 63,62% redukcijo zanosa (primerjava nameščena mreža in brez mreže), na razdalji 8 m pa že 96,83% redukcijo. Na višini 4 metre nad tlemi smo na razdalji 2 m od vira izmerili redukcijo drifta FFS za 83%, na razdalji 8 m pa že 98,52%. V drugem poskusu smo ocenjevali učinkovitost na robu vinograda nameščene protitočne mreže, ob uporabi elektrostatike ali brez nje. Protitočne mreže nameščene na zadnji vrsti vinograda so povzročile manjši odboj škropljenega oblaka in za 20% se je povečal depozit FFS na tleh. Elektrostatska podpora je zmanjšala zanos na tleh ob zadnji vrsti za približno 20%. Pri kombinaciji elektrostatike podpore in protitočne mreže na robu vinograda se nekoliko poveča zanos v neposredni bližini zadnje vrste trt, na večji razdalji pa je uporaba elektrostatike, hkrati s protitočno mrežo dodatno zmanjšala zanos na tleh (za 70%).

ABSTRACT

Installation of different types of nets in vineyards to reduce the drift of plant protection products

Grape growers have started using anti-hail nets and anti-drift nets, which are installed at the edge of vineyards, to reduce the drift of PPP (plant protection products). We have many open questions regarding their effectiveness and installation methods. Additionally, winegrowers are often interested in receiving information on the effectiveness of electrostatic support when applying PPP and utilizing net systems in grape cultivation. We conducted two separate studies. In the first study, we tested the efficacy of an anti-insect net installed at the edge of the vineyard to reduce PPP drift. In the second study, we investigated the interactive effect between the installation of an anti-hail net and the use of electrostatic support during spraying on the extent of PPP drift outside the treatment area when applying PPP. The efficiency of intercepting PPP drift was measured at four

different distances and four heights from the edge of the vineyard. In the first study, we measured a 63.62% reduction in drift on the ground. At a distance of 2 m from the spraying source (comparison of the installed net and no net). At a distance of 8 m, the drift reduction reached 96.83%. At a height of 4 meters above the ground, we measured a decrease in PPP drift amounting to 83% at 2 meters from the source and 98.52% at 8 meters. In the second experiment, we evaluated the effectiveness of an anti-hail net installed at the edge of the vineyard, with or without the use of electrostatic support during spraying. An anti-hail net installed at the last row of the vineyard caused reflection of the spray cloud and increased the PPP deposit on the ground inside of vineyard by 20%. Electrostatic support reduced the drift on the ground in the area of the last row by approximately 20%. When combining the electrostatic spraying and installation of an anti-hail net at the edge of the vineyard, the drift in the immediate vicinity of the last row of vines slightly increases. In contrast, at a greater distance, the use of electrostatics, together with the anti-hail net, further reduces the drift on the ground (by 70%).

Zlata trsna rumenica v Sloveniji: najnovejša epidemiološka spoznanja

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Zlata trsna rumenica je neozdravljiva karantenska bolezen vinske trte, ki jo povzroča fitoplazma iz skupine 16SrV (FDf). V vinogradih se FDf širi predvsem s pomočjo ameriškega škržatka (*Scaphoideus titanus*). Pravočasno odkrivanje okužb je ključnega pomena za omejevanje širjenja bolezni, zato je pomembno redno spremljanje populacije ameriškega škržatka in laboratorijsko testiranje odraslih osebkov ter simptomatičnih rastlin. Raziskave so pokazale, da testiranje preimaginalnih stadijev ameriškega škržatka ni zanesljivo za zgodnje odkrivanje okužb, saj je bila prisotnost FDf potrjena le v majhnem deležu vzorcev. Fitoplazme 16SrV so v naravi prisotne na različnih rastlinskih gostiteljih, med katerimi imajo nekateri lahko vlogo rezervoarjev okužbe. V raziskavi smo analizirali leske, ki rastejo v bližini vinogradov, z namenom ugotoviti, ali bi lahko predstavljale vir okužb za vinsko trto. Rezultati so pokazali, da leske niso ključni izvor okužb z FDf v slovenskih vinogradih, lahko pa predstavljajo rezervoar genetske raznolikosti fitoplazem. V preteklosti so bile namreč v leskah potrjene fitoplazme z genotipi *map-FD*, za katere je

znano, da jih ameriški škržatek lahko prenaša in da povzročajo izbruhe bolezni v vinogradih. Poleg glavnega vektorja smo analizirali tudi vlogo drugih možnih prenašalcev FDf. Med njimi izstopa vzhodnjaški škržatek (*Orientus ishidae*), ki je v nasadih lesk in robni vegetaciji zelo pogost, pri čemer je bil pomemben delež osebkov okužen s fitoplazmo 16SrV. Vloga drugih vrst škržatkov pri širjenju FDf v slovenskih vinogradih je, po dosedanjih podatkih, verjetno omejena. V zadnjih letih potekajo poskusi v mrežnikih, s katerimi preverjamo, ali je vzhodnjaški škržatek zmožen prenosa FDf iz okuženih lesk na trto ali druge leske; ti poskusi se nadaljujejo z namenom razjasnitve epidemiološke vloge te vrste. V prispevku bomo predstavili najnovejša epidemiološka spoznanja o širjenju zlate trsne rumenice v Sloveniji, ki pomembno prispevajo k boljšemu razumevanju bolezni in predstavljajo ključno osnovo za bolj učinkovito preprečevanje njenega širjenja ter varstvo vinske trte pred njenimi posledicami.

ABSTRACT

Grapevine flavescence dorée in Slovenia: Latest epidemiological insights

Grapevine flavescence dorée is an incurable quarantine disease caused by a 16SrV-group phytoplasma (FDp). In vineyards, it spreads mainly through the leafhopper *Scaphoideus titanus*. Early detection is essential to limit spread; therefore, regular monitoring of *S. titanus* populations and testing of adults and symptomatic plants are crucial. Studies have shown that testing immature stages of *S. titanus* is unreliable, as FDp was confirmed in only a small proportion of these samples. 16SrV phytoplasmas occur naturally on various plant hosts, some of which may act as reservoirs of infection. To investigate this, we analyzed *Corylus avellana* (hazel) plants growing close to vineyards to determine whether they could serve as a source of FDp infection for grapevine. Our results indicate that hazels are not a major source of FDp infections in Slovenian vineyards; however, they may represent a reservoir of phytoplasma genetic diversity. In the past, phytoplasmas with *map-FD* genotypes - known to be efficiently transmitted by *S. titanus* and associated with disease outbreaks in vineyards - have been detected in hazels. In addition to the main vector, we examined the role of other potential vectors of FDp. Among these, *Orientus ishidae* stands out because it is very common in hazel plantations and edge vegetation, and a significant proportion of individuals were infected with 16SrV phytoplasma. Current data suggest that other leafhopper species play only a limited role in spreading FDp. In recent years, we have conducted insect-proof cage experiments to test whether *O. ishidae* can transmit FDp from infected hazels to grapevine or other hazels. These experiments are ongoing and aim to clarify the epidemiological significance of this species. We will present the latest epidemiological findings on the spread of FDp in Slovenia. These insights contribute to a better understanding of the disease and provide a solid foundation for more effective strategies to prevent its spread and protect grapevine from its harmful consequences.

Izkušnje z zatiranjem ameriškega škržatka (*Scaphoideus titanus* [Ball 1932], Hemiptera, Cicadellidae) v letih 2024 in 2025

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Ameriški škržatek (*Scaphoideus titanus* Ball) je najpomembnejši prenašalec karantenske bolezni – fitoplazme Grapevine Flavescence dorée (FD). Bolezen se je v zadnjih petih letih močno razširila v okuženem območju severovzhodne in jugozahodne Slovenije. V letih 2024 in 2025 smo na območju severovzhodne Slovenije izvedli štiri poskuse zatiranja ameriškega škržatka. Preizkušali smo učinkovitost delovanja insekticidov registriranih v Slovenije na osnovi aktivnih snovi piretrin, acetamiprid, flupiradifuron, spirotetramat in tau-fluvalinat, ter iz tujine; kombinacije deltametrin- a in flupiradifuron-a in etofenproks. Rezultati so potrdili, da imajo insekticidi uporabljeni proti imagom ameriškega škržatka kratko rezidualno delovanje. Populacija imagov ameriškega škržatka v mesecu avgustu je močno narastla v vseh obravnavanjih. Zaradi dolgega obdobja izleganja preimaginalnih stadijev ameriškega škržatka, je potrebno izvesti v obdobju izleganja do pojava prvih imagov dvoje ali troje škropljenj, kar pomeni, da je potrebno izvesti tretiranja z insekticidi od konca cvetenja pa do prve dekade meseca julija.

ABSTRACT

Experiences with the control of American grapevine leafhopper (*Scaphoideus titanus*[Ball 1932], Hemiptera, Cicadellidae) in 2024 and 2025

The American leafhopper (*Scaphoideus titanus* Ball) is the most important vector of the quarantine disease Grapevine Flavescence dorée (FD) phytoplasma. The disease has spread rapidly in the infected areas of northeastern and southwestern Slovenia over the past five years. In 2024 and 2025, we conducted four experiments to control the American leafhopper in northeastern Slovenia. We tested the effectiveness of insecticides registered in Slovenia based on the active substances pyrethrin, acetamiprid, flupiradifuron, spirotetramat, and tau-fluvalinate, as well as combinations of deltamethrin and flupiradifuron and etofenprox from abroad. The results confirmed that the insecticides used against adult American grapevine leafhopper have a short residual effect. The population of adult *Scaphoideus titanus* increased significantly in August in all cases. Due to the long period of hatching of the pre-imaginal stages of the American grapevine leafhopper, it is necessary to carry out two or three sprayings during the hatching period until the first adults appear, which means that insecticide treatments must be carried out from the end of flowering until the first ten days of July.

Biostimulativni učinek pripravka na podlagi endofitne bakterije AB-strain na vinsko trto, okuženo s fitoplazmo, povzročiteljico zlate trsne rumenice (Flavescence dorée)

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Mikrobni biostimulanti pomagajo rastlinam pri premagovanju abiotskega in biotskega stresa, kamor sodijo tudi fitoplazemske okužbe. Bakterija AB-strain deluje kot endosimbiont v vinski trti. Raziskava je ocenjevala učinkovitost večkratne aplikacije liofilizirane kulture AB-strain v razmerah velike izpostavljenosti trte zlati trsni rumenici (FD), ki jo povzroča fitoplazma *Candidatus Phytoplasma vitis*. Poljski poskus je potekal v vinogradu sorte Laški rizling. Bakterijo smo nanašali petkrat v rastni sezoni, primerjali pa smo dve koncentraciji (K1 – višja, K2 – nižja) in netretirano kontrolo. Intenzivnost znakov okužbe je bila ocenjena trikrat v sezoni 2025. Pri prvem ocenjevanju (10. julij) je apliciranje AB-strain zmanjšalo delež trt z intenzivnimi znaki FD na polovico (K1: 8,4 %; K2: 10 %; kontrola: 20 %). Pri drugem ocenjevanju (25. avgust) je imela obravnava K1 za 69 % manj trt z intenzivno izraženimi znaki kot kontrola (K1: 9 %; K2: 24 %; kontrola: 30 %). Obravnavanje K1 je izkazalo tudi višji delež navidezno zdravih trt (62,5 %) kot kontrola (40,3 %). Ločeno smo ocenili tudi stanje trt glede na stopnjo prizadetosti v letu 2024. Med trtami, ki so bile že leta 2024 močno okužene, je v letu 2025 po tretiranju z AB-strain, hudo prizadetih ostalo le 20 %, medtem ko je v kontrolni skupini takih bilo kar 97 %. Aplikacija AB-strain v vinogradu je povečala delež rastlin brez znakov okužb (pogojno zdravih) in zmanjšala intenziteto znakov FD. Pripravek AB-strain na podlagi preliminarnih analiz omogoča boljšo rast vinske trte v območjih z visokim vektorskim pritiskom in velikim deležem okuženih trt. Potrebni so nadaljnji lončni in poljski poskusi z molekularno analitiko za določanje vpliva na pridelek in kakovost grozdja.

ABSTRACT

Biostimulant effect of the product based on the AB-strain bacterium on grapevine infected with grapevinw yellows phytoplasma (Flavescence dorée)

Microbial biostimulants help plants overcome abiotic and biotic stress, including phytoplasma infections. The AB-strain bacterium acts as an endosymbiont in the grapevine. The study evaluated the effectiveness of multiple applications of a lyophilized AB-strain culture under conditions of high exposure of grapevine to Flavescence dorée (FD), caused by *Candidatus Phytoplasma vitis*. The field trial was conducted in a vineyard of the Welsh Riesling variety. The bacterium was applied five times during the growing season, comparing two concentrations (K1 – higher, K2 – lower) and an untreated control. The intensity of infection symptoms was assessed three times in the 2025 season. At the first assessment (July 10), application of AB-strain reduced the proportion of vines showing intense FD symptoms by half (K1: 8.4%; K2: 10%; control: 20%). At the second assessment (August 25), the K1 treatment had 69% fewer vines with severe symptoms compared to the control (K1: 9%; K2: 24%; control: 30%). Grapevines treated at K1 concentration also showed a higher percentage of apparently healthy vines (62.5%) than the control (40.3%). We also separately assessed vine condition in 2025 compared to the level of infection in 2024. Among vines that were heavily infected in 2024, only 20% remained severely affected in 2025 after treatment with AB-strain, whereas in the control group, as many as 97% were still severely affected. Application of AB-strain in the vineyard increased the proportion of apparently healthy plants and reduced the intensity of FD symptoms. Preliminary analyses suggest the preparation promotes better grapevine growth in areas with high FD vector pressure and a high share of infected vines. Further pot and field trials with molecular analytics are needed to determine effects on yield and grape quality.

Zgodnje odkrivanje zlate trsne rumenice z uporabo hiperspektralnega daljinskega zaznavanja v vinogradih - FD-GAMEPLAN (CRP V4-2225)

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Fitoplazma *Flavescence dorée* (FD), povzročiteljica zlate trsne rumenice, ki je v Evropski uniji uvrščena med karantenske škodljive organizme, je danes prisotna v vseh slovenskih vinorodnih deželah. Zgodnje odkrivanje okužb je ključnega pomena za učinkovito omejevanje širjenja te bolezni in s tem zmanjšanje gospodarske škode. Ker so klasični terenski pregledi na velikih površinah časovno zamudni, smo v okviru raziskave proučevali možnost zgodnjega odkrivanja okužb s FD z uporabo hiperspektralnega daljinskega zaznavanja v kombinaciji z metodami strojnega učenja. Izbrane vinograde smo slikali s hiperspektralnim sistemom v vidnem, bližnjem in kratkovalovnem infrardečem delu spektra, nameščenim na letalu. Slikanje smo izvedli dvakrat v rastni sezoni, v poletnem času, ko simptomi FD še niso jasno izraženi, in jeseni, ko smo ob izraženih simptomih lahko izvedli še vizualne ocene na terenu. Slike smo radiometrično in atmosfersko korigirali, jih georeferencirali in ortorektificirali, ter segmentirali na raven posameznih trt. Nato smo spektralne podatke obdelali z metodami multiplikativne korekcije sipanja, detrendinga in izračunali derivate 2. reda z glajenjem po metodi Savitzky–Golay. Za manjšanje dimenzionalnosti podatkov in izluščenje značilk smo uporabili metodi delnih najmanjših kvadratov in Fourierjeve transformacije, klasifikacijske modele pa smo razvili z metodo podpornih vektorjev. Rezultati potrjujejo uporabnost razvitega metodološkega pristopa za zgodnje odkrivanje FD. Spektralne razlike med zdravimi in okuženimi rastlinami so razmeroma majhne in so predvsem omejene na območje NIR/SWIR, medtem ko so v vidnem delu spektra slabo izražene. Zaznavanje okuženih rastlin je zanesljivejše v jesenskem obdobju, ko so spektralni kontrasti simptomov izrazitejši, medtem ko je spomladi zgodnje zaznavanje sicer izvedljivo, vendar z nižjo napovedno natančnostjo. Hiperspektralno daljinsko zaznavanje v kombinaciji s strojnim učenjem predstavlja obetavno orodje za zgodnje, objektivno in prostorsko natančno spremljanje FD ter pomembno podporo fitosanitarnemu nadzoru vinogradov.

ABSTRACT

Early detection of grapevine flavescence dorée using hyperspectral remote sensing in vineyards - FD-GAMEPLAN (CRP V4-2225)

Flavescence dorée (FD) phytoplasmas, the agent of grapevine yellows disease and a quarantine organism in the European Union, is currently present in all Slovenian wine-growing regions. Early detection of infections is crucial for effective control of disease spread and thus for the reduction of economic damage in viticulture. As classical field inspections over large vineyard areas are time-consuming, our study investigated the potential for early detection of FD infections using hyperspectral remote sensing in combination with machine learning methods. Selected vineyards were surveyed from an airplane using a hyperspectral system in the visible, near and shortwave infrared spectral ranges. Imaging was performed twice during the growing season, in summer, when the symptoms of FD are not visible, and in autumn, when symptoms were fully developed. Visual field assessments were also performed in autumn. The images were radiometrically

and atmospherically corrected, georeferenced, ortorectified, and segmented to individual vines. Spectral data were first preprocessed using multiplicative scatter corrections, detrending, and Savitzky–Golay 2. order derivatives. Partial least squares and Fourier transforms were used for dimensionality reduction, and features developed using support vector machines. The results confirm the applicability of the developed methodological approach for early detection of FD. Spectral differences between healthy and infected plants are relatively small and are mainly confined to the NIR/SWIR regions, while they are poorly expressed in the visible part of the spectrum, in spring. Detection of infected plants is more reliable in autumn, when symptom-related spectral contrasts are more distinct, whereas early detection in spring is possible but with lower predictive accuracy. Hyperspectral remote sensing combined with machine learning represents a promising tool for early, objective, and spatially precise monitoring of FD and provides important support for phytosanitary surveillance in vineyards.

Varstvo gozdnega drevja

Učinkovitost različnih tipov pasti za spremljanje tujerodnih ambrozijskih podlubnikov

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Slovenski gozdovi se v zadnjih desetletjih vse bolj soočajo s pojavom tujerodnih organizmov. Njihovo širjenje je tesno povezano s povečano globalno trgovino in mobilnostjo ljudi. Med najpogostejšimi zaznami tujerodnimi vrstami so podlubniki (Coleoptera: Curculionidae: Scolytinae), še zlasti ksilomicetofagne oz. ambrozijske vrste, ki se pogosto prenašajo z napadenim lesom in rastlinami. Slovenija sodi med države Evropske unije z najvišjim številom tujerodnih vrst podlubnikov, pri čemer je v zadnjem desetletju zabeležen izrazit porast pojava novih vrst. To povečuje skrb glede njihovega vpliva na gozdne ekosisteme. V raziskavi smo ocenili učinkovitost treh tipov pasti (večlijakaste, režaste, križne) za spremljanje azijskega ambrozijskega podlubnika (*Xylosandrus crassiusculus*), ki predstavlja modelni primer tujerodnega organizma v slovenskih gozdovih. Kot vaba je bil uporabljen etanol. Preliminarni rezultati razlik v učinkovitosti za privabljanje *X. crassiusculus* med različnimi tipi pasti niso pokazali. Višek ulova smo zabeležili v mesecu aprilu. Analize za druge vrste podlubnikov še potekajo, smo pa z raziskavo pridobili tudi nove podatke o razširjenosti nekaterih drugih tujerodnih vrst podlubnikov (npr. *Ambrosiodmus rubricollis*, *Ambrosiophilus atratus*, *Anisandrus maiche*) pri nas. Primerjava učinkovitosti pasti omogoča natančnejše določanje optimalnih metod spremljanja in predstavlja podlago za razvoj orodij za zgodnje odkrivanje karantenskih škodljivih organizmov. Tako lahko lažje oblikujemo učinkovite preventivne ukrepe za omejevanje vnosa in širjenja tujerodnih vrst v gozdnih ekosistemih.

ABSTRACT

Efficacy of different trap types for monitoring of non-native ambrosia beetles

Slovenian forests have increasingly been confronted with the presence of non-native organisms in recent decades. Their spread is closely linked to intensified global trade and human mobility. Among the most frequently detected non-native species are bark beetles (Coleoptera: Curculionidae: Scolytinae), particularly xylomycetophagous or ambrosia beetles, which are often transported with infested wood and plants. Slovenia ranks among the european countries with the highest number of non-native bark beetle species, with a increase in new detections recorded in the past decade. This raises concern about their potential impacts on forest ecosystems. In this study, we evaluated the efficacy of three trap types (multi-funnel, slit and cross-traps) for monitoring the Asian ambrosia beetle (*Xylosandrus crassiusculus*), a model example of a non-native organism in Slovenian forests. Ethanol was used as an attractant. Preliminary results showed no significant differences in trap efficacy for attracting *X. crassiusculus* among the tested trap types. Peak captures were recorded in April. Analyses for other bark beetle species are still underway, nevertheless the study already provides new data on the distribution of several other non-native species (e.g., Ambrosiodmus rubricollis, Ambrosiophilus atratus, Anisandrus maiche) in Slovenia. Comparing trap efficacy enables more precise determination of optimal monitoring methods and provides a foundation for developing tools for early detection of quarantine pests. This helps the development of effective preventive measures to limit the introduction and spread of non-native species in forest ecosystems.

Uporaba avtomatiziranih pasti Trapview za spremljanje pinijevega sprevodnega prelca v Sloveniji

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Pinijev sprevodni prelec (*Thaumetopoea pityocampa* (Denis & Schiffermüller, 1775)) je znan po tem, da pri ljudeh povzroča alergijske reakcije, v gozdovih pa defoliacijo. Da bi razvili učinkovit sistem zgodnjega obveščanje splošne javnosti in gozdarjev o prisotnosti in naraščanju številčnosti te vrste, je treba postaviti pasti za spremljanje njene populacije. Vzdrževanje sistema za spremljanje zahteva znatne delovne in finančne vire. V zadnjih letih je bil dosežen velik napredek pri avtomatizaciji pasti za spremljanje več vrst škodljivcev. Tukaj predstavljamo rezultate prvega spremljanja vrste *T. pityocampa* z avtomatiziranimi pastmi, razvitimi v okviru projekta Horizon Europe FORSAID (www.forsaid.eu). S spremljanjem smo preverjali: (1) ali avtomatizirane pasti Trapview kažejo podobno dinamiko pojavljanja vrste *T. pityocampa* kot tradicionalne pasti; (2) ali obstajajo razlike v številčnosti vrste med mestnimi in gozdnimi območji; in (3) ali uporaba glikola, ki preprečuje plenjenje, poveča ulov in s tem izboljšala občutljivost spremljanja. Raziskava je potekala na širšem območju Kozine. Skupno smo namestili dvajset pasti, in sicer pet avtomatskih in pet tradicionalnih pasti v mestu in enako število število pasti v gozdu. Vzorčenje je potekalo od konca maja do konca septembra, pri čemer smo tradicionalne pasti pregledovali enkrat tedensko, avtomatske pa enkrat dnevno. Ugotovili smo, da se je aktivnost metuljev začela v začetku junija, dosegla vrhunec v začetku avgusta in končala konec septembra. Avtomatizirane in tradicionalne pasti so pokazale podobno dinamiko pojavljanja vrste. Gostota metuljev je bila v urbanih območjih višja kot v gozdnih območjih. Tradicionalne pasti z glikolom so ujele več metuljev kot tradicionalne pasti brez glikola ali avtomatizirane pasti. Ti rezultati bodo obravnavani v okviru vzpostavitve sistema zgodnjega zaznavanja in obveščanja o prisotnosti pinijevega sprevodnega prelca v Sloveniji.

ABSTRACT

The use of automated Trapview traps for monitoring the pine processionary moth in Slovenia

The pine processionary moth (*Thaumetopoea pityocampa* (Denis & Schiffermüller, 1775)) is known to cause allergic reactions in humans and defoliation in forests. To develop an effective early warning system for informing the general public and foresters about the presence and increasing abundance of this species, traps should be set up to monitor its population. However, maintaining a monitoring network requires significant labor and financial resources. In recent years, considerable progress has been made in automating traps for several pest species. Here, we present the results of the first monitoring effort using automated traps, developed within the Horizon Europe project FORSAID

(www.forsaid.eu). Specifically, we focused on: (1) whether the automated traps from Trapview showed similar patterns to traditional traps; (2) whether there were differences between urban and forest areas; and (3) whether the use of glycol, which prevents predation, would increase the catch and thereby improve monitoring sensitivity. We deployed ten traps in urban areas and ten traps in forest areas in Kozina, with five automated traps and five traditional traps in each area. Sampling was conducted from the end of May to the end of September, with weekly intervals for traditional traps and daily intervals for automated traps. We found that moth activity began in early June, peaked in early August, and ended in late September. Both automated and traditional traps showed similar patterns. Moth densities were higher in urban areas compared to forest areas. Traditional traps with glycol captured more moths than traditional traps without glycol or automated traps. These results will be discussed in the context of establishing an early warning and detection system for the pine processionary moth in Slovenia.

Bioinformacijsko iskanje šivanke v kupu (s)e(D)NA

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Zaradi spreminjanja okoljskih pogojev in razvoja globalne trgovine imajo škodljivci in povzročitelji bolezni drevja vedno več priložnosti za širitev in ustalitev na novih območjih. Med orodji za preprečevanje potencialne škode ima pomembno mesto tudi zgodnja zaznava. Ena izmed obetajočih novejših metod zaznave je uporaba okoljske DNA (angl. environmental DNA, eDNA), kjer izoliramo vso v vzorcu prisotno DNA, nato pa na različne načine pridemo do informacij o organizmih, ki so v vzorcu pustili svojo sled. Pri tem pomembno vlogo igra bioinformacijska obdelava rezultatov visokozmogljivega sekvenciranja. Predstavili bomo enega od načinov, kako s presejalno meta analizo črtnih kod lahko pridemo do prve informacije o tem, da se v preučevanem okolju nahaja potencialno škodljiv organizem. Široka presejalna metoda je nato podlaga za nadaljnje usmerjeno vzorčenje. Zgodnja zaznava tako v primeru potrditve prisotnosti omogoča hitro ukrepanje in posledično zmanjšanje potencialne škode v okolju.

ABSTRACT

Bioinformatic Search for the Proverbial Needle in the eDNA Haystack

Climate change and development of global trade present new opportunities for novel introductions of tree pests and pathogens and can facilitate their establishment in new locations. Early detection is an important tool for damage prevention. Environmental DNA (eDNA) is a promising method, where all DNA present in the sample is extracted and different types of analyses are used to determine which organisms have left their mark on the sample. Bioinformatic analysis of the raw high-throughput sequencing results plays a major role in the final outcome. We will be presenting one of the ways that metabarcoding can be used to screen for the first information about whether a potentially harmful organism is present in the sampled environment. The broad screening method can then serve as the basis for further targeted sampling. In the case of confirmation of presence,

such early detection enables timely implementation of measures that minimize the potential damage in the environment.

Pomen ustaljene terminologije za učinkovito komunikacijo v gozdarstvu

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Slovensko gozdarstvo se vse pogosteje sooča z motnjami, kot so vremenske ujme in širjenje škodljivih organizmov, kar zahteva jasno in usklajeno komunikacijo med vsemi deležniki. Med pomembnimi škodljivi organizmi, ki ogrožajo naše gozdove, so tudi različne vrste podlubnikov (Coleoptera, Curculionidae, Scolytinae). V nedavno obljavljeni publikaciji o podlubnikih Slovenije, ki sicer predstavlja pomemben prispevek k poznavanju teh vrst pri nas, so bila predlagana nova slovenska imena. Predlogi sprememb ustaljenih slovenskih imen sprožajo pomisleke o strokovni ustreznosti, funkcionalnosti in ustaljenosti terminologije, pravtako pa se je izkazalo, da v slovenskem prostoru ni vzpostavljenega postopka za uvajanje novih poimenovanj, ki bi sistematično vključeval strokovno presojo, jezikoslovna načela in širši konsenz stroke. S prispevkom želimo opozoriti na pomen ohranjanja ustaljenih slovenskih poimenovanj, ki so v stroki uveljavljena že desetletja, ter predlagamo mehanizme za vzpostavitev strukturiranega procesa za usklajevanje slovenske strokovne terminologije.

ABSTRACT

The importance of established terminology for effective communication in forestry

Slovenian forests are increasingly threatened by numerous disturbances, such as weather events and the spread of harmful organisms, which requires clear and coordinated communication between all stakeholders. Important harmful organisms that threaten our forests include various species of bark beetles (Coleoptera, Curculionidae, Scolytinae). In a recently published publication on bark beetles of Slovenia, which otherwise represents an important contribution to the knowledge of these species in our country, new Slovenian names were proposed. Proposals for changes to established Slovenian names raise concerns about the professional suitability, functionality and stability of terminology, and it has also been shown that there is no established procedure in Slovenia for introducing new names that would systematically include professional judgment, linguistic principles and a broader consensus among the professionals. With this contribution, we wish to draw attention to the importance of preserving established Slovenian names, that have been used in the profession for decades, and propose mechanisms for establishing a structured process for harmonizing Slovenian professional terminology.

Poškodovanost borovih gozdov zaradi glive *Diplodia pinea* v Sloveniji v zadnjih 30 letih

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Gliva *Diplodia pinea* (Desm.) J. Kickx f. (sinonim *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton), povzročiteljica sušice najmlajših borovih poganjkov, je stalno prisotna v naših gozdovih in je najnevarnejša bolezen borov v Sloveniji. Gliva je kozmopolitska, razširjena je po vsem svetu. Na okužbo so najbolj občutljivi bori, prizadene pa lahko tudi druge iglavce, redkeje listavce. V gostiteljskih drevesih deluje kot parazit, saprofit ali endofit. V Sloveniji sta za bolezen najbolj občutljiva črni bor (*Pinus nigra* Arnold) in rdeči bor (*Pinus sylvestris* L.). Bolezen najpogosteje povzroča odmiranje enoletnih poganjkov (od tod ime bolezni); v oslabelih borih lahko povzroči odmiranje večletnih poganjkov in celih vej, redkeje povzroči razvoj raka na vejah ali deblu ali odmrtje celega drevesa. Če gliva naseli les, ga obarva modro, kar povzroči njegovo tehnično razvrednotenje. V zadnjih 30. letih se poškodovanost borov zaradi sušice najmlajših borovih poganjkov v Sloveniji povečuje, kar povezujemo tudi s posledicami podnebnih sprememb. Poškodbe so posledica delovanja glive *Diplodia pinea*, ki kot endofit živi v različnih rastlinskih tkivih, ne da bi pri tem povzročala škodo, dokler gostiteljska rastlina zaradi stresnih dejavnikov, najpogosteje suše, visokih temperatur ali toče, ne oslabi. Toča lahko povzroči obsežne mehanske poškodbe borovih vej in debla. Že sama mehanska poškodba skorje sproži, da se endofitni način prehranjevanja glive *D. pinea* prelevi v parazitskega. Poleg tega mehanske poškodbe povzročijo nastanek odprtih ran, skozi katere ima prost vstop naravno prisoten inokulum *D. pinea* in drugih patogenov. Zato smo po toči pogostokrat priča površinsko zelo obsežnim in zaskrbljujočim sušenjem borov. Na spletnem portalu Varstvo gozdov (https://www.zdravgozd.si/) je prvi zapis o večji poškodovanosti črnega bora iz leta 1983. Lastnikom gozdov na prizadetih površinah svetujemo posek borov z več kot 80 % poškodovanostjo krošnje, saj bodo zaradi okužbe z glivo najverjetneje odmrli.

ABSTRACT

Damage to Pine Forests Caused by the Fungus *Diplodia pinea* in Slovenia Over the Last 30 Years

The fungus *Diplodia pinea* (Desm.) J. Kickx f. (synonym *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton), the causal agent of tip blight of young pine shoots, is permanently present in our forests and is the most dangerous pine disease in Slovenia. The fungus is cosmopolitan and occurs worldwide. Pines are the most susceptible to infection, but the fungus can also affect other conifers and, more rarely, broadleaf species. In host trees, it can act as a parasite, saprophyte, or endophyte. In Slovenia, the most susceptible species are the Austrian pine (*Pinus nigra* Arnold) and Scots pine (*Pinus sylvestris* L.). The disease most frequently causes dieback of one-year-old shoots (hence its name); in weakened pines it may cause dieback of multi-year shoots and entire branches, and more rarely, the development of cankers on branches or the trunk, or the death of the entire tree. If the fungus colonizes the wood, causing bluestain, reducing its technical value. Over the last 30 years, pine damage caused by tip blight of young shoots has been increasing in Slovenia, which is associated with the consequences of climate change. The damage results from the activity of *Diplodia pinea*, which lives as an endophyte in various

plant tissues without causing harm until the host becomes weakened by stress factors. These are most commonly drought, high temperatures, or hail. Hail can cause extensive mechanical injuries to pine branches and trunks. The mechanical injury of the bark alone can trigger the shift of *D. pinea* from an endophytic to a parasitic mode of nutrition. Moreover, mechanical injuries create open wounds that allow easy entry for naturally present inoculum of *D. pinea* and other pathogens. Consequently, after hailstorms we often observe extensive and alarming surface-level dieback of pines. The first report of significant Austrian pine damage on the online Forest Protection portal (https://www.zdravgozd.si/) dates back to 1983. Forest owners in affected areas are advised to fell pines with more than 80% crown damage, as they are likely to die due to fungal infection.

Verjetnostne napovedi sanitarnega poseka smreke zaradi podlubnikov v Sloveniji v obdobju 2020–2025

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Gozdarski inštitut Slovenije v okviru Poročevalske, prognostično-diagnostične službe za gozdove vsako leto napove verjetnost sanitarnega poseka navadne smreke zaradi podlubnikov v Sloveniji. Napovedi izdelujemo od leta 2020 naprej s pomočjo prostorskega modela, ki je bil razvit z logistično regresijo in ima ločljivost 1 km × 1 km. Na podlagi dejavnikov, izmerjenih v preteklem letu, z modelom napovemo verjetnost sanitarnega poseka smreke zaradi podlubnikov v tekočem letu. V model za napoved verjetnosti sanitarnega poseka smreke zaradi podlubnikov so vključene naslednje neodvisne spremenljivke: lesna zaloga smreke, lokacija, naklon terena, tri lastnosti tal, standardizirani padavinski indeks za prejšnje leto, temperatura zraka v prejšnjem letu, sanitarni posek smreke zaradi žuželk v prejšnjem letu, posek oslabljene smreke zaradi abiotskih poškodb v prejšnjem letu, sanitarni posek smreke zaradi abiotskih poškodb v prejšnjem letu. V obdobju 2020–2025 so imele v povprečju višjo verjetnost sanitarnega poseka smreke gozdnagospodarska območja z večjim deležem smreke v gozdnih sestojih, to so Slovenj Gradec, Kranj, Nazarje, Kočevje in Bled. Napovedi vsako leto preverimo z dejanskimi podatki o sanitarni sečnji navadne smreke zaradi podlubnikov, ki jih evidentira Zavod za gozdove Slovenije. Validacija verjetnostnega modela je pokazala, da je zanesljivost napovedi visoka, tj. AUC (angl. Area Under the Curve) je znašal 0,82–0,89, točnost je znašala 64,1–73,5 %. Verjetnost napovedi ima vrednosti na intervalu med nič in ena, tj. od nizke do visoke verjetnosti. Vsako leto smo izračunali optimalni prag, ki določi najmanjšo verjetnost napovedi, ko se bo zgodil sanitarni posek smreke zaradi podlubnikov. Optimalni prag v obdobju 2020–2025 je imel vrednosti 0,30–0,55 s povprečjem 0,47. Optimalni prag gravitira proti 0,50, kar je statistično pričakovano, in ga bomo uporabili za izdelavo vseh nadaljnjih napovedi. Rezultate napovedi sanitarnega poseka smreke zaradi podlubnikov uporabljamo za bolj osredotočeno iskanje novih lubadark, za načrtovanje gozdnogospodarskih dejavnosti, za načrtovanje razporeditve dela, za načrtovanje ukrepov varstva gozdov idr.

ABSTRACT

Probabilistic forecasts of sanitary felling of spruce due to bark beetles in Slovenia for the period 2020–2025

The Slovenian Forestry Institute, within the Forest Reporting, Prognostic and Diagnostic Service, publishes annual forecasts of the probability of sanitary felling of Norway spruce due to bark beetles in Slovenia. We have been producing these forecasts since 2020 using a spatial model developed through logistic regression, with a resolution of 1 km × 1 km. Based on factors measured in the previous year, the model predicts the probability of sanitary felling of Norway spruce due to bark beetles in the current year. The model includes the following independent variables: Norway spruce growing stock, location, terrain slope, three soil properties, standardized precipitation index for the previous year, air temperature in the previous year, sanitary felling of Norway spruce due to insects in the previous year, felling of weakened Norway spruce due to abiotic damage in the previous year, and sanitary felling of Norway spruce due to abiotic damage in the previous year. Between 2020 and 2025, forest management areas with a higher proportion of spruce in forest stands—such as Slovenj Gradec, Kranj, Nazarje, Kočevje, and Bled—had, on average, a higher probability of sanitary felling. Each year, we validate the forecasts against actual data on sanitary felling of Norway spruce due to bark beetles, recorded by the Slovenia Forest Service. Validation of the probabilistic model showed high reliability, with AUC (Area Under the Curve) values ranging from 0.82 to 0.89 and accuracy between 64.1% and 73.5%. The predicted probability ranges from zero to one, i.e., from low to high likelihood of sanitary felling of Norway spruce due to bark beetles. Each year, we calculate an optimal threshold that determines the minimum predicted probability at which sanitary felling of spruce due to bark beetles is expected to occur. During 2020–2025, the optimal threshold ranged from 0.30 to 0.55, with an average of 0.47. The threshold gravitates toward 0.50, which is statistically expected, and will be used for all future forecasts. The results of these forecasts are used for more targeted detection of new bark beetle infestations, planning forest management activities, work allocation, forest protection measures, and more.

Spremljanje škode hrastove čipkarke (*Corythucha arcuata* [Say]) s pomočjo daljinskega zaznavanja

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Hrastova čipkarka (*Corythucha arcuata* (Say)) je invazivna vrsta, ki povzroča poškodbe v hrastovih gozdovih. Prvič se je pojavila v Evropi, in sicer v Italiji leta 2000. Nato se je hitro razširila na Balkan in v srednjo Evropo. Med najbolj ogroženimi so čisti hrastovi gozdovi nižjih nadmorskih višin v bližini avtocest in železnic. Na globalni ravni je bilo 25 vrst hrastov prepoznanih kot potencialni gostitelj. Hrastova čipkarka povzroča škodo s sesanjem listnega soka. Nekaj mesecev po začetku vegetacijske sezone (julij/avgust), se na listih pojavijo rumene lise in razbarvanje, kar vodi v zmanjšano delovanje fotosinteze in prezgodnje rumenenje ter odpadanje listov. Hrastova čipkarka prezimi pod lubjem in ima od aprila do novembra lahko tri generacije. Daljinsko zaznavanje je v zadnjih letih postalo pomembno orodje tudi na področju raziskovanja varstva gozdov. Razpoložljivost

satelitskih, letalskih in brezpilotnih posnetkov visoke ločljivosti omogoča zaznavanje poškodb na ravni krošenj, v nekaterih primerih pa celo na ravni posameznih listov. V našem raziskovalnem delu narejenem v okviru Horizon Europe project FORSAID (www.forsaid.eu), smo uporabili podatke, pridobljene z brezpilotnim letalnikom, opremljenim z navadno (RGB) in multispektralno kamero, kar nam je omogočilo natančno prostorsko in spektralno analizo stanja vegetacije. Sezonski razvoj krošenj, kjer je bila hrastova čipkarka prisotna, smo spremljali na treh lokacijah v Sloveniji, kjer je delež hrastov v sestoju več kot 80 % (Cigonca, Dobova in Krakovski gozd). Z brezpilotnim letalnikom smo vsak mesec (od maja do oktobra) preleteli štiri hektare veliko območje na vsaki lokaciji. Na enem hektarju smo znotraj območja vizualno ocenili poškodovanost dreves in zabeležili njihove koordinate. Za vsako lokacijo in vsak mesec smo iz posnetkov izračunali različne vegetacijske indekse, ki so pokazali poškodovanost krošenj. Izračunane indekse in terenski popis smo uporabili za nadaljnje analize sezonskega razvoja hrastove čipkarke in ugotavljanja prelomne točke napadenosti dreves.

Patogenost izolatov izbranih vrst gliv na *Juglans regia* `Franquette`

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Na sadikah oreha (*Juglans regia* L., sorta Franquette) smo testirali patogenost šestih izbranih izolatov gliv (*Botryosphaeria dothidea*, *Diaporthe eres*, *Diaporthe foeniculina*, *Fusarium juglandicola*, *Juglanconis juglandina* in *Neofusicoccum parvum*), ki smo jih izolirali iz obolelih orehov v Sloveniji. Inokulirali smo skupno 77 sadik orehov (vključno s kontrolo), periodično smo preverjali njihovo zdravstveno stanje in ob prvih znakih sušenja izvedli reizolacije gliv iz robov nastalih nekroz. Glede na preliminarne rezultate so bile reizolacije uspešne v primeru inokulacije z vsemi izolati gliv, razen *J. juglandina*. Najdaljše povprečne nekroze je povzročil izolat *N. parvum* (6 cm; reizolacije izvedene po mesecu dni). Na drugem mestu je bil izolat glive *D. foeniculina* (2,5 cm). Ostali izolati (*B. dothidea*, *D. eres*, *F. juglandicola, J. juglandina*) pa so povzročili podobne povprečne dolžine nekroz (1,6–1,9 cm). Vsi izolati gliv so povzročili statistično značilno daljše nekroze od kontrole ($p < 0,05$), kjer so se mesta inokulacij do konca poskusa že zarasla. Povprečna dolžina nekroz sadik oreha inokuliranih z *N. parvum* se je statistično značilno razlikovala od vseh ostalih obravnavanj ($p < 0,01$), razen od povprečnih dolžin nekroz sadik oreha inokuliranih z *D. foeniculina* ($p = 0,18$). Prav tako se povprečne dolžine nekroz niso statistično značilno razlikovale med sadikami inokuliranimi z *B. dothidea*, *D. eres*, *F. juglandicola* in *J. juglandina* ($p > 0,12$). Vizualna histopatološka analiza izolatov *B. dothidea, D. eres, D. foeniculina*, *F. juglandicola* in *J. juglandina* je pokazala, da so ti izolati povzročali v veliki večini zgolj nekrozo povrhnjice skorje, kar je značilno za endofite in latentne patogene. Izolat *N. parvum* se je v našem poskusu izkazal za agresivnejšega od ostalih testiranih izolatov gliv. Pri sadikah inokuliranih z *N. parvum* se je nekroza poleg povrhnjice skorje širila tudi v kambij, kar kaže na njegovo sposobnost hitrega povzročanja obsežnih poškodb poganjkov in vej oreha sorte Franquette tudi v naravnih razmerah. Za trdnejše zaključke bi bilo smiselno raziskati patogenost različnih izolatov *N. parvum* na različnih sortah oreha.

ABSTRACT

Pathogenicity of selected fungal species isolates on *Juglans regia* `Franquette`

The pathogenicity of six selected fungal isolates (*Botryosphaeria dothidea*, *Diaporthe eres, Diaporthe foeniculina*, *Fusarium juglandicola*, *Juglanconis juglandina* and *Neofusicoccum parvum*), isolated from diseased walnuts in Slovenia, was tested on saplings of *Juglans regia* `Franquette`. We inoculated a total of 77 walnut saplings (including the control), regularly checked their health status, and performed re-isolations from necrotic margins at the first signs of desiccation. Based on the preliminary results re-isolations were successful when inoculated with all fungal isolates, except *J. juglandina*. The longest mean necroses were caused by the *N. parvum* isolate (6 cm; re-isolations performed after one month). The second longest necroses were induced by the *D. foeniculina* isolate (2.5 cm). The remaining isolates (*B. dothidea*, *D. eres*, *F. juglandicola, J. juglandina*) caused similar mean necrosis lengths (1.6–1.9 cm). All fungal isolates produced significantly longer necroses than the control ($p < 0.05$), in which the inoculation points had already healed by the end of the experiment. The mean necrosis length of walnut saplings inoculated with *N. parvum* differed significantly from all other treatments ($p < 0.01$), except from those inoculated with *D. foeniculina* ($p = 0.18$). Likewise, there were no significant differences in mean necrosis lengths among saplings inoculated with *B. dothidea*, *D. eres*, *F. juglandicola* and *J. juglandina* ($p > 0.12$). Visual histopathological examination of the isolates *B. dothidea*, *D. eres*, *D. foeniculina*, *F. juglandicola*, and *J. juglandina* showed that these isolates caused predominantly epidermal bark necrosis, which is characteristic of endophytes and latent pathogens. In our experiment, the *N. parvum* isolate proved to be more aggressive than the other tested fungal isolates. In saplings inoculated with *N. parvum*, necrosis extended from the bark epidermis into the cambium, indicating its ability to rapidly cause extensive damage to shoots and branches of the walnut cultivar Franquette even under natural conditions. To draw more robust conclusions, it would be advisable to investigate the pathogenicity of different *N. parvum* isolates across various walnut cultivars.

Posterji

Sezonska dinamika grozdnih sukačev in navadne tenčičarice ter pojavljanje resarjev in talnih hroščev v vinogradih dveh vinorodnih okolišev v Sloveniji

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V letu 2025 smo v okviru projekta Soildivine, financiranega s strani evropskega partnerstva za biotsko raznovrstnost Biodiversa+, spremljali sezonsko dinamiko križastega grozdnega sukača (*Lobesia botrana*), pasastega grozdnega sukača (*Eupoecilia ambiguella*) ter navadne tenčičarice (*Chrysoperla carnea*) v dveh vinorodnih deželah, Štajerski in Primorski. V vsaki od dežel je poskus potekal v dveh vinogradih. Na Primorskem smo feromonske pasti za sukača in atraktante za navadno tenčičarico postavili v vinogradih v Pliskovici in Komnu. Na Štajerskem smo v raziskavo vključili vinograda na Mestnem vrhu in v Ritoznoju. V raziskavi smo uporabili feromonske pasti in atraktante madžarskega proizvajalca CSALOMON iz Budimpešte. Pregled pasti je potekal v 10-14 dnevnih intervalih, medtem ko smo feromone/atraktante menjali v mesečnih intervalih. Posamezni vinograd smo razdelili na tri bloke. Znotraj posameznega bloka smo razporedili pasti za vsako preučevano žuželčjo vrsto. Izjema je bila postavitev pasti za navadno tenčičarico v vinogradu v Pliskovici, kjer smo pasti postavili glede na obdelavo tal v vinogradu, tj. zatravljeno oziroma orano. Prve metulje križastega grozdnega sukača smo v vinogradih na Štajerskem zaznali že v časovnem intervalu od 22.4.-7.5., ko smo v pasteh v Ritoznoju ugotovili več kot 11 samcev na past na dan. V vinogradu v Mestnem vrhu je bil ulov bistveno manjši (1 samec past/dan). Drugi rod se je pojavljal v obdobju 29.6.-16.7., tretji rod pa smo v pasteh zaznali v obdobju od 8.8 do 5.9. Pasastega grozdnega sukača v izbranih štajerskih vinogradih nismo potrdili. Jajčeca navadne tenčičarice smo na obeh lokacijah beležili vse do 27.10.; največje število odloženih jajčec je bilo v intervalu 30.7.-7.8. na obeh lokacijah. Večje število jajčec navadne tenčičarice smo v pasteh v primorskih vinogradih zaznali od intervala 17.7.-28.7. naprej, v pateh pa so se pojavljala vse do konca rastne dobe. Številčnost grozdnih sukačev je bila na Primorskem bistveno manjša kot v štajerskih vinogradih, saj v nobenem od časovnih intervalov nismo ujeli več kot enega osebka na past na dan. V prispevku bomo prav tako predstavili pojavljanje talnih hroščev in resarjev v preučevanih vinogradih. Ugotovili smo, da se zastopanost žuželk med posameznimi vinogradi zelo razlikuje.

ABSTRACT

Seasonal dynamics of grapevine moths and the common green lacewing, and the occurrence of thrips and ground beetles in vineyards of two wine-growing districts in Slovenia

In 2025, as part of the SOILDIVINE project—funded by the Biodiversa+ European Biodiversity Partnership—we monitored the seasonal dynamics of the European grapevine moth (*Lobesia botrana*), the European grape berry moth (*Eupoecilia ambiguella*), and the common green lacewing (*Chrysoperla carnea*) in two wine-growing regions: Štajerska and Primorska. In each of the regions, the experiment was conducted in two vineyards. In the Primorska region, pheromone traps and attractants for the common green lacewing were placed in vineyards in Pliskovica and Komen. Pheromone

traps and attractants from the Hungarian manufacturer CSALOMON (Budapest) were used in the research. The traps were inspected at 10–14 day intervals, while the pheromones/attractants were replaced on a monthly basis. Each vineyard was divided into three blocks. Within each block, traps for specific arthropod were arranged. An exception was the placement of traps for the common green lacewing in the Pliskovica vineyard, where traps were positioned according to the soil management practices, i.e., grass-covered versus tilled soil. The first European grape vine moths in the Štajerska vineyards were detected as early as the interval between 22nd April and 7th May, when more than 11 males per trap per day were recorded in the Ritoznoj vineyards. In the Mestni vrh vineyard, the catch was significantly lower (1 male/trap/day). The second generation appeared in the period from 29th June to 16th July, while the third generation was detected in the traps between 8th August and 5th September. The European grape berry both (*Eupoecilia ambiguella*) was not detected in the selected Štajerska vineyards. Common green lacewing eggs were recorded at both locations until 27th October, with the highest number of eggs deposited in the interval from 30th July to 7th August at both sites. In the vineyards of the Primorska region, a higher number of common green lacewing eggs was detected in traps from the 17th-28th July onwards, with eggs continuing to appear in the traps until the end of the growing season. The abundance of grapevine moths in the Primorska region was significantly lower than in the Štajerska vineyards, as we did not capture more than one individual per trap per day in any of the time intervals. In this paper, we will also present the occurrence of ground beetles and thrips in the studied vineyards. We found that the presence of arthropods varies greatly between individual vineyards.

Assessment of the biocontrol potential of *Bacillus* strains against *Diaporthe ampelina* in Montenegro

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Diaporthe dieback is a grapevine disease caused by fungi of the genus *Diaporthe* (anamorph: *Phomopsis*), and it belongs to the group of grapevine trunk diseases (GTDs). The disease is widely distributed in all vineyard regions of Montenegro and causes significant production losses. Typical symptoms appear on leaves as small chlorotic spots, while on shoots, dark lesions occur between nodes, most often on the basal internodes. Advanced infections lead to necrosis of the vascular tissues of shoots or the whole grapevine, which may result in partial or, in severe cases, complete grapevine decline. In line with the European Green Deal, which promotes the use of innovative and sustainable technologies, biopesticides play a key role in integrated plant protection. The aim of this study was to assess the antagonistic potential of the biocontrol microorganisms *Bacillus subtilis* (Erwix) and *Bacillus amyloliquefaciens* FZB24 (Taegro®) against the *Diaporthe ampelina* MN001 isolate, from Montenegro. The antagonistic activity was tested *in vitro* and *in planta* on detached grapevine shoots. All experiments were conducted in three replicates. Data were grouped, normality was tested using the Shapiro-Wilk test, followed by ANOVA and Tukey's test. *In vitro* tests showed a statistically significant antagonistic effect of both microorganisms against the *D. ampelina* MN001 isolate, ranging from 45.7–

58.9% for *B. subtilis* and 44.2–64.1% for *B. amyloliquefaciens* FZB24. Preliminary *in planta* results demonstrated inhibition ranging from 41.5–48.2% for *B. subtilis* and 41.03–58.4% for *B. amyloliquefaciens* FZB24, indicating the potential applicability of biofungicides in grapevine protection programs. Further *in planta* testing under vineyard conditions is necessary to confirm these findings and assess practical applicability.

Vinske trte brez simptomov krošnje povezanih z ESCA, imajo lahko hude bolezni debla, ki jih povzročajo glive, ki razkrajajo les

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ESCA je bolezen debla vinske trte, ki jo povzroča skupina gliv, ki razgrajujejo les. Okužene trte lahko več let izgledajo zdrave, zato pridelovalci redko izvajajo destruktivno vzorčenje, zaradi česar obseg notranjega razpadanja in raznolikost gliv ostajata slabo opredeljena. Da bi povezali simptome na krošnji z notranjo trohnobo debla, smo tri leta spremljali 100 trt (sorta Šipon, stare približno 25 let, Litmerk) glede na pojav tigrastih prog na listih in črnih madežev. Oktobra 2025 so bila vsa debla destruktivno vzorčena, vzdolžno razrezana in fotografsko dokumentirana za kvantifikacijo temnega progastega razkroja (askomicetes) in bele gnilobe (bazidiomicete). Iz 36 trt smo iz območij med zdravim in gnilim lesom izolirali glive ter jih identificirali morfološko in z določanjem črtnih kod DNK. Simptomi na krošnji so bili sporadični: le 8 % trt je pokazalo zgodnje ali napredne tigraste proge, ena trta je propadla zaradi apopleksije. Nasprotno pa je bilo notranja trohnoba široko razširjena: 100 % debel (mlade trte izključene) je kazalo hudo poškodbo, 34 % je imelo obsežne temne proge, 66 % pa temne proge in belo gnilobo. Vzorec gnilobe je potrdil izvor v ranah zaradi obrezovanja, najmočnejša je bila na vrhu trt, širila se je navzdol v obliki temnih prog, sledila je bela gniloba. Čeprav tigraste proge signalizirajo napredno poškodbo, so tudi trte brez vidnih simptomov imele hudo notranjo gnilobo. Razvidnost listnih simptomov podcenjuje pojavnost in resnost bolezni, kar omejuje praktičnost zdravljenja. Identifikacija gliv je potrdila prisotnost znanih patogenov kompleksa vrst bolezni ESCA in drugih povzročiteljev bolezni lesa ali prevodnih tkiv. Rezultati podpirajo tudi razvoj daljinskega zaznavanja za zgodnje odkrivanje očem nevidnih signalov na krošnji. Zahvala: finančna podpora s strani L7-50153 RESENS-VITIS.

ABSTRACT

Grapevines without ESCA-related canopy symptoms can have sever trunk diseases caused by wood decaying fungi

ESCA is a grapevine trunk disease caused by a consortium of wood-decaying fungi. Because infected grapevines can appear healthy for years, destructive sampling and pathogen diagnosis are typically done for individual vines only, leaving the extent of internal decay and fungal diversity poorly characterized. To link canopy symptoms with internal trunk rots, tiger-stripe leaf patterns and black measles, both ESCA-related canopy

symptoms, were monitored for 100 grapevines (cv. Šipon, ca. 25 years, Litmerk) over three years. In October 2025, all trunks were destructively sampled, longitudinally sectioned, and photo-documented to quantify dark wood streaking (caused by ascomycetes) and white rot (basidiomycetes). Fungal communities were characterized from 36 vines through culture-dependent isolation, followed by morphological and DNA-barcode-based identification. Canopy symptoms were sporadic: in 2025, 8% of vines showed few or numerous leaves with tiger-stripe symptoms, and only one vine died from apoplexy. In contrast, internal wood rots were highly developed. Excluding young vines, all trunks displayed severe wood deterioration; 34% showed extensive dark wood streaking, and 66% exhibited dark streaking and white rot. Patterns of decay confirmed a pruning-wound origin, as rot was strongest in the heads of the cane-pruned vines and progressed downward first as dark streaking followed by white rot. Although tiger-stripe symptoms were associated with trunk damage, grapevines without canopy symptoms also showed severe internal rots. Reliance on foliar symptoms may underestimate trunk disease incidence and severity. Because nearly all vines harboured advanced decay, curative treatments appear impractical, emphasizing the need for pruning-wound protection strategies. Fungal identifications confirmed the presence of known ESCA-associated pathogens and other causal agents of wood or vascular diseases. Results may also support the development of remote sensing methodologies for detecting early but naked-eye invisible canopy signals. Acknowledgement: funded by L7-50153 RESENS-VITIS.

Pregled vrst parazitoidov iz poddružine Microgastrinae (Hymenoptera: Braconidae) v Sloveniji

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Poddružina Microgastrinae (Hymenoptera: Braconidae) predstavlja eno najbolj vrstno pestrih skupin z okoli 3.000 opisanimi vrstami. Vsi predstavniki te poddružine so izključno obligatni koinobionti in endoparazitoidi ličink metuljev. Med njimi je tudi nekaj pomembnih vrst, ki se v svetu pogosto uporabljajo v biotičnem varstvu proti škodljivcem v kmetijstvu in gozdarstvu. Kljub njihovi ekološki in aplikativni vrednosti pa so podatki o prisotnosti vrst iz poddružine Microgastrinae v številnih predelih Evrope zelo skopi. V prispevku predstavljamo prvi pregled favne te poddružine v Sloveniji. Do sedaj lahko na podlagi pregleda virov in lastnih raziskav v Sloveniji potrdimo 19 vrst parazitoidov iz 7 različnih rodov: *Apanteles* (1), *Choeras* (1), *Cotesia* (12), *Diolcogaster* (1), *Glyptapanteles* (1), *Microgaster* (2) in *Microplitis* (1). Največ, kar 12 vrst, smo v Sloveniji našli iz rodu *Cotesia*, ki v svetu obsega okoli 320 znanih vrst. Najbolj pogosto najedena vrsta je bila *Cotesia ofella*.

ABSTRACT

The check of Microgastrinae (Hymenoptera: Braconidae) parasitoids in Slovenia

With approximately 3,000 described species worldwide, the subfamily Microgastrinae (Hymenoptera: Braconidae) represents one of the most species-rich groups of parasitoid wasps. All members of this subfamily are obligate koinobiont endoparasitoids of Lepidoptera larvae. Several species play important roles in biological control programs targeting agricultural and forestry pests. Despite their ecological and applied importance, regional faunistic data on Microgastrinae remain incomplete for many parts of Europe. This contribution provides the first overview of the Microgastrinae fauna of Slovenia. Based on extensive original field research, we confirm the presence of 19 Microgastrinae species belonging to seven genera in Slovenia: *Apanteles* (1), *Choeras* (1), *Cotesia* (12), *Diolcogaster* (1), *Glyptapanteles* (1), *Microgaster* (2), and *Microplitis* (1). The genus *Cotesia* is the most species-rich, represented by 12 confirmed species. *Cotesia ofella* was most frequently recorded species.

Plenilska stenica *Perillus bioculatus* (Heteroptera: Pentatomidae: Asopinae), naravni sovražnik koloradskega hrošča (*Leptinotarsa decemlineata* [Say]), ugotovljen tudi v Sloveniji

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V zahodni Sloveniji smo leta 2024 prvič zabeležili plenilsko stenico *Perillus bioculatus* (Fabricius, 1775) (Heteroptera: Pentatomidae), specializiranega plenilca vseh razvojnih stadijev koloradskega hrošča (*Leptinotarsa decemlineata* [Say]). Gre za severnoameriško vrsto plenilske ščitaste stenice iz poddružine Asopinae, ki je bila v Evropo prvič načrtno vnesena v tridesetih letih 20. stoletja z namenom biotičnega zatiranja koloradskega hrošča, nato pa ponovno od poznih petdesetih let dalje. V Sloveniji je bila prva odrasla stenica najdena novembra 2024 v vasi Kozana v Goriških brdih, in sicer v gospodarskem objektu, kamor se je zatekla med prezimovanjem. V maju in juniju 2025 so bile posamezne odrasle stenice opažene na posevkih krompirja na več lokacijah v spodnji Vipavski dolini (Kromberk, Orehovlje, Miren), na Dolenjskem (Šentpavel na Dolenjskem in okolica Žužemberka) in Notranjskem (Stari trg pri Ložu, Cerkniško jezero) ter na širšem območju Ljubljane (Horjul, okolica Mengša in Brezovice). V avgustu 2025 smo zabeležili večjo populacijo odraslih stenic, nimf in odloženih jajčec na posevku soje v Orehovljah in na krompirju, v Horjulu. V septembru 2025 je bila plenilska stenica prvič opažena tudi v zgornjem Posočju. Pojav *P. bioculatus* v Sloveniji je najverjetneje povezan z naravno širitvijo vrste z območij na Balkanskem polotoku, od koder se je v preteklosti začela širiti proti severu in severozahodu Evrope. V zadnjih dveh letih je bila vrsta zabeležena tudi v državah, ki mejijo na Slovenijo: na Madžarskem (2023), Hrvaškem (2024) in v Italiji (2024). V prispevku bodo predstavljene osnovne morfološke in biološke značilnosti vrste in podatki o njeni trenutni razširjenosti v Sloveniji.

ABSTRACT

The predatory stink bug *Perillus bioculatus* (Heteroptera: Pentatomidae: Asopinae), a natural enemy of the Colorado potato beetle (*Leptinotarsa decemlineata* [Say]), is also recorded in Slovenia

In 2024, the predatory stink bug species *Perillus bioculatus* (Fabricius, 1775) (Heteroptera: Pentatomidae), a specialized predator of the Colorado potato beetle (*Leptinotarsa decemlineata* [Say]), was recorded for the first time in western Slovenia. This North American species, belonging to the subfamily Asopinae, was initially introduced into Europe in the 1930s for the biological control of the Colorado potato beetle, with further introductions occurring from the late 1950s onward. The first adult specimen was found in Slovenia in November 2024 in the village of Kozana, (Goriška Brda), inside an agricultural facility where it had taken refuge for overwintering. During May and June 2025, individual adults were observed on potato crops at several locations, including the lower Vipava Valley (Kromberk, Orehovlje, Miren), the Dolenjska region (Šentpavel na Dolenjskem and the surroundings of Žužemberk), Notranjska region (Stari trg pri Ložu, Lake Cerknica), and the wider area of Ljubljana (Horjul, the surroundings of Mengeš and Brezovica). In August 2025, a larger population consisting of adults, nymphs, and eggs was recorded on soybean crop in Orehovlje and on potatoes in Horjul. In September 2025, *P. bioculatus* was also documented for the first time in the Upper Soča Valley. The occurrence of *P. bioculatus* in Slovenia is most likely associated with the natural spread of the species from the Balkan Peninsula, from where it has expended northward and north–westward across Europe. In recent years, the species has also been reported in neighboring countries, including Hungary (2023), Croatia (2024), and Italy (2024). This study presents the basic morphological and biological characteristics of *P. bioculatus* and provides data on its current distribution in Slovenia.

Biofumigacija s križnicami in njihovimi derivati pri zatiranju strun (Coleoptera: Elateridae): možnosti in izzivi

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Biofumigacija je okolju prijazna agronomska metoda, ki temelji na uporabi bioaktivnih spojin iz vrst rodu *Brassica* za zatiranje talnih škodljivih organizmov. Obravnavamo jo kot trajnostno alternativo kemičnim fumigantom, ki se uporabljajo pri klasični fumigaciji tal, s poudarkom na njenem potencialu pri obvladovanju strun (Coleoptera: Elateridae). Na podlagi analize obstoječih raziskav ocenjujemo učinkovitost biofumigacije z rastlinami iz rodu Brassica, s posebnim poudarkom na vrstah rjave indijske gorčice *Brassica juncea* (L.) Czern. in etiopske gorčice *Brassica carinata* A. Braun, ki sta bogati z glukozinolati (Gln). Posvetimo se tudi procesom in mehanizmom razgradnje glukozinolatov, pri katerih encimska hidroliza sprošča izotiocianate (IsoT) in druge bioaktivne spojine s pesticidnimi lastnostmi. V pregledu raziskav učinkovitosti biofumigacije proti strunam obravnavamo rezultate, pridobljene v laboratorijskih analizah, poskusih v polkontroliranih razmerah in dolgoročnih poljskih preizkusih, z namenom ocene vpliva biofumigacije na strune, zdravje tal in širše strategije varstva rastlin. Poleg tega preučujemo, kako lahko biofumigacija moti prehranjevalno vedenje strun ter hkrati izboljšuje talno strukturo in mikrobno aktivnost. Kljub obetavnim možnostim lahko na učinkovitost in širšo uvedbo biofumigacije vplivajo

številni izzivi, med katerimi so: spremenljiva učinkovitost v poljskih razmerah, vplivi na koristne talne organizme in ovire pri uvedbi metode biofumigacije v večjem obsegu. Poudarjamo potrebo po nadaljnjih raziskavah, ki bodo izboljšale načine uporabe biofumigacije, povečale stabilnost izotiocianatov in drugih bioaktivnih snovi v tleh, ter omogočile vključitev te metode v integrirano varstvo rastlin, predvsem z namenom trajnostnega obvladovanja strun.

ABSTRACT

Biofumigation with cruciferous crops and their products for wireworm control (Coleoptera: Elateridae): applications and potential challenges

Biofumigation represents an environmentally sustainable agronomic approach based on the use of bioactive compounds derived from plants of the genus *Brassica* to suppress soil-dwelling pests. In our case, biofumigation is examined as a viable alternative to conventional chemical soil fumigants, with particular emphasis on its potential for the management of wireworms (Coleoptera: Elateridae). Through an evaluation of available scientific literature, we assess the effectiveness of biofumigation using *Brassica* crops, focusing especially on Indian mustard (*Brassica juncea* (L.) Czern.) and Ethiopian mustard (*Brassica carinata* A. Braun), both characterized by high glucosinolate (Gln) content. Special attention is given to the biochemical processes underlying glucosinolate degradation, during which enzymatic hydrolysis leads to the formation of isothiocyanates (IsoTs) and other bioactive compounds with pesticidal activity. Our work integrates results from laboratory assays, semi-controlled experiments, and long-term field studies to evaluate the effects of biofumigation on wireworm populations, soil health, and broader plant protection strategies. Furthermore, we examine evidence suggesting that biofumigation can interfere with wireworm feeding behavior while simultaneously enhancing soil structure and microbial activity. Despite its considerable potential, the practical performance and wider implementation of biofumigation remain constrained by several challenges, including variable efficacy under field conditions, possible impacts on beneficial soil organisms, and limitations associated with large-scale application. Finally, we highlight the need for further research aimed at optimizing biofumigation practices, improving the persistence and stability of isothiocyanates and other bioactive compounds in soil, and facilitating the integration of biofumigation into integrated pest management systems for the sustainable control of wireworms.

Množični ulov poljskega majskega hrošča (*Melolontha melolontha* L.) s svetlobnimi pastmi logu v Zadlogu na Idrijskem

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Obsežna travišča Črnovrške planote v občini Idrija, obdana z gozdovi in mejicami, predstavljajo pomemben habitat poljskega majskega hrošča (*Melolontha melolontha* L.) v Sloveniji. Zgodovinsko dokumentirani izbruhi populacije tega škodljivca so na obravnavanem območju znani že iz tridesetih let 20. stoletja. V zadnjih petindvajsetih letih

klimatske spremembe in spremembe v rabi tal ter obdelavi kmetijskih zemljišč ustvarjajo ugodne pogoje za povečevanje populacij *M. melolontha*, kar se odraža v ponavljajočih se obdobjih prerazmnožitve. Številčnemu rojenju odraslih osebkov praviloma sledi množičen pojav ličink (ogrcev) v tleh, ki v obdobju triletnega razvojnega kroga povzročajo postopno degradacijo travne ruše. V skrajnih primerih lahko velike populacije ličink ob neugodnih vremenskih razmerah, zlasti v sušnih obdobjih, povzročijo popolno izgubo travne ruše. Jeseni leta 2022 smo na obravnavanem območju ponovno zabeležili obsežno poškodovanost travne ruše zaradi napada ličink *M. melolontha*, pri čemer se je v letih 2023 in 2024 med razvojem ličink še povečevala. Z namenom preprečitve nadaljnjega nastajanja gospodarske škode smo leta 2025 poskusno uvedli ukrep zgodnjega zmanjšanja populacije *M. melolontha*, ki je temeljil na metodi množičnega ulova odraslih osebkov. V začetku aprila 2025 smo na prizadetem območju namestili 42 svetlobnih pasti. Ročno izdelane pasti so bile opremljene z lovilno posodo in svetlobnim virom (aktinijska sijalka), ki je oddajal modro zeleno svetlobo valovnih dolžin 500-540 nm, za katero je znano, da privablja pahljačnike. Aktinijske sijalke so delovale v času leta odraslih osebkov, in sicer od sončnega zahoda do popolne znočitve, v skupnem trajanju približno štirih ur dnevno. Ulov hroščev je bil največji od sredine aprila do začetka maja, in sicer v prvih 20 dneh po izletu iz tal, ko so dnevne temperature zraka ob sončnem zahodu presegale 15 °C. Največje število hroščev je bilo ujetih v pasteh, ki so bile nameščene na travnikih z največjo gostoto ličink v tleh, dokumentirano leta 2024. Učinkovitost množičnega ulova poljskega majskega hrošča s svetlobnimi pastmi smo ocenili jeseni 2025 z izvedbo talnih izkopov in ugotavljanjem gostote ličink v tleh (št. ličink / m^2). Ugotovili smo, da je bilo povprečno število ličink *M. melolontha* na parcelah s svetlobnimi pastmi 57 % manjše v primerjavi s kontrolnimi parcelami brez pasti.

ABSTRACT

Mass trapping of the common cockchafer (*Melolontha melolontha* L.) using light traps in Zadlog (Idrija region)

The grasslands of the Črni Vrh Plateau in the Municipality of Idrija, surrounded by forests and hedgerows, represent an important habitat for the common cockchafer (*Melolontha melolontha* L.) in Slovenia. Over the past 25 years, climate change, together with changes in land use and agricultural management have created favourable conditions for increases of *M. melolontha* population, resulting in recurring periods of mass outbreaks. The emergence of large numbers of adults is usually followed by a mass occurrence of larvae (white grubs) in the soil, which during their three-year life cycle, cause progressive degradation of the grass sward. Under extreme conditions, large populations of white grubs in the soil combined with unfavourable weather conditions, particularly drought, can lead to complete loss of the grass sward. After a decade and a half without major outbreaks, extensive damage to the grass sward caused by *M. melolontha* larvae was again recorded in the study area in autumn 2022. To prevent recurrence of severe damage to grasslands, experimental early population-suppression measures targeting *M. melolontha* were implemented in 2025, based on mass trapping of adult beetles. In early April, 42 light traps were deployed across the affected area. The locally manufactured traps were equipped with a collecting container and an actinic light source emitting in the blue-green spectral region (500-540 nm), which is known to attract common cockchafers. The lights operated during the adult flight period, from sunset until complete darkness, for approximately four hours per day. Beetle captures peaked from mid-April to early May, during the first 20 days following adult emergence from the soil, when temperatures at sunset exceeded 15 °C. The highest numbers of adults were recorded in light traps placed in the meadows with the highest densities of white grubs in the soil, as recorded in 2024. The efficiency of light-trap-based mass trapping of the common cockchafer was assessed

by determining the density of white grubs (number per m²) in the soil and comparing these values with control plots without light traps. The results demonstrated a 57% reduction in white-grub populations in plots with light traps relative to the controls.

Spremljanja poljskega majskega hrošča (*Melolontha melolontha* L.) z različnimi tipi pasti za množični ulov odraslih hroščev

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Poljski majski hrošč (*Melolontha melolontha* L.), polifagni hrošč iz družine Scarabaeidae, je v Evropi poznan kot pomemben škodljivec poljščin, vrtnin in travinja. V ugodnih podnebnih razmerah se lahko prekomerno razmnoži in povzroči gospodarsko škodo v večjem obsegu. Največjo škodo povzročajo ogrci, ki živijo v tleh več let in intenzivno objedajo korenine gojenih in samoniklih rastlinskih vrst, kar vodi v oslabitev rastlin, zmanjšanje pridelka in degradacijo travnih površin. Zaradi pomanjkanja učinkovitih metod za neposredno obvladovanje ogrcev v tleh oziroma omejitev pri njihovi uporabi, se iščejo alternativni pristopi, ki so osredotočeni na zmanjševanje populacije odraslih hroščev. Leta 2025 smo v okviru projekta CRP V4-2414: ″Preučevanje učinkovitosti, optimizacija in implementacija metod množičnega lovljenja in motenja parjenja izbranih gospodarsko pomembnih škodljivcev gojenih in samoniklih rastlin″ na območju Črnega Vrha preučevali učinkovitosti različnih načinov množičnega lovljenja odraslih osebkov *M. melolontha*.. V preizkušanje smo vključili pet tipov pasti z različno oblikovanimi lovilnimi posodami (Pherobank zelena, G-TRAP, Past ECONEX Popillia, inPEST MASS LARGE, PROBODELT rdeča, opremljenimi s privabilom Melowit Kombi proizvajalca WITASEK PflanzenShutz GmbH), in dva tipa svetlobnih pasti (Funnel trap bucket in svetlobna vaba lastne izdelave). Past Pherobank zelena brez privabila je služila kot kontrola. Poskus z naključno razporeditvijo pasti v treh ponovitvah je potekal na travnikih v bližini vasi Črni Vrh, kjer so bile pasti nameščene na nosilce ali na obrobno vegetacijo v začetku aprila.. Od začetka aprila do konca junija 2025 smo tedensko pregledovali in šteli ulovljene hrošče, pri čemer smo podatke sproti beležili v spletno aplikacijo za nadaljnjo analizo. V prispevku so predstavljeni rezultati spremljanja poljskega majskega hrošča (*Melolontha melolontha* L.) v letu 2025 in primerjava učinkovitosti različnih tipov pasti za množični ulov.

ABSTRACT

Monitoring of the common cockchafer (*Melolontha melolontha* L.) using different trap types for mass trapping of adult beetles

The common cockchafer (*Melolontha melolontha* L.), a polyphagous beetle belonging to the family Scarabaeidae, is known in Europe as an important pest of field crops, vegetables, and grasslands. Under favourable climatic conditions, its populations can increase excessively and cause large-scale economic damage. The greatest damage is caused by the larvae (white grubs), which live in the soil for several years and feed intensively on the roots of cultivated and wild plant species, leading to plant weakening, yield reduction, and degradation of grassland surfaces. Due to the lack of effective

methods for the direct control of larvae in the soil, or limitations on their use, alternative approaches are being sought that focus on reducing adult beetle populations. In 2025, within the framework of the CRP V4-2414 project *"Investigation of the effectiveness, optimization, and implementation of mass trapping and mating disruption methods for selected economically important pests of cultivated and wild plants"* in the Črni Vrh area, we investigated the effectiveness of different mass-trapping methods for adult *M. melolontha*. Five types of traps with differently designed collection containers (Pherobank green, G-TRAP, ECONEX Popillia trap, inPEST MASS LARGE, and PROBODELT red), all equipped with the attractant Melowit Kombi produced by WITASEK Pflanzenschutz GmbH, and two types of light traps (a funnel trap bucket and a custom-made light trap) were included in the study. A Pherobank green trap without attractant served as the control. The experiment, with randomized trap placement in three replications, was conducted on meadows near the village of Črni Vrh, where the traps were mounted on supports or placed along marginal vegetation in early April. From early April to the end of June 2025, the traps were inspected weekly and the captured beetles were counted, with the data recorded continuously in an online application for further analysis. This paper presents the results of monitoring the common cockchafer (*Melolontha melolontha* L.) in 2025 and compares the effectiveness of different trap types for mass trapping.

Množično lovljenje odraslih osebkov junijskega hrošča (*Amphimallon solstitiale* [L.]) na svetlobno past in različne feromonske pasti na naravnem travinju na Kočevskem

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Na dveh lokacijah na Kočevskem (Stari Breg in Dolnja Briga) smo v letu 2025 preučevali učinkovitost različnih načinov privabljanja odraslih osebkov junijskega hrošča, da bi ugotovili, kateri način je najustreznejši za njihovo množično lovljenje. Predpostavljali smo, da bi bilo mogoče z uporabo najučinkovitejšega načina lovljenja hroščev zmanjšati številčnost ogrcev v travniških tleh, s tem pa na travnikih tudi obseg poškodb zaradi ritja divjega prašiča. Poskusni zemljišči sta bila trajna travnika, ki smo ju na gozdnem robu razdelili v tri bloke, znotraj katerih smo naključno razporedili sedem obravnavanj (pasti). Šest preučevanih pasti (v pet pasti smo namestili feromonski dispenzor (R)-acetoin grškega proizvajalca NovAgrica, ena past pa je bila brez feromonskega dispenzorja) je bilo različnih oblik in barv, sedmo obravnavanje pa je predstavljala svetlobna past. V poskusa, v katerih smo pasti v obdobju od 26.4 do 5.8. pregledovali v približno 10-dnevnih intervalih, so bila tako vključena naslednja obravnavanja: 1) svetlobna past (proizvajalec: Insects & Light, Nemčija) z UV LED žarnico, 2) zeleni lonec (proizvajalec Pherobank, Nizozemska) brez feromonskega dispenzorja, 3) zeleni lonec (proizvajalec Pherobank, Nizozemska) s feromonskim dispenzorjem, 4) G-trap (proizvajalec: Sanidad Agricola Econex, Španija) s feromonskim dispenzorjem, 5) past Econex Popillia (proizvajalec: Sanidad Agricola Econex, Španija) s feromonskim dispenzorjem, 6) past inPEST Mass Large (proizvajalec: Gea, Italija) in 7) past Probodelt s feromonskim dispenzorjem (proizvajalec: Probodelt, Španija). Šest pasti (razen svetlobne pasti) smo v vsakem bloku namestili na debla dreves na gozdnem robu na višini 1,5 m. Razdalja med pastmi, v katerih smo feromonske dispenzorje menjavali na približno en mesec, je bila okrog 50 m. Svetlobna past je bila v vsakem bloku postavljena najmanj 100 m od najbližje od ostalih

tipov pasti. Svetlobno past, ki jo je predstavljala LED-žarnica je oddajala svetlobo elektromagnetnega spektra z vrhovi pri 368 nm (ultravijolična), 450 nm (modra), 530 nm (zelena) in 550 nm (hladno bela) in je sevala 1,43 W m^{-2}. V prvem letu raziskave so se pasti s feromonskimi dispenzorji izkazale za neučinkovite pri privabljanju odraslih osebkov junijskega hrošča. V Dolnji Brigi smo od 15.5. do 28.7. ulovili 180 hroščev, pri čemer se le eden ni ulovil v svetlobno past. Največji ulov hroščev (pribl. 5 osebkov/past/dan) smo ugotovili med 24.6. in 2.7. V Starem Bregu se je v svetlobne pasti od 5.5. do 21.7. ulovilo 47 hroščev, pri čemer smo največji ulov (en osebek/past/dan) ugotovili med 2.7. in 8.7.

ABSTRACT

Mass trapping of European june beetle (*Amphimallon solstitiale* [L.]) adults using a light trap and various pheromone traps on permanent grasslands of the Kočevje region

In 2025, we investigated the effectiveness of different methods for attracting adults of European june beetle at two locations in the Kočevje region (Stari Breg and Dolnja Briga) in order to determine the most suitable method for their mass trapping. We hypothesized that the use of the most effective trapping method could reduce the abundance of white grubs in grassland soils and consequently decrease the extent of damage to grasslands caused by wild boar rooting. The experimental sites were permanent grasslands, which were divided into three blocks along the forest edge, within which seven treatments (traps) were randomly arranged. Six of the tested traps (five equipped with a pheromone dispenser containing (R)-acetoin from the Greek manufacturer NovAgrica, and one without a pheromone dispenser) differed in shape and color, while the seventh treatment consisted of a light trap. The experiment, in which traps were inspected at approximately 10-day intervals between 26 April and 5 August, included the following treatments: (1) a light trap (manufacturer: Insects & Light, Germany) with a UV LED lamp; (2) a green pot trap (manufacturer: Pherobank, The Netherlands) without a pheromone dispenser; (3) a green pot trap (manufacturer: Pherobank, The Netherlands) with a pheromone dispenser; (4) a G-trap (manufacturer: Sanidad Agricola Econex, Spain) with a pheromone dispenser; (5) an Econex Popillia trap (manufacturer: Sanidad Agricola Econex, Spain) with a pheromone dispenser; (6) an inPEST Mass Large trap (manufacturer: Gea, Italy); and (7) a Probodelt trap with a pheromone dispenser (manufacturer: Probodelt, Spain). Six traps (all except the light trap) were mounted on tree trunks along the forest edge at a height of 1.5 m in each block. The distance between traps, in which pheromone dispensers were replaced approximately once per month, was about 50 m. In each block, the light trap was positioned at least 100 m away from the nearest other trap types. The light trap, which was mounted on a steel post, consisted of an UV LED lamp emitting electromagnetic radiation with peaks at 368 nm (ultraviolet), 450 nm (blue), 530 nm (green), and 550 nm (cool white), with an irradiance of 1.43 W m^{-2}. In the first year of the study, traps equipped with pheromone dispensers proved to be ineffective in attracting adult June beetles. In Dolnja Briga, 180 beetles were captured between 15 May and 28 July, with only one individual not caught in the light trap. The highest capture rate (approximately 5 individuals per trap per day) was recorded between 24 June and 2 July. In Stari Breg, 47 beetles were captured in the light trap between 5 May and 21 July, with the highest capture rate (one individual per trap per day) recorded between 2 July and 8 July.

Množično lovljenje poljske pokalice (*Agriotes lineatus* [L.)] na feromonske pasti in predposevek navadne ajde (*Fagopyrum esculentum* Moench) kot dejavnika zmanjševanja škodljivosti strun na njivah z okopavinami

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V prispevku bodo predstavljeni rezultati spremljanja številčnosti odraslih samcev poljske pokalice (*Agriotes lineatus*) z dvema tipoma feromonskih pasti (tip Yatlorf, proizvajalec Gea, Italija in tip Escolitrap®, proizvajalec Econex, Španija) na njivah z ozimno pšenico (Ljubljana, Orehovlje in Zgornje Partinje) in ozimnim ječmenom (Kamenče pri Braslovčah). V 3-bločnem poskusu s tremi obravnavanji (1. tri pasti Yatlorf/parcelo, 2. tri pasti Escolitrap®/parcelo, 3. brez pasti oz. negativna kontrola) smo od marca 2025 do septembra 2025 spremljali sezonsko dinamiko odraslih samcev, z lovljenjem samcev v pasti pa smo želeli dolgoročno zmanjšati številčnost strun v tleh. Feromonske pasti smo v dveh obravnavanjih nastavljali na vseh lokacijah tudi po žetvi ozimnega žita, ko smo na polovico poskusnega zemljišča posejali navadno ajdo (želeli smo preučiti potencialno repelentno delovanje njenih koreninskih izločkov na strune), polovico pa smo pustili neobdelano. V navedenih obravnavanjih smo s talnimi izkopi ugotavljali tudi povprečno število strun v tleh. Na vseh štirih lokacijah smo v povprečju večji ulov samcev ugotovili v pasteh tipa Escolitrap®, a smo signifikantno razliko glede na povprečni ulov samcev v pasteh tipa Yatlorf potrdili le v Ljubljani, kjer je bila populacija preučevanega škodljivca najštevilčnejša. Z izjemo lokacije Orehovlje, kjer smo prve samce ulovili v pasti že v drugi dekadi marca, smo na ostalih treh lokacijah ta pojav potrdili v zadnjih dneh marca oz. prvih dneh aprila. V Ljubljani, Zgornjih Partinjah in Orehovljah so se samci v pasteh pojavljali do druge polovice avgusta, medtem ko so bile v Kamenčah pri Braslovčah pasti prazne že od začetka julija. Številčnost strun v različnih obravnavanjih v prvem letu poskusa pričakovano (strune imajo namreč 3-5 letni razvojni krog) še ne kaže na učinkovitost metode masovnega lovljenja odraslih samcev, veseli pa ugotovitev, da so koreninski izločki ajde vplivali na določeno zmanjšanje števila strun v tleh.

ABSTRACT

Mass trapping of the lined click beetle (*Agriotes lineatus* [L.]) adults using pheromone traps and common buckwheat (*Fagopyrum esculentum* Moench) as a cover crop for reducing wireworm damage in fields with field crops

This paper will present the results of monitoring the abundance of adult male lined click beetles (*Agriotes lineatus*) using two types of pheromone traps (Yatlorf type, manufactured by Gea, Italy, and Escolitrap® type, manufactured by Econex, Spain) in winter wheat fields (Ljubljana, Orehovlje, and Zgornje Partinje) and winter barley fields

(Kamenče pri Braslovčah). In a three-block experiment with three treatments (1. three Yatlorf traps per plot, 2. three Escolitrap® traps per plot, and 3. no traps/negative control), the seasonal dynamics of adult males were monitored from March 2025 to September 2025. By trapping the males, the long-term objective was to reduce the wireworm population in the soil. In two of the treatments, pheromone traps remained set at all locations even after the winter cereal harvest. At that time, buckwheat was sown on one half of the experimental plot to study the potential repellent effect of its root exudates on wireworms, while the other half was left uncultivated. In the aforementioned treatments, soil sampling was also conducted to determine the average number of wireworms in the soil. At all four locations, a higher average catch of males was recorded in the Escolitrap® traps; however, a significant difference compared to the average catch in the Yatlorf traps was confirmed only in Ljubljana, where the population of the studied pest was the most abundant. With the exception of the Orehovlje location, where the first males were captured as early as the second decade of March, this occurrence was confirmed at the other three locations in late March or early April. In Ljubljana, Zgornje Partinje, and Orehovlje, males were present in the traps until the second half of August, whereas in Kamenče pri Braslovčah, the traps remained empty from the beginning of July. As expected, given their 3–5 year life cycle, the wireworm abundance across different treatments in the first year of the experiment does not yet demonstrate the effectiveness of the mass trapping method. However, it is encouraging to find that buckwheat root exudates contributed to a certain reduction in the number of wireworms in the soil.

Prvi rezultati načrtnega vzorčenja talnih plenilskih pršic v Sloveniji

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V Sloveniji se lahko v kmetijski praksi za zatiranje rastlinskih škodljivcev uporabljajo le naravni sovražniki s Seznama domorodnih vrst organizmov za biotično varstvo rastlin (Seznam). Seznam, ki je sestavni del Pravilnika o biotičnem varstvu rastlin (Uradni list RS, št. 45/2006), trenutno vsebuje 38 vrst plenilcev, parazitoidov in entomopatogenih ogorčic. Med 19 vrstami plenilcev na Seznamu še ni niti ene vrste talnih plenilskih pršic, čeprav so tri izmed njih (*Macrocheles robustulus*, *Gaeolaelaps aculeifer* in *Stratiolaelaps scimitus*) uvrščene na pozitivni seznam EPPO, kar je poleg domorodnosti drugi pogoj za uvrstitev na Seznam. Zato smo v letu 2024 začeli s sistematičnim vzorčenjem organskih substratov (predvsem hlevskega gnoja), ki predstavljajo pomemben habitat za talne plenilske pršice, ki plenijo ogorčice in druge mikroskopske nevretenčarje. Spremljanje se je nadaljevalo tudi v letu 2025. Glavni cilj raziskave je bil ugotoviti domorodnost katerekoli od treh vrst talnih plenilskih pršic s pozitivnega seznama EPPO, kar bi omogočilo njihovo uporabo pri biotičnem varstvu talnih žuželk in pršic. Skupno smo zabeležili 32 taksonov plenilskih

pršic, ki pripadajo devetim družinam: Macrochelidae, Parasitidae, Urodinychidae, Diplogyniidae, Veigaiidae, Trachytidae, Epicriidae, Uropodidae in Blattisociidae. V sklopu dveletne raziskave nismo potrdili pojavljanja nobene od treh vrst talnih plenilskih pršic s pozitivnega seznama EPPO.

ABSTRACT

First results of a systematic sampling of soil predatory mites in Slovenia

In Slovenia, in agricultural practice, only natural enemies from the List of native biological control agents (List) can be used to control plant pests. The List, which is an integral part of the Regulations on Biological Control (Official Gazette of the Republic of Slovenia, No. 45/2006), currently contains 38 species of predators, parasitoids and entomopathogenic nematodes. Among the 19 predatory species on the List, there is not yet a single species of soil predatory mites, although three of them (*Macrocheles robustulus*, *Gaeolaelaps aculeifer*, and *Stratiolaelaps scimitus*) are part of the EPPO positive list, which, in addition to the species being native, is the second condition for inclusion on the List. Therefore, in 2024, we began systematic sampling of organic substrates (especially stable manure), which represent an important habitat for soil predatory mites that prey on nematodes and other microinvertebrates. Monitoring was carried forward into 2025. The main objective of the research was to determine the nativeness of any of the three species of soil predatory mites from the EPPO positive list, thus enabling their implementation in biological control of soil insect and mite pests. A total of 32 predatory mite taxa belonging to nine families were recorded: Macrochelidae, Parasitidae, Urodinychidae, Diplogyniidae, Veigaiidae, Trachytidae, Epicriidae, Uropodidae and Blattisociidae. As part of the two-year study, we did not confirm the occurrence of any of the three soil predatory mite species from the EPPO positive list.

Prvi rezultati fumigantnega delovanja izbranih eteričnih olj na zobatega žitnika (*Oryzaephilus surinamensis*) v laboratorijskih razmerah

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V laboratorjiskih razmerah preučujemo insekticidno delovanje eteričnih olj kanadske zlate rozge (*Solidago canadensis* L.), koriandra (*Coriandrum sativum* L.), zelenke (*Gaultheria procumbens* L.), ingverja (*Zingiber officinale* Roscoe) in ožepka (*Hyssopus officinalis* L.) na odrasle osebke zobatega žitnika (*Oryzaephilus surinamensis*). Delovanje eteričnih olj preučujemo pri dveh vrednostih relativne zračne vlage (55 in 75%) in pri štirih temperaturah (15, 20, 25 in 30°C). Smrtnost izpostavljenih odraslih osebkov zobatega žitnika ugotavljamo 3., 7. in 10. dan po nastavitvi poskusa. Poskus poteka pri 4 različnih koncetracijah eteričnih olj (1000, 750, 500 in 250 µL). Doslej smo pridobili rezultate za tri kombinacije abiotičnih dejavnikov, in sicer pri 25°C in 55% vlagi, 25°C in 75% vlagi ter 30°C in 75% vlagi. Prvi rezultati fumigantnega delovanja preučevanih eteričnih olj kažejo na največjo učinkovitost eteričnega olja ingverja (68% smrtnost po 10. dnevu izpostavljenosti pri 25°C in 75% vlagi) in eteričnega olja kanadske zlate rozge (63% smrtnost po 10. dnevu izpostavljenosti pri 25°C in 75% vlagi). V prispevku bodo prikazane

interakcije med različnimi dejavniki v poskusu in podani predlogi za uporabo najučinkovitejše snovi v kmetijski praksi.

ABSTRACT

First results of the fumigant activity of selected essential oils against the sawtoothed grain beetle (*Oryzaephilus surinamensis*) under laboratory conditions

Under laboratory conditions, we investigated the insecticidal activity of essential oils of Canadian goldenrod (*Solidago canadensis* L.), coriander (*Coriandrum sativum* L.), wintergreen (*Gaultheria procumbens* L.), ginger (*Zingiber officinale* Roscoe), and hyssop (*Hyssopus officinalis* L.) against adult sawtoothed grain beetles. Insecticidal efficacy was tested at two different relative humidity levels (55 in 75 %) and at four different temperatures (15, 20 25 and 30°C). Mortality of adults was evaluated third, seventh, and tenth day after exposure. Essential oils were tested at four different dose rates (1000, 750, 500 in 250 µL). So far, we have conducted three experimental combinations: at 25 °C and 55% relative humidity, at 25 °C and 75% relative humidity, and 30 °C and 75% relative humidity. The initial results of the fumigant effect of essential oils indicate the highest effectiveness of ginger essential oil (68% mortality after 10 days of exposure at 25°C and 75% humidity) and Canadian goldenrod essential oil (63% mortality after 10 days of exposure at 25°C and 75% humidity). The paper will present a detailed analysis of the interactions among the various factors in the experiment and provide recommendations for the application of the most effective substance in agricultural practice.

Podatkovno podprta prilagoditev vizualnih pregledov uvoženega krompirja iz Egipta za *Ralstonia solanacearum*

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Uvoz krompirja iz Egipta je vrsto let zahteval temeljit vizualni pregled gomoljev in testiranje, da bi se preprečil vnos karantenske bakterije *Ralstonia solanacearum* v Evropsko unijo. V skladu z Izvedbenim sklepom Komisije 2011/787/EU so morale države članice ob vstopu v EU vzorčiti, prerezati in pregledati veliko število gomoljev, izvajati teste na latentno okužbo ter uvesti stroge kontrole za vsako pošiljko. Takšen pristop je pomenil znatno obremenitev za mejne inšpekcijske službe in laboratorije. Slovenija je v zadnjih letih zbrala podrobne podatke iz več sezon, ki so pokazali, da imajo sistematični vizualni pregledi gomoljev nizko diagnostično vrednost glede na vložen čas in porabljene materiale, zlasti če krompir prihaja iz pridelovalnih območij z dobro fitosanitarno

zgodovino. V sodelovanju z Upravo za varno hrano, veterinarstvo in varstvo rastlin (NPPO) in Fitosanitarno inšpekcijo so bili ti podatki združeni in posredovani Evropski komisiji, skupaj s strokovnimi razpravami, pri katerih so sodelovale vse tri organizacije. Leta 2025 je Evropska komisija sprejela Izvedbeno uredbo (EU) 2025/1289, ki je nadomestila Sklep iz leta 2011 ter uvedla bolj sorazmeren in na tveganju temelječ nadzor. Novi okvir poudarja uradno potrjena območja brez škodljivega organizma, okrepljene nadzore v izvoru ter ciljno usmerjeno vzorčenje na mejnih kontrolnih točkah EU, ob hkratnem zmanjšanju obveznega prereza gomoljev v posamezni pošiljki. V prispevku predstavljamo tehnične podatke, ki so v Sloveniji podprli prehod k učinkovitejšemu in sorazmernemu sistemu pregledov. Izpostavljamo: (i) primerjalno analizo med vizualno in laboratorijsko diagnostiko; (ii) operativni vpliv nekdanje pogostosti pregledov; (iii) prednosti prilagajanja intenzivnosti vzorčenja glede na tveganje pridelovalnega območja; ter (iv) širšo vrednost znanstveno-regulativnega sodelovanja pri izboljševanju ukrepov na ravni EU. Rezultati kažejo, da je mogoče ohraniti enako raven fitosanitarne zaščite ob bolj sorazmerni uporabi inšpekcijskih virov ter da lahko usklajeno delo NPPO, fitosanitarne inšpekcije in laboratorija učinkovito prispeva k oblikovanju odločitev na ravni EU.

ABSTRACT

Data-Driven Adjustment of Visual Inspections for *Ralstonia solanacearum* in Imported Potatoes from Egypt

The import of ware potatoes from Egypt has long required thorough visual inspection and testing to prevent *Ralstonia solanacearum* from entering the European Union. Under Implementing Decision 2011/787/EU, Member States had to cut and inspect a large number of tubers upon entry, alongside latent infection testing and strict controls on each batch. This approach for early risk management placed a significant burden on border inspection services and laboratories in terms of resources. Over recent years, Slovenia has accumulated detailed, multi-season data indicating that the systematic visual inspection of tubers, particularly from production sites with a robust phytosanitary history, yielded an extremely low diagnostic value relative to the time and materials required. Working in close collaboration with the National Plant Protection Organisation (NPPO) and the Phytosanitary Inspection these data were consolidated and submitted to the European Commission, accompanied by technical discussions in which all three organisations participated. In 2025, the European Commission adopted Implementing Regulation (EU) 2025/1289, replacing the 2011 Decision and introducing a more risk-proportionate regime. This new framework emphasises officially verified pest-free production sites, strengthened upstream controls and targeted sampling strategies at EU border control posts, while reducing the requirement to cut large numbers of tubers per lot. This contribution presents the technical evidence generated in Slovenia that supported the shift towards a more efficient, proportionate inspection system. It highlights: (i) a comparative analysis of visual versus laboratory detection performance; (ii) the operational impact of the former inspection frequency; (iii) the benefits of aligning sampling intensity with production-site risk categorisation; and (iv) the broader value of scientific–regulatory cooperation in improving EU-wide plant health measures. These results show that equivalent phytosanitary protection can be achieved with more proportionate use of inspection resources, and that coordinated work between the NPPO, phytosanitary inspection and the laboratory can effectively support EU-level decision-making.

Optimizacija PCR v realnem času z uporabo hitrih polimeraz za hitrejše odkrivanje kompleksa vrst *Ralstonia solanacearum*

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Kompleks vrst *Ralstonia solanacearum* (RSSC) vključuje rastlinske patogene bakterije, ki po svetu predstavljajo veliko grožnjo za številne kmetijsko pomembne rastline, med drugim tudi krompir. Bakterija povzroča zamašitev žilnega tkiva in s tem propad rastline. Širi se z okuženim sadilnim materialom ter preživi v okuženi zemlji in vodi. Zgodnje in zanesljivo odkrivanje sta ključnega pomena za učinkovito obvladovanje bolezni. Za laboratorijsko ugotavljanje prisotnosti bakterij običajno izvajamo test PCR v realnem času (qPCR). Standardni protokol traja približno 1 uro in 40 minut, kar pomembno prispeva k celotnemu času testiranja. V raziskavi smo ovrednotili možnost hitrejšega odkrivanja RSSC v ekstraktih krompirja z uporabo devetih komercialnih qPCR mastermiksov, ki vsebujejo hitre polimeraze. Delovanje smo preverili z dvema uveljavljenima diagnostičnima testoma, Vreeburg *in sod*. (2016) za RSSC ter Weller *in sod*. (2000), ki je specifičen za *R. solanacearum.* Ekstraktom krompirja smo dodali nizke koncentracije RSSC, negativne kontrole pa so vsebovale samo rastlinski ekstrakt. DNA iz izolatov *R. solanacearum* (Rs) in *R. pseudosolanacearum* (Rps) je služila kot pozitivna kontrola. Ovrednotili smo skupni čas pomnoževanja, občutljivost, specifičnost, robustnost v rastlinskih ekstraktih gomoljev krompirja ter ponovljivost znotraj in med ponovitvami. Nekateri mastermiksi s hitrimi polimerazami so ohranili primerljivo občutljivost in specifičnost kot standardni protokoli, hkrati pa občutno skrajšali čas analize. Rezultati predstavljajo praktične smernice za laboratorije, ki želijo izboljšati in skrajšati postopke PCR v realnem času, ne da bi pri tem ogrozili diagnostično zanesljivost in bi na ta način omogočili bolj tekoče trgovanje z rastlinami in rastlinskimi proizvodi.

ABSTRACT

Optimising real-time PCR by using fast polymerases for the rapid detection of the *Ralstonia solanacearum* species complex

The *Ralstonia solanacearum* species complex (RSSC) comprises plant-pathogenic bacteria that pose a major threat to many agriculturally important crops, including potato. The pathogen causes blocks vascular tissue, leading to wilting and plant death. It spreads efficiently through infected planting material and can survive in soil and water. Early and reliable detection is therefore essential to prevent disease spread, avoid yield losse, and minimise delays in trade. Laboratory examination for the presence of pathogens is critical, and real-time PCR (qPCR) is routinely used for this purpose. However, standard qPCR protocols typically require around 1 hour and 40 minutes, which adds to the overall testing time. In this study, we evaluated the potential for faster detection of RSSC in potato extracts using nine commercially available qPCR mastermixes containing fast polymerases. Their performance was assessed using two established diagnostic tests: Vreeburg *et al*. (2016) for RSSC and Weller *et al*. (2000), which is specific for *R. solanacearum*. Low concentrations of RSSC were added to potato extracts, while negative controls contained only plant extract. Purified DNA isolated from *R. solanacearum* (Rs) and *R. pseudosolanacearum* (Rps) served as positive controls. We evaluated total cycling time, sensitivity, specificity, robustness in plant matrix of potato tubers, and repeatability within and between runs. Several fast-polymerase master mixes

maintained amplification efficiency and specificity comparable to standard protocols while significantly reducing total analysis time. The results provide practical guidance for plant health laboratories seeking to optimise qPCR workflows without compromising diagnostic reliability thus reducing time in routine monitoring, and supporting smoother plant trade.

Tveganje vnosa in širjenja novih glivičnih patogenov pri pridelavi sladkega krompirja

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V treh letih (2022, 2023, 2024) preučevanja glivičnih bolezni na sladkem krompirju (*Ipomoea batatas*) smo ugotovili, da večjih težav pri pridelavi zaradi glivičnih okužb ni bilo, kljub prisotnosti raznolikih vrst gliv. Najpogosteje opaženi simptomi na poljih sladkega krompirja so bili rumenenje listov ter različne pege na listih, ki jih povzročajo predvsem glive iz rodov *Alternaria* in *Fusarium*. Na listih so prevladovale predvsem vrste *Alternaria*, predstavniki kompleksov *A. alternata*, *A. arborescens*, *A. humicola* in *A. tenuissima*. Na gomoljih so bile potrjene le glive iz rodu *Fusarium*, identificirali smo tri vrste kompleksov: *F. oxysporum* species complex, *F. fujikuroi* species complex, *F. incarnatum equisetii* species complex. Izolirali in identificirali smo nekaj vrst gliv, ki so za naše okolje manj poznane ali celo nepoznane. Za vrsti *Didymella americana* in *D. glomerata* v literaturi ni poročil o njuni patogenosti na sladkem krompirju. Obe vrsti sta patogena s širokim krogom drugih gostiteljskih rastlin: grah, pšenica, rdeča pesa, trta, jablana in druge. Sladki krompir ni znan gostitelj glive *Stagonosporopsis dennisii*, katere vpliv na kmetijske rastline je še zelo nepoznan. Več vrst iz rodu *Stagonosporopsis* prizadene širok spekter kultur, na katerih lahko povzročajo nekroze listov in stebelno gnilobo. Glivo *Allophoma tropica*, ki smo jo izolirali iz listov sladkega krompirja, v Italiji opisujejo kot patogena solate. Vrsta je bila prvotno opisana v tropskih regijah, sedaj pa se pojavlja tudi drugod po svetu. Nepoznane glive s sabo prinašajo neznane vplive na pomembne kmetijske rastline ter lahko spreminjajo vedenje že prisotnih in poznanih rastlinskih patogenov. Sladki krompir zaradi svoje enostavne pridelave lastnih sadik z vegetativnim razmnoževanjem in pridelave sadik iz kupljenih gomoljev, predstavlja tveganje za vnos in širjenje patogenih gliv, ki pri nas ali v Evropi (še) niso prisotne.

ABSTRACT

Risk of introduction and spread of novel fungal pathogens in sweet potato production

In three years (2022, 2023, 2024) of studying fungal diseases on sweet potato *(Ipomoea batatas*), we found that there were no major problems in production due to fungal infections, despite the presence of variety of fungal species. The most commonly observed symptoms in sweet potato fields were leaf yellowing and various leaf spots, caused by fungi from the genera *Alternaria* and *Fusarium*. *Alternaria* predominated on leaves, they were identified as members of *A. alternata*, *A. arborescens*, *A. humicola*, and

A. tenuissima species complexes. On the tubers, members of the *Fusarium oxysporum*, *Fusarium fujikuroi*, *Fusarium incarnatum-equiseti* species complexes were confirmed. We isolated and identified several fungal species that are less known or even unknown in agricultural ecosystems of our region. There are no reports in the literature on the pathogenicity of *Didymella americana* and *D. glomerata* on sweet potato. Both species are pathogenic to a wide range of other host plants, including pea, wheat, red beet, grapevine, apple, and others. Also *Stagonosporopsis dennisii was isolated for the first time from sweet potato*, whose impact on agricultural crops is largely unknown. Several species of the genus *Stagonosporopsis* affect a wide range of crops, on which they can cause leaf necrosis and stem rot. The fungus *Allophoma tropica*, which we isolated from sweet potato leaves, is described in Italy as a pathogen of lettuce. The species was described from tropical regions but is now appearing in other parts of the world as well. Unknown fungi bring unpredictable impacts on important agricultural crops and can change the behavior of already present and well-known plant pathogens. Due to the ease of producing its own planting material through vegetative propagation, as well as producing seedlings from purchased tubers, sweet potato presents a risk for the introduction and spread of pathogenic fungi that are not (yet) present in our region or in Europe.

Bolezen SBR sladkorne pese in njen povzročitelj '*Candidatus* Arsenophonus phytopathogenicus'

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'*Candidatus* Arsenophonus phytopathogenicus', povzročitelj bolezni Syndrome Basses Richesses (SBR), povzroča znižano vsebnost sladkorja, zakrnelo rast, rumenenje in splošno oslabelo rast sladkorne pese. Bakterija, ki je ni mogoče gojiti v aksenični kulturi, je omejena na prevodno tkivo, prenašajo pa jo predvsem žuželčji vektorji, zlasti škržati, ki se hranijo s ksilemskim sokom npr. *Pentastiridius leporinus*. Naraščajoča pojavnost bolezni v Evropi kaže, da njen fitosanitarni pomen v zadnjih letih narašča. SBR je v zadnjem desetletju postal pomemben v več državah srednje in zahodne Evrope, predvsem na območjih intenzivne pridelave sladkorne pese. Nedavne raziskave so pokazale, da se lahko *P. leporinus* pojavlja tudi na krompirju, kar odpira vprašanje o morebitnih poteh prenosa iz sladkorne pese na druge kulture. Čeprav okužba krompirja z izraženimi bolezenskimi znamenji doslej ni bila zanesljivo potrjena, prisotnost vektorja na krompirjevih poljih ter njegova sposobnost prenosa iz sladkorne pese nakazujeta možen epidemiološki most. V literaturi so opisani tudi nekateri pleveli in alternativne gostiteljske rastline, ki lahko vplivajo na lokalno vzdrževanje inokuluma. V prispevku povzemamo trenutno poznavanje taksonomije, biologije in epidemiologije povzročitelja, bolezenska znamenja, vlogo prenašalcev ter diagnostične metode. Ozaveščanje o '*Ca*. A. phytopathogenicus' in njegovih bolezenskih znakih je ključnega pomena za pravočasno prepoznavo in bo podprlo ustrezno ukrepanje na regionalni in nacionalni ravni, tudi v državah, kjer bolezen še ni bila ugotovljena, vendar je prisoten njen prenašalec ali se le-ta širi.

ABSTRACT

Syndrome Basses Richesses (SBR) of Sugar Beet and Its Causative Agent '*Candidatus* Arsenophonus phytopathogenicus'

'*Candidatus* Arsenophonus phytopathogenicus', the causative agent of Syndrome Basses Richesses (SBR), is associated with reduced sugar content, stunting, yellowing and reduced vigour in sugar beet. The bacterium cannot be cultivated in axenic culture and is xylem-limited. It is primarily transmitted by insect vectors, in particular xylem-feeding planthoppers such as *Pentastiridius leporinus*. Over the past decade, SBR has become increasingly relevant in several countries in Central and Western Europe, especially in regions with intensive sugar beet cultivation. Recent studies have shown that *P. leporinus* can also occur on potato, raising questions about possible transmission routes from sugar beet to other crops. Although symptomatic infection of potato has not yet been reliably confirmed, the presence of the vector in potato fields and its ability to acquire the bacterium from sugar beet suggest a potential epidemiological link. The literature also reports the presence of weeds and alternative host plants that may contribute to the local maintenance of inoculum. This contribution summarises current knowledge on the taxonomy, biology and epidemiology of the pathogen, as well as disease symptoms, vector biology and available diagnostic methods. Increased awareness of '*Ca*. A. phytopathogenicus' and its associated disease is essential for timely detection and appropriate action at regional and national levels, including in countries where the pathogen has not yet been confirmed but where the vector is already present.

Prva najdba ´*Candidatus* Phytoplasma solani´ na sladkorni pesi v Sloveniji

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V letu 2025 smo v analizo prejeli osem vzorcev sladkorne pese z območja SV Slovenije, na katerih so bile opazne deformacije listov, rumenenja, nekroze na listih ter obarvanja prevodnega tkiva korenov. Iz različnih tkiv smo izolirali celokupno DNK in izvedli analize na prisotnost fitoplazem s PCR v realnem času, pri čemer smo fitoplazmo iz skupine 16SrXII zaznali v enem vzorcu. Ločeno testiranje posameznih tkiv je pokazalo, da je fitoplazmo mogoče zaznati v koreninicah, ki izraščajo iz korena, v prevodnem tkivu korena ter na stiku med korenom in listi, medtem ko je v listnih žilah nismo zaznali. S Sangerjevim sekvenciranjem produkta univerzalnega PCR za fitoplazme, ki pomnožuje del gena 16S rRNA, smo potrdili okužbo s *'Candidatus* Phytoplasma solani' 16SrXII-A. Ta fitoplazma je v Sloveniji pogosto odkrita na vinski trti, kjer povzroča rumenice tipa počrnelosti lesa (Bois Noir). Fitoplazme iz skupine 16SrXII so bile v Sloveniji predhodno potrjene tudi na drugih gostiteljskih rastlinah: krompirju, jajčevcu, papriki, paradižniku,

korenju, slaku in koprivi. V nekaterih državah (npr. Nemčija, Srbija) so poročali o primerih, kjer so te fitoplazme ali njej sorodne *'Candidatus.* Phytoplasma solani' 16SrXII-P povzročale opazne izgube pri pridelavi sladkorne pese, vendar so takšni izbruhi povezani predvsem s specifičnimi epidemiološkimi pogoji, zlasti z visoko številčnostjo prenašalcev. V zadnjih letih pogosto poročajo o okužbah sladkorne pese z bakterijo '*Candidatus* Arsenophonus phytopathogenicus', ki je lahko povezana z večjimi gospodarskimi izgubami, vendar je v naših vzorcih nismo potrdili.

ABSTRACT

First detection of ´*Candidatus* Phytoplasma solani´ on sugar beet in Slovenia

In 2025, we received eight sugar beet samples from northeastern part of Slovenia showing leaf deformations, yellowing, necrosis of leaves and discoloration of vascular tissue in taproots. Total DNA was extracted from various tissues, and real-time PCR was performed to detect phytoplasmas. A phytoplasma belonging to the 16SrXII group was identified in one sample. Separate testing of individual tissues showed that the phytoplasma could be detected in the fine roots emerging from the taproot, in the vascular tissue of the taproot, and at the junction between the taproot and the leaves, while it was not detected in the leaf veins. Using Sanger sequencing of the product of a universal phytoplasma PCR amplifying a fragment of the 16S rRNA gene, we confirmed infection with '*Candidatus* Phytoplasma solani' 16SrXII-A. This phytoplasma is frequently detected in Slovenia on grapevine, where it causes grapevine yellows - Bois Noir disease. Phytoplasmas from the 16SrXII group have previously been confirmed in Slovenia on other host plants as well: potato, eggplant, pepper, tomato, carrot, bindweed, and nettle. In some countries (e.g., Germany, Serbia), cases have been reported in which these phytoplasmas or the related '*Candidatus* Phytoplasma solani' 16SrXII-P caused noticeable yield losses in sugar beet production; however, such outbreaks are primarily associated with specific epidemiological conditions, particularly high vector abundance. In recent years, frequent reports have described sugar beet infections with the bacterium '*Candidatus* Arsenophonus phytopathogenicus', which can be associated with significant economic losses, but it was not confirmed in our samples.

Identifikacija bakterij na ploščah iz ekstraktov listov koruze: kako metoda MALDI-TOF podpira izbor kolonij za nadaljnje testiranje

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Točna identifikacija bakterij, izoliranih iz ekstrakta koruze, je pomembna pri preiskovanju vzrokov za opažena bolezenska znamenja in pri preverjanju, ali je v vzorcu prisotna določena nadzorovana bakterija npr. *Pantoea stewartii* subsp. *stewartii*. V obeh primerih, postopek izolacije bakterij na neselektivnih umetnih gojiščih pogosto privede do rasti številnih bakterij, ki so naravno prisotne v teh vzorcih in katerih kolonije so lahko zelo podobne ciljni bakteriji. To lahko oteži rutinsko delo, podaljša čas analiz in povzroči nepotrebna dodatna testiranja. Za boljše razumevanje te mikroflore ozadja, smo pregledali kolonije, ki so se razvile na gojišču King B med rutinskimi izolacijami iz ekstraktov

koruze z bolezenskimi znamenji, zbranimi v letu 2025, in jih identificirali z metodo masne spektrometrije MALDI-TOF MS. Gre za hitro metodo, ki temelji na beljakovinskih profilih. Na ta način smo dokumentirali, katere vrste se najpogosteje pojavljajo. Najpogosteje smo zaznali bakterije iz rodov *Sphingomonas*, *Curtobacterium*, *Microbacterium*, *Agrobacterium* ter več vrst bakterij iz rodu *Pantoea*. Za diagnostično natančnost so bile posebej pomembne bakterije *Pantoea ananatis* in *Microbacterium* spp., ki so pogosto tvorile kolonije, zelo podobne *P. stewartii*, kar je oteževalo izbiro za nadaljnje testiranje. Razumevanje te »normalne mikroflore« vzorcev ekstrakta iz koruze podpira splošno diagnostiko (ugotavljanje vzroka bolezenskih znamenj) in ciljno testiranje nadzorovanih bakterijskih povzročiteljev bolezni. Izboljšuje natančnost pri izbiri kolonij, pomaga zmanjšati nepotrebne nadaljnje teste ter podpira usposabljanje novih diagnostikov. Kot praktični rezultat pripravljamo fotogalerijo, ki bo povezovala videz kolonij z identifikacijami MALDI-TOF, da bi olajšali vsakodnevno diagnostično delo.

ABSTRACT

Identifying bacteria on plates in analysis of maize leaf extracts: how MALDI-TOF supports the selection of colonies for further testing

Accurate identification of bacteria isolated from maize samples is important both when investigating the causes of observed symptoms and when checking whether a specific regulated bacterium, such as *Pantoea stewartii* subsp. *stewartii*, is present. In both situations, laboratory isolations on non-selective artificial media frequently yield many naturally occurring bacteria whose colonies resemble those of the target pathogen. This can complicate routine diagnostics, prolong the analysis time, and lead to unnecessary additional testing. To better characterise this background microflora, we examined colonies appearing on King's B medium during routine isolations from maize leaf extracts and identified them using MALDI-TOF MS, a rapid technique based on protein profiles. This allowed us to document which species are most commonly encountered during plate reading. Frequently observed groups included *Sphingomonas* spp., *Curtobacterium* spp., *Microbacterium* spp., *Agrobacterium* spp., and several *Pantoea* species. Of particular relevance for diagnostic accuracy, *Pantoea ananatis* and *Microbacterium* spp. often formed colonies that closely resemble *P. stewartii*, complicating colony selection for further testing. Improved understanding of this "normal background microflora" supports both general diagnostics (identifying the cause of symptoms) and targeted testing for regulated pathogens. It increases confidence when selecting colonies, helps reduce unnecessary follow-up analyses, and contributes to the training of new diagnosticians. As a practical output, we are preparing a photo gallery linking colony morphology with MALDI-TOF identifications to support day-to-day diagnostic work.

Zaznavanje sprememb hranil pri koruzi s kemometričnimi podpisi in hiperspektralnim slikanjem ob abiotskih in biotskih stresorjih

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Natančno zaznavanje dinamike hranil v pridelkih pod vplivom več prekrivajočih se stresnih dejavnikov je ključno za izboljšanje upravljavskih odločitev, vendar so

tradicionalne ocene hranil destruktivne in težko prilagodljive. V tej študiji smo preverili, ali je mogoče spremembe v stanju hranil v rastlinah zaznati na nedestruktiven način z integracijo kemometričnih značilnosti hranil s hiperspektralnim slikanjem. Najprej smo količinsko opredelili profile hranil in s kemometričnimi metodami izpeljali multivariatne značilnosti hranil, ki zajemajo spremembe med hranili. Hiperspektralne slike smo pridobili iz istih eksperimentalnih enot, spektralne informacije pa smo združili s kemometričnimi podpisi, da bi modelirali spremembe v odbojnosti, ki jih povzročajo hranila. Da bi zagotovili, da je bila zaznavnost hranil preizkušena v realističnih virih spremenljivosti, smo v analizo vključili ključne fiksne učinke, vključno z vrsto koruze, režimom vodnega stresa, antagonističnimi obdelavami in dvema vrstama koreninskih škodljivcev. Nato smo usposobili napovedne in klasifikacijske modele, da povežemo hiperspektralne značilnosti s hranilnimi podpisi ob upoštevanju teh fiksnih učinkov, kar nam je omogočilo oceniti, ali spektralni signali, povezani s hranili, ostanejo tudi po vplivih genotipa, abiotskega in biotskega stresa. Integrirani pristop je omogočil identifikacijo spektralnih območij in večrazsežnostnih vzorcev hranil, ki so najmočneje povezani s spremembami hranil, pogojenimi z obdelavo, ter oceno učinkovitosti modela v različnih eksperimentalnih pogojih. Naši rezultati kažejo izvedljivost povezovanja kemometričnih značilnosti hranil s hiperspektralnim slikanjem za odkrivanje sprememb hranil v koruzi, povezanih z obdelavo, tudi v prisotnosti učinkov sorte, vodnega stresa, antagonističnih posegov in izzivov koreninskih škodljivcev.

ABSTRACT

Detecting nutrient changes in maize using chemometric signatures and hyperspectral imaging under abiotic and biotic stressors

Accurate detection of crop nutrient dynamics under multiple overlapping stressors is essential for improving management decisions, yet traditional nutrient assessments are destructive and difficult to scale. Here, we evaluated whether changes in plant nutrient status can be detected non-destructively by integrating chemometric nutrient signatures with hyperspectral imaging. We first quantified nutrient profiles and used chemometric methods to derive multivariate nutrient “signatures” that capture changes among nutrients. Hyperspectral images were acquired from the same experimental units, and spectral information was combined with the chemometric signatures to model nutrient-driven variation in reflectance. To ensure that nutrient detectability was tested under realistic sources of variability, we explicitly incorporated key fixed effects into the analysis, including maize variety, water-stress regime, antagonistic treatments, and two types of root pests. Predictive and classification models were then trained to link hyperspectral features to nutrient signatures while accounting for these fixed effects, allowing us to assess whether nutrient-related spectral signals persist beyond the influences of genotype, abiotic and biotic stress. The integrated approach enabled identification of spectral regions and multivariate nutrient patterns most strongly associated with treatment-driven nutrient shifts, and it provided an assessment of model performance across the different experimental conditions. Overall, our results demonstrate the feasibility of coupling chemometric nutrient signatures with hyperspectral imaging to detect treatment-associated nutrient changes in maize, even in the presence of variety effects, water stress, antagonistic interventions, and contrasting root pest challenges.

Variability of *Avena fatua* L. seed morphology and germination temperatures: A comparison between Slovenia, Italy, Hungary and Croatia

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Considering the high morphological and ecological diversity of wild oat (*Avena fatua* L.), the objective of this study was to examine the variability of spikelets and seeds from Slovenia, Croatia, Hungary and Italy. Intraspecific variation in spikelet and seed morphology and germination temperature was assessed for eight populations, collected across these four countries in the summer of 2015. Eight morphological features were analyzed in 30 samples per each population. The variations of the selected morphological traits were assessed using Statistica 7.0 software. Variation in morphological parameters was detected between the two Slovenian populations. Additionally, significant differences were observed in morphological paramteres between the two Slovenian and other tested populations (Croatian CR1 and CR2, Hungarian H1 and H2, and Italian IT1 and IT2). Seed and awn mass were greatest in population SL2, whereas awn length, spikelet length, and spikelet width were greatest in population SL1. The tested Slovenian populations differed in color compared to other populations, while awn hairiness did not differ between the tested populations. When considering their germination behaviour, the Slovenian populations did not emerge at 5 °C and 10 °C, whereas the other tested populations emerged at 10 °C. A temperature of 35 °C affected germination energy but did not reduce it below 50%. The best germination percentage was observed in the Hungarian populations. Finally, despite the observed differences in morphology and germination behaviour, all the tested populations were grouped in the same cluster, based on the analyzed parameters.
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Prisotnost watermelon crinkle leaf-associated virusa 1 (WCLaV-1) in WCLaV-2 v lubenicah

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V letu 2023 sta bila na EPPO opozorilni seznam dodana watermelon crinkle leaf-associated virus 1 (WCLaV-1) in WCLaV-2. To sta na novo odkrita virusa, ki lahko okužita lubenice (*Citrullus lanatus*) in druge rastline iz družine bučevk. Prvič sta bila odkrita na listih lubenic na Kitajskem leta 2015, kasneje v številnih državah Amerike, leta 2023 je bil WCLaV-1 odkrit v Avstraliji, prva poročila o najdbah WCLaV-1 in -2 v Evropi pa so iz leta 2025. Pri okužbi listov lubenic in buč se pojavijo gubanje, rumen mozaik in pegavost, na plodovih pa lezije in deformacije. Bolezenska znamenja so lahko močno izražena, delež okuženih rastlin v pridelavi pa lahko doseže tudi do 50 %. Virusa se prenašata mehansko, drugi možni načini prenosa še niso raziskani, a obstaja sum, da se prenašata tudi s semeni. Nukleinske kisline WCLaV-1 in -2 smo v vzorcih lubenic, nabranih v Sloveniji, z metodo visokozmogljivega sekvenciranja (HTS) prvič zaznali že v letih 2018 in 2019. Leta 2024 smo z obratnim prepisovanjem in verižno reakcijo s polimerazo (RT-PCR) potrdili prisotnost obeh virusov v vseh petih analiziranih vzorcih semen lubenic, kupljenih v različnih trgovinah po Sloveniji (Vučurović in sod., 2025, *Plant disease*, https://doi.org/10.1094/PDIS-02-25-0251-PDN). V letih 2024 in 2025 smo prisotnost teh virusov preverili tudi v petih vzorcih plodov in listov lubenic. Njuno prisotnost smo potrdili v dveh vzorcih iz zahodnega dela Slovenije. V vzorcih ostalih rastlin iz družine bučevk, analiziranih z HTS, nukleinskih kislin WCLaV-1 in -2 doslej še nismo odkrili.Glede na podatke ki jih imamo, ne moremo zanesljivo oceniti dejanskega vpliva WCLaV-1 in -2 na kakovost in količino pridelka lubenic v Sloveniji. Za celovito razumevanje epidemiologije teh dveh virusov, vključno z njihovimi načini prenosa, razširjenostjo in vplivom na pridelavo, so potrebne dodatne raziskave.

ABSTRACT

Presence of watermelon crinkle leaf-associated virus 1 (WCLaV-1) and WCLaV-2 in watermelon

In 2023, watermelon crinkle leaf-associated virus 1 (WCLaV-1) and WCLaV-2 were added to the EPPO Alert List. These are newly discovered viruses that can infect watermelon (*Citrullus lanatus*) and other plants belonging to the *Cucurbitaceae* family. They were first detected on watermelon leaves in China in 2015, later in numerous countries across the Americas. In 2023, WCLaV-1 was detected in Australia, while the first reports of WCLaV-1 and WCLaV-2 in Europe date from 2025. Infected watermelon and zucchini leaves exhibit crinkling, yellow mosaic, and mottling, while lesions and deformities occur on the fruits. Disease symptoms can be severe, and the proportion of infected plants in production can reach up to 50%. The viruses are transmitted mechanically; other possible modes of transmission have not yet been investigated, although seed transmission is suspected. The nucleic acids of WCLaV-1 and WCLaV-2 were first detected in watermelon samples collected in Slovenia as early as 2018 and 2019 using high-throughput sequencing (HTS). In 2024, the presence of both viruses was confirmed in all five analyzed watermelon seed samples purchased from different stores across Slovenia using reverse transcription polymerase chain reaction (RT-PCR) (Vučurović *et al.*, 2025, *Plant Disease*, https://doi.org/10.1094/PDIS-02-25-0251-PDN). In 2024 and 2025, the presence of these viruses was also examined in five samples of watermelon fruits and leaves. Their presence was confirmed in two samples from the western part of Slovenia. To date, the nucleic acids of WCLaV-1 and WCLaV-2 have not been detected in samples of other *Cucurbitaceae* plants analyzed by HTS. Based on the data currently available, we cannot reliably assess the actual impact of WCLaV-1 and WCLaV-2 on the quality and yield of watermelon production in Slovenia. Additional studies are required to achieve a comprehensive understanding of the epidemiology of these two viruses, including their modes of transmission, distribution, and impact on production.

EnviroViroSeq: Napredna HTS analiza viromov v hmelju in okolju podprta z umetno inteligenco

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Naraščajoča globalna populacija povečuje pritisk na kmetijsko proizvodnjo, hkrati pa rastlinske bolezni predstavljajo eno največjih groženj prehranski varnosti. Ocenjuje se, da rastlinski patogeni vsako leto povzročijo več kot 30 % izgub pridelkov na svetovni ravni. Med njimi imajo virusi in viroidi poseben pomen, saj povzročajo letne izgube v vrednosti približno 60 milijard USD in jih ni mogoče obvladovati z obstoječimi pesticidi. Zanesljiva, hitra in celostna diagnostika je zato ključna za omejevanje širjenja teh bolezni. Tradicionalne ciljno usmerjene metode (ELISA, PCR, Sanger sekvenciranje) zahtevajo predhodno znanje o patogenu, kar omejuje njihovo uporabnost pri odkrivanju neznanih ali divergentnih virusov. Projekt »*EnviroViroSeq: Napredna HTS analiza viromov v hmelju in okolju podprta z umetno inteligenco«* (J4-70612; ARIS) naslavlja te izzive z uporabo visoko-pretočnega sekvenciranja (HTS), s posebnim poudarkom na tehnologiji Nanopore. Cilj projekta je celostno preučiti virome hmelja in povezanih okoljskih vzorcev v izbranih agroekosistemih v Sloveniji. Hmelj je bil izbran kot modelna, ekonomsko pomembna kultura, v analizo pa bodo vključeni tudi potencialni rastlinski rezervoarji ter voda za namakanje. Projekt združuje razvoj Nanopore sekvenciranja, primerjavo z drugimi HTS platformami ter razvoj inovativne CRISPR-Cas13 metode za tarčno obogatitev RNA patogenov. Pridobljeni podatki bodo analizirani z naprednimi bioinformatskimi pristopi in umetno inteligenco za identifikacijo znanih in novih virusov ter viroidov, filogenetske analize in preučevanje okoljskih interakcij. Končni cilj projekta je validacija Nanopore diagnostične metode za rutinsko uporabo v skladu z EPPO standardi. Projekt bo pomembno prispeval k razvoju sodobnih diagnostičnih orodij, izboljšanju biovarnosti ter trajnostnemu obvladovanju rastlinskih virusnih bolezni v kmetijstvu.

ABSTRACT

EnviroViroSeq: Advanced HTS and AI-Powered Analysis of Viromes in Hops and the Environment

The growing global population is increasing pressure on agricultural production, while plant diseases represent one of the greatest threats to food security. It is estimated that plant pathogens cause more than 30% crop losses worldwide each year. Among them, viruses and viroids are of particular importance, as they cause annual losses of approximately USD 60 billion and cannot be controlled using existing pesticides. Reliable, rapid, and comprehensive diagnostic methods are therefore essential for limiting the spread of these diseases. Traditional targeted methods (ELISA, PCR, and Sanger sequencing) require prior knowledge of the pathogen, which limits their applicability for the detection of unknown or highly divergent viruses. The project "*EnviroViroSeq: Advanced*

HTS-based analysis of viromes in hops and the environment supported by artificial intelligence" (J4-70612; ARIS) addresses these challenges through the use of high-throughput sequencing (HTS), with a particular focus on Nanopore technology. The aim of the project is to comprehensively investigate the viromes of hops and associated environmental samples in selected agroecosystems in Slovenia. Hops were selected as a model, economically important crop, while potential plant reservoirs and irrigation water will also be included in the analysis. The project integrates the development of Nanopore sequencing, comparison with other HTS platforms, and the development of an innovative CRISPR-Cas13-based method for targeted enrichment of RNA pathogens. The resulting sequencing data will be analyzed using advanced bioinformatic approaches and artificial intelligence to identify known and novel viruses and viroids, perform phylogenetic analyses, and investigate environmental interactions. The ultimate goal of the project is the validation of a Nanopore-based diagnostic method for routine use in accordance with EPPO standards. The project will make a significant contribution to the development of modern diagnostic tools, improved biosecurity, and the sustainable management of plant viral diseases in agriculture.

Kemotaksija ogorčice *Oscheius onirici* na izbrane kemične snovi

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Med gospodarsko pomembne škodljivce v kmetijstvu uvrščamo tudi polže. Njihovo zatiranje še vedno temelji na uporabi fitofarmacevtskih sredstev (FFS), imenovanih limacidi. Zaradi negativnih vplivov FFS na okolje, znanstveniki iščejo okolju prijaznejše rešitve. Mednje spada tudi biotično varstvo, kjer uporabljamo žive koristne organizme za zatiranje populacij škodljivih vrst organizmov. Med pomembne naravne sovražnike polžev spadajo tudi parazitske ogorčice polžev. V Sloveniji so leta 2023 iz španskega lazarja izolirali ogorčico *Oscheius onirici*, ki je še precej nepoznana vrsta. Rastline se lahko pred napadi škodljivcev branijo tudi z izločanjem hlapljivih snovi (HS), ki lahko v njihovo okolico privabijo koristne organizme. Pretekle raziskave so pokazale, da izločanje HS vpliva privabilo ali odvračalno na entomopatogene ogorčice. O vplivu HS na gibanje parazitskih ogorčic polžev pa je znanega bistveno manj. V naši raziskavi smo preučevali odziv vrste *Oscheius onirici* na štirinajst različnih HS: α-pinen, α-humulen, alil izotiocianat, benzonitril, β-kariofilen, bornil acetat, kamfor, dekanal, dimetil disulfid, feniletil izotiocianat, linalol, nonanal, terpinolen in undekan pri dveh temperaturah (18 in 20 °C) ter dveh koncentracijah (100 in 0,001 %). Izbrana snov se je izkazala kot pomemben dejavnik, ki vpliva na gibanje ogorčice. Infektivne ličinke so bile najbolj mobilne pri snoveh linalol in terpinolen. Zanimala nas je tudi kemotaksija (usmerjeno gibanje) ogorčice. Želeli smo ugotoviti ali izbrana snov deluje odvračalno ali privabilno na izbrano vrsto. Ugotovili smo, da so terpinolen, α-humulen, α-pinen, ter β-kariofilen delovali kot šibki repelenti, feniletil izotiocianat in undekan pa kot repelenta. Samo linalol se je izkazal kot šibek atraktant. Vse ostale izbrane snovi na usmerjeno gibanje ogorčice niso imele vpliva.

ABSTRACT

Chemotaxis of the nematode *Oscheius onirici* on seleczed chemical compounds

Among the economically important agricultural pests, slugs also represent a significant concern. Their control still relies primarily on the use of plant protection products, known as molluscicides. Due to the negative impact of pesticides on the environment, researchers are increasingly seeking environmentally friendly alternatives. One such solution is biological control, which uses living beneficial organisms to suppress populations of harmful species. Among the key natural enemies of slugs are slug-parasitic nematodes. In Slovenia, the nematode *Oscheius onirici* was isolated in 2023 from the Spanish slug. Plants can defend themselves against herbivores by emitting volatile organic compounds (VOCs) that attract beneficial organisms to the plants surrounding area. While past studies have shown that VOCs can influence the movement of entomopathogenic nematodes, significantly less is known about their effects on slug parasitic nematodes. In our study, we examined the response of *O. onirici* to fourteen different VOCs: α-pinene, α-humulene, allyl isothiocyanate, benzonitrile, β-caryophyllene, bornyl acetate, camphor, decanal, dimethyl disulfide, phenylethyl isothiocyanate, linalool, nonanal, terpinolene, and undecane. The nematodes were tested at two temperatures (18°C and 20°C) and two concentrations (100% and 0,001%). VOCs were found to impact the mobility of infective larvae, with the highest mobility observed in the presence of linalool and terpinolene. We also investigated the chemotaxis (directed movement) of the nematodes to determine whether a given compound acted as a repellent or an attractant for *O. onirici*. Our results showed that terpinolene, α-humulene, α-pinene and β-caryophyllene functioned as weak repellents, while phenylethyl isothiocyanate and undecane acted as repellents. Linalool was the only compound that exhibited attractant properties. The remaining substances had no detectable effect on the directed movement of the nematodes.

Ko rastline spregovorijo: kako hlapne spojine usmerjajo vedenje parazitskih ogorčic?

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Parazitske ogorčice, zlasti tiste iz družine Rhabditidae, predstavljajo ključne komponente podzemnih ekosistemov, saj pomembno prispevajo k uravnavanju škodljivcev in trajnostnemu kmetijstvu. V tej študiji smo preučevali kemotaktične odzive treh vrst ogorčic—*Phasmarhabditis papillosa*, *Oscheius myriophilus* in *O. onirici* — na hlapne organske spojine (HOS), ki jih izločajo korenine črne gorjušice ob napadu ličink kapusove muhe. Z uporabo kemotaksičnega testa smo preučili učinke petih hlapnih spojin (dimetil sulfid, dimetil disulfid, alil izotiocianat, feniletil izotiocianat in benzonitril) pri dveh koncentracijah (čista snov in 0,03 ppm) ter dveh temperaturah (18 °C in 22 °C). Rezultati so pokazali, da so hlapne spojine in temperatura statistično značilno vplivale na odziv ogorčic, medtem ko sta vrsta ogorčic in koncentracija HOS imeli manj izrazit vpliv.

Benzonitril se je dosledno izkazal kot močan kemopozitivni dejavnik, zlasti za *O. myriophilus* in *O. onirici*. Nasprotno pa je alil izotiocianat pokazal izrazit nematicidni učinek, saj je zaviral gibanje in povzročal smrtnost ogorčic. Dimetil disulfid in dimetil sulfid sta izzvala zmerne do močne privlačne odzive, pri čemer so bile zaznane razlike med vrstami in temperaturami. Pomembne interakcije med HOS, temperaturo in vrsto ogorčic dodatno poudarjajo kompleksnost teh ekoloških odnosov. Ugotovitve poudarjajo ekološko vlogo HOS pri usmerjanju vedenja ogorčic ter njihov potencialni pomen v trajnostnem obvladovanju škodljivcev. Benzonitril se je izkazal kot obetavna spojina za strategije biotičnega varstva z ogorčicami, medtem ko bi alil izotiocianat lahko predstavljal učinkovit neposredni nematicid. Študija poudarja pomen vključevanja kemijskih signalov v sisteme varstva rastlin za izboljšanje trajnosti kmetijske pridelave in zmanjševanje odvisnosti od kemičnih FFS.

ABSTRACT

When plants speak: how volatile compounds shape the behavior of parasitic nematodes

Parasitic nematodes, particularly those in the Rhabditidae family, are vital components of belowground ecosystems, contributing to pest regulation and sustainable agriculture. This study investigated the chemotactic responses of three nematode species—Phasmarhabditis papillosa, Oscheius myriophilus, and O. onirici—to volatile organic compounds (VOCs) emitted by Brassica nigra roots under herbivory by Delia radicum larvae. Using a chemotaxis assay, the effects of five VOCs (dimethyl sulfide, dimethyl disulfide, allyl isothiocyanate, phenylethyl isothiocyanate, and benzonitrile) were tested at two concentrations (pure and 0.03 ppm) and two temperatures (18 ◦C and 22 ◦C). The results revealed that VOCs and temperature significantly influenced nematode responses, while nematode species and VOC concentration showed limited effects. Benzonitrile consistently demonstrated strong chemoattractant properties, particularly for O. myriophilus and O. onirici. Conversely, allyl isothiocyanate exhibited potent nematicidal effects, inhibiting motility and causing mortality. Dimethyl disulfide and dimethyl sulfide elicited moderate to strong attractant responses, with species- and temperature-dependent variations. Significant interactions between VOCs, temperature, and nematode species highlighted the complexity of these ecological interactions. These findings emphasize the ecological roles of VOCs in mediating nematode behavior and their potential applications in sustainable pest management. Benzonitrile emerged as a promising candidate for nematode-based biocontrol strategies, while allyl isothiocyanate showed potential as a direct nematicidal agent. The study underscores the importance of integrating chemical cues into pest management systems to enhance agricultural sustainability and reduce reliance on chemical pesticides.

Plant organ determines insecticidal activity of essential oils against *Hercinothrips femoralis* (Thysanoptera: Thripidae)

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Essential oils are increasingly considered as sustainable alternatives to synthetic pesticides within integrated pest management. In this study, we evaluated the lethal effects of essential oils extracted from different plant parts (seeds and leaves) of coriander (*Coriandrum sativum*), dill (*Anethum graveolens*), and neem (*Azadirachta indica*) against the invasive thrips species *Hercinothrips femoralis*. Marked differences in efficacy were observed between oils derived from different plant organs. Coriander seed oil and dill leaf oil showed rapid lethal activity, achieving high mortality within 60 minutes, whereas neem-based products exhibited delayed but strong effects after 24 hours. The remaining treatments exhibited lower or more gradual insecticidal activity. These results demonstrate that the plant part used for essential oil extraction can substantially influence insecticidal activity. Our findings highlight the importance of precise characterization of plant-derived preparations and support the potential of selected essential oils as phytomedicinal tools for environmentally friendly pest control, particularly in indoor and protected cultivation systems.

IZVLEČEK

Vpliv izbire rastlinskega organa na insekticidno učinkovitost eteričnih olj proti resarju *Hercinothrips femoralis* (Thysanoptera: Thripidae)

Eterična olja se vse pogosteje obravnavajo kot ena izmed potencialnih trajnostnih alternativ sintetičnim fitofarmacevtskim sredstvom v okviru integriranega varstva rastlin. V naši raziskavi smo preučevali insekticidne učinke oziroma akutno toksičnost eteričnih olj, pridobljenih iz različnih rastlinskih organov (semen in listov) koriandra (*Coriandrum sativum*), navadnega kopra (*Anethum graveolens*) in drevesa neem (*Azadirachta indica*) proti invazivni vrsti resarja *Hercinothrips femoralis*. Učinkovitost olj se je značilno razlikovala glede na vrsto rastlinskega organa, iz katerega so bila ta pridobljena. Eterično olje iz semen koriandra in olje iz listov navadnega kopra sta izkazala hitro delovanje ter povzročila visoko smrtnost že 60 minut po nanosu, medtem ko so pripravki na podlagi neema izkazali zakasnjen, vendar izrazit učinek po 24 urah. Ostala obravnavanja so izkazala nižjo oz. postopnejšo insekticidno delovanje. Rezultati potrjujejo, da izvor ekstrakcije eteričnega olja, torej pravilna izbira rastlinskega organa pomembno vpliva na končno insekticidno učinkovitost eteričnega olja. Ugotovitve poudarjajo pomen natančne karakterizacije rastlinskih pripravkov ter potrjujejo potencial izbranih eteričnih olj kot fitofarmacevtskih sredstev za okolju prijaznejše varstvo rastlin, zlasti v zaprtih gojitvenih prostorih (npr. rastlinjakih in plastenjakih).

Izolacija in biotestiranje lokalnih sevov *Bacillus thuringiensis* kot osnova za razvoj novih biotičnih insekticidov v Sloveniji

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Biotično varstvo rastlin in zmanjševanje uporabe kemičnih insekticidov zahtevata razvoj novih, lokalno prilagojenih bioinsekticidov. Namen raziskave, izvedene v okviru Razvojnega stebra stabilnega financiranja (RSF) Kmetijskega inštituta Slovenije, natančneje projekta »Osamitev bakterije *Bacillus thuringiensis* iz tal in žuželk v Sloveniji

za identifikacijo entomopatogenih sevov, ki jih lahko uporabimo za zatiranje škodljivih žuželk v kmetijstvu«, je bil izolirati in karakterizirati seve bakterije *Bacillus thuringiensis* (Bt) iz slovenskih agroekosistemov ter oceniti njihovo entomopatogeno učinkovitost. Terensko vzorčenje je zajemalo 12 lokacij iz petih naravnogeografskih regij ter dodatno vzorčenje mrtvih žuželk, kar je omogočilo vključitev različnih ekoloških niš. Z uporabo selektivne toplotne obdelave in setvijo na LB agar z dodatkom ampicilina je bilo izoliranih 93 bakterijskih sevov, od katerih je 16 doseglo več kot 99 % identičnost z referenčnimi sekvencami Bt na osnovi PCR-amplifikacije in sekvenciranja 16S rRNA. Za oceno entomopatogenosti je bilo testiranih devet sevov, ki so tvorili kristalne δ-endotoksine. Bioanalizni poskusi so bili izvedeni na treh modelnih organizmih: *Drosophila suzukii*, *Tenebrio molitor* in *Culex pipiens*. Najvišjo insekticidno aktivnost sta izkazala seva Bt-68 in Bt-70, ki sta povzročila 100-odstotno smrtnost ličink *T. molitor* in *C. pipiens*, medtem ko so drugi sevi pokazali raznolike ravni učinkovitosti. Aktivnost na *D. suzukii* je bila nižja, kar potrjuje specifičnost Bt toksinov glede na žuželčji red. Rezultati raziskave potrjujejo, da slovenski agroekosistemi predstavljajo bogat vir genetsko in funkcionalno raznolikih sevov *Bacillus thuringiensis*, med katerimi več kandidatov izkazuje izrazit entomopatogeni potencial. Številni analizirani sevi, zlasti Bt-68 in Bt-70, so dosegli visoko smrtnost pri izbranih modelnih organizmih, kar potrjuje njihovo uporabnost v nadaljnjem razvoju bioinsekticidov. Najobetavnejši sevi so bili izbrani za nadaljnje formulacijske in bioprocesne raziskave, s poudarkom na mikroenkapsulaciji ter uporabi UV-odpornih biopolimerov, ki lahko izboljšajo stabilnost in učinkovitost bioinsekticidnih pripravkov v realnih okoljskih razmerah.

ABSTRACT

Isolation and bioassay of local *Bacillus thuringiensis* strains as a basis for the development of new biological insecticides in Slovenia

Biological plant protection and the reduction of chemical insecticide use require the development of new, locally adapted bioinsecticides. The aim of this study, conducted within the Development pillar of stable funding (RSF) at the Agricultural institute of Slovenia, specifically under the project “Isolation of the bacterium *Bacillus thuringiensis* from soil and insects in Slovenia for the identification of entomopathogenic strains suitable for the control of harmful insects in agriculture”, was to isolate and characterize Bacillus thuringiensis (Bt) strains from Slovenian agroecosystems and assess their entomopathogenic potential. Field sampling coverd 12 locations across five natural-geographic regions, with additional sampling of dead insects, to include various ecological niches. Using selective heat treatment and plating on LB agar supplemented with ampicillin, a total of 93 bacterial strains were isolated, of which 16 showed more than 99% sequence identity to reference Bt sequences based on PCR amplification and 16S rRNA sequencing. To evaluate entomopathogenicity, nine strains producing crystalline δ-endotoxins were selected for testing. Bioassays were conducted on three model organisms: *Drosophila suzukii*, *Tenebrio molitor*, and *Culex pipiens*. The highest insecticidal activity was observed in strains Bt-68 and Bt-70, both causing 100% larval mortality in *T. molitor* and *C. pipiens*, while the remaining strains showed varying levels of efficacy. Activity against *D. suzukii* was lower, confirming the specificity of *Bt* toxins with respect to insect order. The results of the study confirm that Slovenian agroecosystems represent a rich source of genetically and functionally diverse *Bacillus thuringiensis* strains, several of which demonstrate pronounced entomopathogenic potential. Many of the analyzed strains, particularly Bt-68 and Bt-70, achieved high mortality rates in the selected model organisms, supporting their applicability in the further development of biological insecticides. The most promising strains were selected for subsequent formulation and bioprocess research, with a focus on microencapsulation and the use of

UV-resistant biopolymers, which may improve the stability and efficacy of bioinsecticidal formulations under real environmental conditions.

Je lahko uporaba traktorskega sesalnika učinkovita alternativa za zatiranje stenic? Rezultati, pridobljeni na privabilnih posevkih, v letu 2025

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V letu 2025 smo preučevali učinkovitost prototipne traktorsko gnane vakuumsko-pnevmatske naprave za mehansko zatiranje stenic (Heteroptera) v vrstnih posevkih. Izvedli smo tudi determinacijo stenic na različnih gostiteljskih rastlinah po Sloveniji. Del raziskave s traktorsko sesalno napravo je potekal na laboratorijskem polju Biotehniške fakultete Univerze v Ljubljani na posevkih lucerne, soje, ajde in sirka. Popis smo v rastni dobi izvedli večkrat z uporabo metuljnice na 1 m² površine neposredno pred in po sesanju (6 ponovitev na kulturo); sesanje smo izvedli petkrat, pri nekaterih posevkih pa 2–3-krat. Pri odraslih osebkih se je številčnost po sesanju zmanjšala pri vseh obravnavanih kulturah: lucerna 4,69→2,56 osebka/m² (≈45 %), soja 2,25→1,17 (≈48 %), ajda 1,08→0,42 (≈61 %) in sirek 0,65→0,31 (≈52 %). Pri ličinkah je bil učinek izrazit pri lucerni (2,54→0,92; ≈64 %), ajdi (1,33→0,58; ≈56 %) in sirku (0,44→0,10; ≈76 %), manjši pa v soji (0,58→0,50; ≈14 %). Skupno je sesanje zmanjšalo številčnost stenic za približno 50–60 %. V sklopu raziskave smo opravili tudi taksonomsko determinacijo stenic na poskusnem polju, pri čemer smo zabeležili 11 taksonomskih enot. Prevladovale so travniške stenice (Miridae; ≈54 %), med ščitastimi stenicami (Pentatomidae) pa *Nezara viridula* (29,2 %), ob manjših deležih *Palomena prasina* (3,7 %), *Dolycoris baccarum* (2,3 %), *Piezodorus lituratus* (2,1 %) in *Halyomorpha halys* (1,6 %). Med 16. 5. in 17. 7. 2025 smo izvajali tudi determinacijo stenic po različnih regijah Slovenije, kjer je bila najpogosteje potrjena rjava usnjatka (*Coreus marginatus*), poleg nje pa še *D. baccarum*, *Eurydema* spp. (na križnicah), *N. viridula* in invazivna *H. halys*. Na žitih smo zabeležili predvsem žitne stenice (*Eurygaster* spp.) in *Aelia acuminata*, pri termofilnih vrstah pa tudi ličinke, zlasti junija in julija, kar kaže na aktivno razmnoževanje. Rezultati, pridobljeni z uporabo traktorsko gnane vakuumsko-pnevmatske sesalne naprave, kažejo na učinkovito mehansko zmanjševanje številčnosti stenic v posevkih. Neodvisno od tega podatki iz determinacij in terenskega monitoringa izpostavljajo razširjenost ter gospodarski pomen različnih vrst stenic v Sloveniji.

ABSTRACT

Is mechanical vacuuming an effective alternative fort he control of stink bugs? Results obtained on trap crops in 2025

In 2025, we evaluated the effectiveness of a prototype tractor-mounted vacuum-pneumatic device for mechanical control of stink bugs (Heteroptera) in row crops. In addition, identifications of stink bugs were carried out on various host plants across

Slovenia. The part of the study involving the tractor-mounted vacuum was conducted at the experimental field of the Biotechnical Faculty, University of Ljubljana, in alfalfa, soybean, buckwheat and sorghum crops. Sampling was performed repeatedly during the growing season using a sweep net on 1 m² plots immediately before and after vacuuming (six replicates per crop). Vacuuming was applied five times during the season, and two to three times in some crops, depending on crop phenology. Adult abundance decreased after vacuuming in all crops: alfalfa 4.69→2.56 individuals/m² (≈45%), soybean 2.25→1.17 (≈48%), buckwheat 1.08→0.42 (≈61%) and sorghum 0.65→0.31 (≈52%). Nymph abundance was strongly reduced in alfalfa (2.54→0.92; ≈64%), buckwheat (1.33→0.58; ≈56%) and sorghum (0.44→0.10; ≈76%), while the effect was smaller in soybean (0.58→0.50; ≈14%). Overall, vacuuming reduced stink bug abundance by approximately 50–60%. As part of the study, a taxonomic identification of stink bugs recorded at the experimental site was also performed, revealing eleven taxonomic units. Miridae were dominant (≈54%), while among Pentatomidae *Nezara viridula* prevailed (29.2%), followed by *Palomena prasina* (3.7%), *Dolycoris baccarum* (2.3%), *Piezodorus lituratus* (2.1%) and *Halyomorpha halys* (1.6%). Between 16 May and 17 July 2025, stink bugs were additionally identified across different regions of Slovenia. The most frequently recorded species was *Coreus marginatus*, along with *D. baccarum*, *Eurydema* spp. (on Brassicaceae), *N. viridula* and the invasive *H. halys*. On cereals, *Eurygaster* spp. and *Aelia acuminata* were predominant, while nymphs of thermophilic species were recorded mainly in June and July, indicating active reproduction. Results obtained using the tractor-mounted vacuum indicate effective mechanical reduction of stink bug abundance in crops. Independently, data from identifications and field monitoring highlight the distribution and economic importance of various stink bug species in Slovenia.

Dve »muhi« na en mah: prva najdba uši *Neotoxoptera formosana* (Hemiptera: Aphididae) za Slovenijo in potrditev najezdnika *Diplazon laetatorius* (Hymenoptera: Ichneumonidae)

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V okviru spremljanja zastopanosti škodljivcev v rastlinjakih smo spomladi 2025 prvič potrdili prisotnost vrste listne uši *Neotoxoptera formosana* (Takahashi, 1921) (Hemiptera, Aphididae) v Sloveniji. Vrsta je bila najdena na drobnjaku (*Allium schoenoprasum*) v Savljah (Ljubljana). Gre za tujerodno invazivno vrsto, ki izvira iz Vzhodne Azije in je bila prvotno opisana po primerkih s Tajvana. V Evropi je bila prvič najdena leta 1984 v Franciji, sledile so najdbe na Nizozemskem (1993), Finskem (1994), v Združenem kraljestvu (1999), Nemčiji (2006), Italiji (2000), Švici (2008) in Avstriji (2025). Vrsta *N. formosana* sesa rastlinske sokove na divje rastočih in gojenih vrstah iz rodu lukov (*Allium*), kot so drobnjak, šalotka, čebula, por in česen. V zmernem podnebju ima anholocikličen razvoj in se razmnožuje partenogenetsko izključno na enem gostitelju. Širi se pasivno in je bila k nam najverjetneje zanesena z rastlinskim materialom. Vrsta *N. formosana* je znana kot prenašalka nekaterih rastlinskih virusov, med drugim navadnega latentnega virusa česna (GarCLV) in virusa mozaika perujske lilije (AlMV). Zaradi zmožnosti prezimovanja, razvoja in širjenja v rastlinjakih predstavlja potencialno grožnjo za

pridelavo lukov. V sklopu vzorčenja listnih uši smo na istem drobnjaku potrdili tudi osico iz družine najezdnikov (Ichneumonidae). Molekularna analiza z metodo DNK črtnega kodiranja COI gena je pokazala, da gre za vrsto *Diplazon laetatorius* (Fabricius 1781) iz poddružine Diplazontinae. Gre za kozmopolitsko vrsto, ki se razmnožuje živorodno v večini območja svojega areala. Vrsto je v Sloveniji našel že Strobl (1903), od takrat pa po nam znanih podatkih v literaturi na našem ozemlju ni bila več zabeležena. Splošno prepričanje, da so vsi parazitoidi iz družine najezdnikov zavezniki pred škodljivimi žuželkami, v tem primeru ne drži. Predstavniki poddružine Diplazontinae so znani kot parazitoidi muh trepetavk (Diptera: Syrphidae), skoraj izključno iz poddružine Syrphinae. Ličinke poddružine Syrphinae so plenilci listnih uši in njihova parazitiranost lahko zmanjša učinkovitost zatiranja populacij listnih uši oziroma biotičnega varstva rastlin.

ABSTRACT

Two "birds" with one stone: first record of *Neotoxoptera formosana* (Hemiptera: Aphididae) in Slovenia and confirmation of *Diplazon laetatorius* (Hymenoptera: Ichneumonidae)

During greenhouse pest monitoring, we confirmed for the first time in spring 2025 the presence of the aphid species *Neotoxoptera formosana* (Takahashi, 1921) (Hemiptera: Aphididae) in Slovenia. The species was found on chives (*Allium schoenoprasum*) in Savlje (Ljubljana). It is an alien invasive species originating from East Asia and was originally described from specimens collected in Taiwan. In Europe, it was first detected in 1984 in France, followed by records in the Netherlands (1993), Finland (1994), the United Kingdom (1999), Germany (2006), Italy (2000), Switzerland (2008), and Austria (2025). *N. formosana* feeds on wild and cultivated species of the genus *Allium*, such as chives, shallot, onion, leek, and garlic. In temperate climates, it has an anholocyclic life cycle and reproduces parthenogenetically on a single host plant. Its spread is passive, and it was most likely introduced into Slovenia via plant material. *N. formosana* is known to transmit several plant viruses, including garlic common latent virus (GarCLV) and Alstroemeria mosaic virus (AlMV). As it can overwinter, develop and spread in greenhouses, it poses a potential threat to *Allium* production. During aphid sampling on the same chive plants, we also confirmed the presence of a wasp belonging to the family Ichneumonidae. Molecular analysis using the COI barcode region identified it as *Diplazon laetatorius* (Fabricius, 1781) of the subfamily Diplazontinae. This is a cosmopolitan species that reproduces viviparously in most parts of its distribution range. The species was previously recorded in Slovenia by Strobl (1903), but to our knowledge it has not been reported in the literature since then. Contrary to the common assumption that all ichneumonid parasitoids are beneficial allies against pest insects, this is not the case here. Members of the subfamily Diplazontinae are known as parasitoids of hoverflies (Diptera: Syrphidae), and almost exclusively parasitise the subfamily Syrphinae. Larvae of Syrphinae are predators of aphids, and their parasitism can reduce their effectiveness in suppressing aphid populations in biological control programmes.

Preizkušanje učinkov treh pripravkov na osnovi antagonističnih mikroorganizmov na rast in pridelek solatnih kumar v zavarovanem prostoru

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V letu 2024 smo v rastlinjaku na Biotehniški fakulteti postavili poskus, v katerem smo preizkušali vpliv treh biotičnih pripravkov na rast in pridelek solatnih kumar. Pripravke smo aplicirali na dva različna načina, z namakanjem sadik v platojih pred presajanjem in z zalivanjem sadik po presajanju v tla. Uporabili smo pripravke na osnovi antagonističnih mikroorganizmov, in sicer Trifender PRO (*Trichoderma asperellum* sev T34), Prestop (*Clonostachys rosea* sev J1446) in Polyversum (*Pythium oligandrum* sev M1). V poskusu smo preučevali vpliv pripravkov na morfološke parametre rastlin (masa, dolžina in premer plodov, št. plodov na rastlino, višina nadzemnega dela, masa korenin) ter skupni pridelek. Ob spravilu poskusa smo ugotovili, da so bile korenine kumar močno napadene s koreninskimi ogorčicami, kar je zagotovo vplivalo tudi na rastline in pridelek. Tako nismo potrdili pozitivnega vpliva pripravkov na morfološke lastnosti kumar ter tudi ne na skupni pridelek, saj so bili najboljši rezultati doseženi pri kontroli, kjer ni bilo dodanega nobenega pripravka.

ABSTRACT

Testing the effects of three products based on antagonistic microorganisms on the growth and yield of salad cucumbers in a protected area

In 2024, we conducted an experiment in the greenhouse at the Biotechnical Faculty to test the effect of three biotic plant protection products on the growth and yield of salad cucumbers. The products were applied in two ways: by soaking seedlings in trays before transplanting and by watering seedlings after transplanting into the soil. We used products based on antagonistic microorganisms: Trifender PRO (*Trichoderma asperellum* strain T34), Prestop (*Clonostachys rosea* strain J1446), and Polyversum (*Pythium oligandrum* strain M1). In the experiment, we examined the effect of the products on the plants' morphological parameters (mass, length and diameter of fruits, number of fruits per plant, height of the aboveground part, root mass) as well as total yield. At harvest, we found that cucumber roots were heavily infested by root-knot nematodes, which certainly affected the plants and yield. Therefore, we did not confirm a positive effect of the products on the morphological characteristics of cucumbers or on total yield, as the best results were achieved in the control, where no products were applied.

Preizkušanje učinkov dveh pripravkov na osnovi antagonističnih mikroorganizmov na rast in pridelek paprike ter okužbo s patogenom *Verticillium dahliae* v lončnem poskusu

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V letu 2025 smo v rastlinjaku na Biotehniški fakulteti postavili lončni poskus, v katerem smo preizkušali vpliv dveh biotičnih pripravkov na rast in pridelek paprike. Pripravka smo aplicirali na dva različna načina, z namakanjem sadik v platojih pred presajanjem in z

zalivanjem sadik po presajanju v lonce. Uporabili smo pripravka na osnovi antagonističnih mikroorganizmov, in sicer Tricho Immun (*Trichoderma afroharzianum* sev TR04 in *Trichoderma simmonsii* sev TR05.) in Polyversum (*Pythium oligandrum* sev M1). V poskusu smo preučevali vpliv pripravkov na okužbo s patogenom *V. dahliae* in morfološke parametre rastlin (masa, dolžina in premer plodov, št. plodov na rastlino, masa nadzemnega dela, masa korenin) ter skupni pridelek. Rezultati so pokazali, da uporaba pripravkov pozitivno vpliva na rast rastlin paprike in njen pridelek ob odsotnosti patogena. Najboljše rezultate pri skoraj vseh preučevanih parametrih rasti in pridelka je doseglo obravnavanje, kjer smo platoje sadik pred sajenjem namočili v pripravek Tricho Immun. Kljub temu pa ob dodatku patogena *V. dahliae* pripravka nista imela želenega učinka na zmanjšanje okužb, ne glede na način oziroma čas aplikacije in so bila ta obravnavanja primerljiva s kontrolo s patogenom.

ABSTRACT

Testing the effects of two products based on antagonistic microorganisms on pepper growth, yield, and infection by the pathogen Verticillium dahliae in a pot experiment

In 2025, we conducted a pot experiment in the greenhouse at the Biotechnical Faculty to test the effect of two biotic products on the growth and yield of peppers. The products were applied in two ways: by soaking the seedlings in trays before transplanting and by watering the seedlings after transplanting into pots. We used products based on antagonistic microorganisms, namely Tricho Immun (*Trichoderma afroharzianum* strain TR04 and *Trichoderma simmonsii* strain TR05) and Polyversum (*Pythium oligandrum* strain M1). The experiment examined the effect of the products on infection by the pathogen *V. dahliae* and on plant morphological parameters (weight, fruit length and diameter, number of fruits per plant, aboveground biomass, root biomass) as well as total yield. The results showed that use of the products positively affected the growth and yield of pepper plants in the absence of the pathogen. The best results for almost all growth and yield parameters were achieved when the seedling trays were soaked in the product Tricho Immun before planting. However, when the pathogen *V. dahliae* was present, the products did not have the desired effect on reducing the infection rate, regardless of the method or timing of application, and these treatments were comparable to the pathogen control.

Prvi dokaz sposobnosti okužbe paradižnika z bakterijo *Dickeya fangzhongdai* po umetni inokulaciji

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Dickeya fangzhongdai je rastlinski patogen s širokim naborom gostiteljev, ki povzroča mehko gnilobo pri zelnatih rastlinah in razjede pri azijskih hruškah. V Evropi je bila vrsta potrjena na orhidejah, krompirju, cvetači in v površinskih vodah, kar kaže na njeno sposobnost preživetja v različnih okoljih. Prejšnje študije so pokazale tudi genetsko raznolikost in izrazito agresivnost nekaterih izolatov, kar nakazuje, da se patogene lastnosti med izolati lahko razlikujejo. V tej študiji smo preverili sposobnost okužbe paradižnika

(*Solanum lycopersicum*, sorta Moneymaker). Rastline smo umetno inokulirali s sevom *D. fangzhongdai* B16, ki je bil izoliran iz orhideje s simptomi mehkih gnilob. Uporabili smo laboratorijski način inokulacije, primeren za dokaz patogenosti. Po 24 dneh smo na nekaterih rastlinah opazili bolezenska znamenja črne noge, obsežno nekrozo stebelnega tkiva in propadanje rastlin. Prisotnost bakterije smo potrdili z izolacijo na gojišču CPG ter s PCR v realnem času. Po naših podatkih gre za prvi dokaz, da lahko *D. fangzhongdai* okuži paradižnik in povzroči črno nogo v nadzorovanih eksperimentalnih pogojih. Ker je bila okužba povzročena z umetno inokulacijo, rezultati ne potrjujejo nujno, da do okužbe pride tudi v naravnih razmerah. Kljub temu ugotovitve prispevajo k poznavanju potencialnih gostiteljev te vrste in poudarjajo potrebo po nadaljnjem spremljanju, preizkušanju več izolatov, uporabi naravnejših načinov inokulacije ter oceni epidemiološke pomembnosti. Rezultat je pomemben za slovenske in evropske strokovnjake, saj kaže na potencialne nove grožnje za kmetijstvo pomembne rastline.

ABSTRACT

Demonstration of *Dickeya fangzhongdai* pathogenicity on tomato following artificial inoculation

Dickeya fangzhongdai is an emerging plant pathogen with a broad host range. It can cause soft rot in herbaceous plants and bleeding canker disease in Asian pear trees. In Europe, the species has been found on orchids, potato and cauliflower, as well as in surface waters, which indicates its ability to survive in diverse environments. Previous studies have also revealed the genetic diversity and pronounced aggressiveness of some isolates, suggesting that pathogenic traits may vary among strains. In this study, we examined the ability of *D. fangzhongdai* to infect the tomato plant (*Solanum lycopersicum*, cv. Moneymaker). Plants were artificially inoculated with the strain B16, which was originally isolated from orchids with soft rot symptoms. We used a laboratory inoculation method suitable for pathogenicity testing. After 24 days, some plants exhibited black leg symptoms, extensive necrosis of the stem tissue, and general decline. The presence of the bacterium was confirmed by isolation on CPG medium and real-time PCR analysis. To our knowledge, this is the first evidence that *D. fangzhongdai* can infect tomatoes and cause black leg under controlled experimental conditions. As the infection was induced by artificial inoculation, these results do not necessarily confirm the possibilities of the natural infection. Nevertheless, these findings contribute to the understanding of this species' potential host range and emphasize the need for further monitoring, testing of the other *D. fangzhongdai* isolates, the use of more natural inoculation methods, and the assessment of epidemiological significance. These results are important for Slovenian and European experts, as they highlight potential new threats to economically important crops.

Virulenca slovenskih populacij ogorčic koreninskih šišk (*Meloidogyne* spp.) na *Mi*-odpornem paradižniku

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Ogorčice koreninskih šišk (RKN; *Meloidogyne* spp.) sodijo med najbolj škodljive rastlinsko-parazitske ogorčice in povzročajo znatne izgube pridelka po vsem svetu. Čeprav se geni odpornosti iz družine *Mi* pogosto uporabljajo pri paradižniku za obvladovanje RKN, so se nekatere populacije razvile v virulenco in se lahko razmnožujejo tudi na odpornih gostiteljih. V naši raziskavi smo z lončnim poskusom v rastlinjaku ocenili stopnjo virulence štirih slovenskih populacij RKN. Rastline paradižnika sorte Velasco F1 (mi/mi, občutljiv hibrid) in sorte Rally F1 (Mi/mi, odporni hibrid) smo inokulirali z 1.000 drugostopenjskimi ličinkami ogorčic (J2) na rastlino (10 ponovitev na populacijo in sorto) ter jih šest tednov gojili pri približno 25 °C. Ocenili smo indeks tvorbe koreninskih šišk in nivo razmnoževanja preko štetja novonastalih jajčec ter izračunali reprodukcijski indeks (RI) kot razmerje med številom novonastalih jajčec na odporni in občutljivi sorti. Tri populacije — *M. incognita* NE13-110 (RI < 0,01), *M. arenaria* NE12-110 (RI < 0,01) in *M. luci* NE12-69 (RI < 0,01), vse izolirane na območju Vrtojbenskega polja leta 2024 — so bile opredeljene kot avirulentne. Populacija *M. luci* SI-Šmartno/1, izolirana v Šmartnem pri Ljubljani leta 2015, pa je bila opredeljena kot virulentna (RI > 0,8), saj je izkazala primerljivo razmnoževanje na občutljivi in odporni sorti paradižnika. Rezultati poudarjajo pomen določanja virulence populacij RKN za primerno uporabo odpornih sort ter izbiro ustreznih fitosanitarnih ukrepov za učinkovito obvladovanje teh škodljivih organizmov. Zahvala: Raziskavo sta financirala Evropska unija v okviru programa Obzorje Evropa (pogodba o sofinanciranju št. 101083727, projekt NEM-EMERGE) in Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije (ARIS; programa P4-0072 in P4-0431).

ABSTRACT

Virulence of Slovenian root-knot nematodes (*Meloidogyne* spp.) populations against *Mi*-resistant tomato

Root-knot nematodes (RKN; *Meloidogyne* spp.) are among the most damaging plant-parasitic nematodes, causing substantial yield losses worldwide. Although resistance genes from the *Mi* family are widely used in tomato, some RKN populations have evolved virulence, enabling reproduction on resistant hosts. In this study, the virulence of four Slovenian RKN populations was assessed using a greenhouse pot experiment. Tomato cv. Velasco F1 (mi/mi, susceptible hybrid) and cv. Rally F1 (Mi/mi, resistant hybrid) were inoculated with 1.000 second-stage juveniles (J2) per plant (10 replicates per population and cultivar) and grown at ~25 °C for six weeks. Galling index and egg production were evaluated, and the reproduction index (RI) was calculated as the ratio of eggs on resistant versus susceptible plants. Three populations—*M. incognita* NE13-110 (RI < 0.01), *M. arenaria* NE12-110 (RI < 0.01), and *M. luci* NE12-69 (RI = 0.01), all isolated from Vrtojbensko polje in 2024—were classified as avirulent. In contrast, *M. luci* SI-Šmartno/1, isolated from Šmartno pri Ljubljani in 2015, was virulent (RI > 0.8), showing somewhat comparable reproduction on susceptible as well as on resistant tomatoes. These results highlight the necessity of determining RKN virulence status to support informed deployment of resistant cultivars and appropriate phytosanitary management strategies. Acknowledgement: This work was supported by the European Union under the Horizon Europe programme (Grant Agreement No. 101083727, NEM-EMERGE) and Slovenian Research and Innovation Agency (programs P4-0072, P4-0431).

Pojav tropske vrste ogorčic koreninskih šišk *Meloidogyne luci* na rastlinah paradižnika, gojenih na prostem v Sloveniji

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Ogorčice koreninskih šišk (RKN) iz rodu *Meloidogyne* so gospodarsko pomembne in polifagne rastlinsko-parazitske ogorčice, ki zajedajo širok spekter gostiteljev, kot so enokaličnice, dvokaličnice, zelnate in lesnate rastline. RKN so obligatni endoparaziti, ki povzročajo večje izgube pridelka v svetovni kmetijski proizvodnji. Razmnožujejo se v koreninah gostiteljskih rastlin, na katerih povzročajo nastanek značilnih koreninskih šišk in tako onemogočajo njihovo normalno delovanje. Temperatura tal je ključna za preživetje hladnejših okoljskih razmer, ter vpliva na razvoj in razširjenost RKN. Vrsta *Meloidogyne luci* spada med tropske RKN, ki potrebuje relativno visoke temperature tal za preživetje in razmnoževanje v regijah s submediteranskim in celinskim evropskim podnebjem. O vrsti *M. luci* so prvič poročali iz Irana, Brazilije in Čila na različnih gostiteljih. Ta vrsta je bila kasneje najdena tudi v državah Evropske unije: Sloveniji, Italiji, Grčiji in Portugalski; ter nadalje v Turčiji, Gvatemali, Srbiji, Argentini, Boliviji, Ekvadorju in Etiopiji. Vrsta *M. luci* je zaradi visokega gospodarskega pomena uvrščena na seznam škodljivih organizmov Evropske in mediteranske organizacije za varstvo rastlin (EPPO A2 List). V Sloveniji so bile ogorčice *M. luci* doslej najdena le v rastlinjakih. Leta 2024 smo ogorčice vrste *M. luci* določili v 20 % vzorčenih rastlin paradižnika na manjši njivi v bližini Vrtojbe v mešani okužbi z ogorčicami *M. arenaria*. Vrsti smo potrdili z analizo morfologije, PCR v realnem času in analizo vrstno-specifičnih izoencimskih vzorcev. Tokratna detekcija je pokazala, da so se ogorčice *M. luci* razširile na gostiteljske rastline izven zavarovanih območij (rastlinjaki), saj smo jih tokrat prvič v Sloveniji ugotovili na polju. Podnebne spremembe, višje temperature tal in polifagna narava teh RKN, omogočajo visok potencial za širjenje ogorčic *M. luci* ter škodo v kmetijski proizvodnji v prihodnosti, tako v zavarovanih območjih kot so rastlinjaki kot na prostem v Sloveniji. Zahvala: finančna podpora s strani EU (Horizon Europe, GA No. 101083727 – NEM-EMERGE) in ARIS (P4-0072, P4-0431).

ABSTRACT

Occurrence of tropical root-knot nematode *Meloidogyne luci* in field-grown tomato plants in Slovenia

Root-knot nematodes (RKN) of the *Meloidogyne* genus are economically important and polyphagous plant-parasitic nematodes affecting a wide range of hosts, such as monocotyledons, dicotyledons, herbaceous and woody plants. RKN are obligate endoparasites causing significant yield losses in agricultural production systems worldwide. RKN reproduce in host plant roots where they elicit the formation of characteristic galls (root-knots) and negatively impact their normal function. Soil temperature is key to the ability of RKN to survive cooler environmental conditions and influence the development and distribution of RKN. *Meloidogyne luci* is a tropical RKN species that requires relatively high temperatures for survival and reproduction in fields, located in regions with sub-Mediterranean and continental European climates. *M. luci* was first reported from Iran, Brazil and Chile, on different crops. This species was later also reported from European Union countries: Slovenia, Italy, Greece and Portugal; and

furthermore from Turkey, Guatemala, Serbia, Argentina, Bolivia, Ecuador and Ethiopia. *M. luci* was included in the European and Mediterranean Plant Protection Organization (EPPO) A2 List of harmful organisms due to its economic significance. In Slovenia, *M. luci* has previously only been found in greenhouses. In 2024, *M. luci* was determined in 20% of the sampled tomato plants in a small field near Vrtojba village in a mixed infection with *M. arenaria*. The species were identified by analysis of morphology, real-time PCR and species-specific isoenzyme patterns. Present detection demonstrated that *M. luci* has spread in Slovenia not only in protected growing areas (greenhouses), but also in fields. Climate change, higher soil temperatures and polyphagous nature of these RKNs mean there is a high chance of *M. luci* spreading and causing damage to agricultural production in the future, both in protected areas like greenhouses and outdoors in Slovenia. Acknowledgement: funded by EU (Horizon Europe GA No. 101083727 – NEM-EMERGE) and ARIS (P4-0072, P4-0431).

Učinki različnih bakrovih fungicidov na entomopatogeno glivo *Beauveria bassiana*

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Bakrovi fungicidi in mikoinsekticidi na podlagi entomopatogene glive *Beauveria* bassiana so zelo pogosto uporabljena fitofarmacevtska sredstva v ekološki kmetijski pridelavi. Proučevali smo *in vitro* fungicidne učinke šestih pogosto uporabljenih bakrovih fungicidov – bakrovega oksida, bakrovega hidroksida, bakrovega oksiklorida, bakrovega sulfata, dibakrovega klorida trihidroksida in bakrovega trihidroksi sulfata – na rast micelija, sporulacijo in kalitev konidijev komercialnega izolata *B. bassiana* (ATCC 74040). Rast micelija pri 15 in 25 °C smo ocenili na PDA ploščah, ki so vsebovale 100, 75, 50, 25, 12,5, 6,25 in 0 % priporočenega odmerka vsakega fungicida. Sporulacijo in kalitev konidijev smo ocenili pri priporočenem poljskem odmerku testiranih fungicidov pri 25 °C. Vseh šest bakrovih fungicidov je pokazalo fungistatične ali fungicidne učinke različne intenzivnosti, odvisno vrste in njihove koncentracije v gojišču ter deloma temperature. Vsi testirani fungicidi so v primerjavi s kontrolnim obravnavanjem znatno zavrli sporulacijo in kalitev konidijev glive. Razen bakrovega oksiklorida (inhibicija 13,6 %) so imeli vsi drugi testirani fungicidi zelo negativen vpliv na kalitev konidijev (inhibicija 91,5–100 %). Biološki indeks (BI), tj. ocena združljivosti entomopatogene glive *B. bassiana* in bakrovih fungicidov, se je gibal med 0,8 (bakrov sulfat) in 18,1 (bakrov oksiklorid). Glede na BI so bili vsi fungicidi uvrščeni v zgornjo polovico kategorije zelo strupenih (ZS) in zato niso primerni za sočasno uporabo z entomopatogeno glivo *B. bassiana*.

ABSTRACT

Effects of different copper fungicides on the entomopathogenic fungus *Beauveria bassiana*

Copper fungicides and mycoinsecticides based on the entomopathogenic fungus *Beauveria bassiana* are the most common agents used in organic crop production systems. The *in vitro* fungicidal effects of six commonly used copper fungicides – copper oxide, copper hydroxide, copper oxychloride, copper sulphate, dicopper chloride

trihydroxide, and copper sulfate trihydrate – on mycelial growth, sporulation, and conidial germination of the commercial isolate of *B. bassiana* (ATCC 74040) were investigated. Mycelial growth at 15 and 25°C was evaluated on PDA plates containing 100, 75, 50, 25, 12.5, 6.25, and 0% of the recommended application rate of each fungicide. Sporulation and conidial germination were assessed at the recommended field dosage rate of the tested fungicides at 25°C. All six copper fungicides showed fungistatic or fungicidal effects of varying intensities, depending on the type of fungicide, its concentration in the medium, and partly on the temperature. Sporulation and conidial germination of fungus were significantly inhibited by all tested fungicides compared to the control treatment. Except for copper oxychloride (inhibition 13.6%), all other tested fungicides had a very negative impact on conidial germination (inhibition 91.5–100%). The biological index (BI), i.e. compatibility assessment for the entomopathogenic fungus *B. bassiana* and copper fungicides, ranged between 0.7 (copper sulphate) and 18.1 (copper oxychloride). According to the BI, all fungicides were classified in the upper half of the highly toxic (HT) category and are therefore unsuitable for concomitant use with the entomopathogenic fungus *B. bassiana*.

Vključitev modulov projekta Poseidone za napovedovanje pojava škodljivcev v sadjarstvu, oljkarstvu in vinogradništvu v Agrometeorološki portal Slovenije

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Zaradi strogih zahtev po varovanju okolja in pridelavi zdrave hrane brez ostankov kemičnih sredstev mora biti uporaba fitofarmacevtskih sredstev v kmetijski pridelavi skrbno načrtovana. Uporaba slednjih je upravičena le v primeru preseženega praga škodljivosti oz. v primeru, ko se vzpostavijo ugodne razmere za pojav škodljivca ali rastlinske bolezni. V preteklosti se je za termin zatiranja škodljivih žuželk odločalo zgolj na podlagi pojava ali ulova le-teh na lepljive plošče/lovilne posode/lepljive trakove oz. na feromonske pasti. V zadnjih desetletjih se prognostične službe po svetu poslužujejo tudi napovedovalnih modelov, ki temeljijo na zbiranju okoljskih podatkov s pomočjo meteoroloških postaj in spremljanj fenologije kmetijskih rastlin. Moduli omogočajo natančnejše določanje termina zatiranja rastlinskih bolezni ali škodljivcev, kar poleg manjšega vpliva na okolje pripomore tudi k gospodarnejši rabi sredstev za varstvo rastlin. Javna služba zdravstvenega varstva rastlin (KGZS-Zavod Nova Gorica) trenutno na območju celotne Primorske razpolaga z meteorološkimi podatki iz več kot 40 agrometeoroloških in meteoroloških postaj iz različnih virov. Vremenski parametri kot so temperatura zraka, relativna zračna vlaga, količina padavin, hitrost vetra, temperatura tal in omočenost lista se redno beležijo ter so pridelovalcem in zainteresirani javnosti v realnem času dostopni na Agrometeorološkem portalu (UVHVVR - MKGP). Na podlagi podatkov zbranih z večletnim spremljanjem leta škodljivcev na območju KGZS-Zavod Nova Gorica kot so breskov zavijač (*Grapholita molesta* Busck), oljčna muha (*Bactrocera oleae* Gmelin) in križasti grozdni sukač (*Lobesia botrana* Denis & Schiffermüller), vsot efektivnih temperatur pri različnih pragovih in spremljanja razvojnih faz rastlin (BBCH) so bili v sklopu projekta POSEIDONE (Program Interreg VI-A Italija–Slovenija 2021–2027) izdelani prognostični moduli za spremljanje in napovedovanje pogojev za pojav

breskovega zavijača, oljčne muhe in križastega grozdnega sukača. Moduli so vključeni v Agrometeorološki informacijski sistem UVHVVR. Uporaba orodij, ki temeljijo na izračunu vsote efektivnih temperatur bodo pripomogli k lažjemu določanju primernega termina zatiranja omenjenih škodljivih žuželk.

ABSTRACT

Implementation of forecasting models developed in the project Poseidone for the prediction of pest occurrence in fruit growing, olive production and viticulture in the agrometeorological portal of Slovenia

Due to strict environmental requirements and the production of healthy food without chemical residues, the use of plant protection products must be carefully planned. The use of plant protection products is justified only in cases where the damage threshold is exceeded or when favourable conditions for the occurrence of a pest or plant disease are established. In the past, the period of pest control was decided only on the basis of their occurrence or the catch on sticky traps/containers/tapes or on pheromone traps. Since the past decades, pest control services around the world are using the forecasting models based on the recorded environmental data from meteorological stations. The mentioned forecasting models enable a more precise timing of plant disease or pest control, which helps to reduce the impact on the environment and also contributes to a more economical use of plant protection products. The Public Plant Health Service (KGZS-Zavod Nova Gorica) currently operates with meteorological data of more than forty agrometeorological and meteorological stations which are located throughout the entire Primorska region (West Slovenia). Weather parameters such as air temperature, air humidity, precipitation, wind speed, soil temperature and leaf wetness are regularly recorded and are available to growers and the public in real time on the website of the Agrometeorological Portal (Administration for Food Safety, Veterinary Sector and Plant Protection). Based on data collected in the area through several years of pests monitoring such as the oriental fruit moth (*Grapholita molesta* Busck), the olive fruit fly (*Bactrocera oleae* Gmelin) and the European grape berry moth (*Lobesia botrana* Denis & Schiffermüller), the sum of effective temperatures at different thresholds and records of plant phenological stages (BBCH) the forecasting models for pest prediction were made. The forecasting tools for predicting the pest occurrence in orchards, olives and vines were developed as part of the POSEIDONE project (Interreg VI-A Italy-Slovenia Program 2021–2027). The forecasting models are implemented in the Agrometeorological Portal. The use of tools based on the calculated sum of effective temperatures will help to more accurately determine the time for the control of the mentioned harmful insects.

Ogorčica *Xiphinema rivesi*, potrjena v sadovnjakih na Dolenjskem

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Ogorčice vrste *Xiphinema rivesi* so parazitske ogorčice iz skupine *Xiphinema americanum* sensu lato (družina Longidoridae). Njihova pomembnost izhaja iz sposobnosti prenosa nekaterih nepovirusov (PRMV, CRLV, TRSV in ToRSV), ki lahko povzročajo resne virusne bolezni na sadnih rastlinah in vinski trti, kar lahko vodi v znatno gospodarsko

škodo. V Sloveniji je bila vrsta *X. rivesi* prvič potrjena leta 2002 v sadovnjaku v Biljah v Vipavski dolini, kar je bila takrat prva potrditev prisotnosti te vrste v državi in ena prvih v Evropi. Od takrat so to vrsto potrdili tudi v nekaterih drugih državah EU (Italija, Nemčija, Francija, Španija, Portugalska ter Bosna in Hercegovina). Na Kmetijskem inštitutu Slovenije v okviru programa Posebnih preiskav »Karantenske nematode« spremljamo prisotnost karantenskih virusonosnih ogorčic na območju celotne Slovenije. Poleg usmerjenosti v detekcijo specifičnih karantenskih vrst, dodatno spremljamo tudi populacijo nekaterih nekaranteskih virusonosnih ogorčic (npr. *X. index*, *X. diversicaudatum*, *X. rivesi*...). Po do sedaj zbranih podatkih so bile te vrste omejene na območje Zahodne Slovenije, v letu 2025 pa smo prisotnost *X. rivesi* prvič potrdili tudi v sadovnjakih na Dolenjskem — na dveh ločenih lokacijah: Leskovec pri Krškem (breskev) in Rodine pri Trebnjem (češnja). To nakazuje na širjenje te vrste izven območja Zahodne Slovenije, kar je lahko pomembno za lokalno sadjarstvo. Zaradi omejenih možnosti za nadzor in dejstva, da ogorčice preživijo globoko v tleh in se širijo z napadenimi tlemi ali sadilnim materialom, je ključno sistematično spremljanje ter ukrepi za preprečevanje širjenja te ogorčice v sadovnjakih in drugih kmetijskih nasadih.

ABSTRACT

Presence of the nematode species *Xiphinema rivesi* confirmed in orchards in the Dolenjska region

The nematode species *Xiphinema rivesi* is a plant-parasitic nematode belonging to the *Xiphinema americanum* sensu lato group (family Longidoridae). Its importance stems from its ability to transmit several nepoviruses (PRMV, CRLV, TRSV, and ToRSV), which can cause severe viral diseases in fruit crops and grapevine, potentially leading to significant economic losses. In Slovenia, *X. rivesi* was first confirmed in 2002 in an orchard in Bilje, Vipava Valley, representing the first report of this species in the country and one of the earliest in Europe. Since then, it has also been reported in other European countries (Italy, Germany, France, Spain, Portugal and Bosnia and Herzegovina). At the Agricultural Institute of Slovenia, within the framework of the Special Survey programme »Quarantine Nematodes«, we monitor the occurrence of quarantine virus-vector nematodes throughout the country. In addition to targeted detection of specific quarantine species, we also monitor populations of certain non-quarantine virus-vector nematodes (e.g. *X. index*, *X. diversicaudatum*, *X. rives*i...). Based on data collected so far, these species were previously limited to western Slovenia; however, in 2025, the presence of *X. rivesi* was confirmed for the first time in orchards in the Dolenjska region — at two separate locations: Leskovec pri Krškem (peach) and Rodine pri Trebnjem (cherry). This indicates a potential spread of the species beyond western Slovenia, which may be relevant for local fruit production. Due to limited control options and the ability of nematodes to survive deep in the soil and spread via contaminated soil or planting material, systematic monitoring and measures to prevent the dissemination of this nematode in orchards and other agricultural plantations are essential.

Vpliv entomotoksičnih proteinov iz gob na marmorirano smrdljivko (*Halymorpha halys*) in medonosno čebelo (*Aphis mellifera carnica*)

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Lektini, proteini z visoko afiniteto do specifičnih glikanov, predstavljajo obetavno skupino bioloških učinkovin za razvoj novih bioinsekticidov. V zadnjih letih so v različnih vrstah gliv prepoznali številne entomotoksične lektine, kar je spodbudilo raziskave njihove selektivnosti do tarčnih in netarčnih žuželk. V študiji smo ocenili oralno toksičnost izbranih glivnih proteinov na invazivno vrsto kmetijskega škodljivca marmorirano smrdljivko (*Halyomorpha halys*) (Heteroptera: Pentatomidae) ter hkrati preverili morebitne učinke na ne-tarčni organizem, medonosno čebelo (*Apis mellifera carnica*) (Hymenoptera: Apidae), ki je ključni opraševalec kmetijskih ekosistemov. Na ličinkah *H. halys* smo s prehranskimi testi ovrednotili oralno toksičnost šestnajstih izbranih lektinov (AAL, CNL, SRL, SSA, AAG, TAP1, XCL, CC1G, ABL, BEL, BELBETA, CML1, MOA, CCL2, CGL2, CGL3) in dveh proteaznih inhibitorjev (PIC, CCP1). Proteine smo vnesli v umetno gojišče ter dnevno spremljali vpliv na smrtnost in prehranjevanje žuželk. Pri koncentraciji 500 µg/ml nobeden od osemnajstih različnih proteinov iz gob ni značilno povečal smrtnosti; toksičnost je izkazovala le pozitivna kontrola (acetamiprid). Razviti protokol omogoča zanesljivo oceno vpliva proteinskih bioinsekticidov na *H. halys* in predstavlja osnovo za nadaljnje presejalne študije novih kandidatov. Ker je pri razvoju le-teh treba oceniti tudi tveganje za koristne žuželke, smo izvedli akutne in kronične prehranske teste na odraslih čebelah in ličinkah *A. m. carnica*. Testirali smo lektine MOA, AAL, CGL2, CGL3, CCL2 in CCP1. Kaplan-Meierjevi testi in post-hoc analize so pokazali, da tudi pri odraslih čebelah noben izmed lektinov ni zmanjšal preživetja niti vplival na hranjenje v primerjavi z negativno kontrolo (PBS). Pri ličinkah prav tako nismo zaznali razlik v preživetju; masa ličink se je med tretmaji le minimalno razlikovala in ni značilno odstopala od negativne kontrole. Rezultati kažejo, da so testirani lektini pri uporabljenih koncentracijah varni za *A. m. carnica*, hkrati pa ne učinkujejo na *H. halys*.

ABSTRACT

Impact of entomotoxic fungal proteins on the brown marmorated stink bug (*Halyomorpha halys*) and the honey bee (*Apis mellifera carnica*)

Lectins, proteins with high affinity for specific glycans, represent a promising group of biological agents for developing novel bioinsecticides. In recent years, numerous entomotoxic lectins have been identified in various fungal species, stimulating research into their selectivity toward target and non-target insects. In this study, we assessed oral toxicity of selected fungal proteins to the invasive agricultural pest brown marmorated stink bug (*Halyomorpha halys*) (Heteroptera: Pentatomidae) and concurrently evaluated potential non-target effects on the honey bee (*Apis mellifera carnica*) (Hymenoptera: Apidae), a key pollinator in agricultural ecosystems. Using diet incorporation bioassays on *H. halys* nymphs, we evaluated the oral toxicity of sixteen selected lectins (AAL, CNL, SRL, SSA, AAG, TAP1, XCL, CC1G, ABL, BEL, BELBETA, CML1, MOA, CCL2, CGL2, CGL3) and two protease inhibitors (PIC, CCP1). Proteins were incorporated into artificial diet, and insect mortality and feeding were monitored daily. At 500 µg/ml, none of the eighteen fungal proteins caused a significant increase in mortality; only the positive control (acetamiprid) showed toxicity. The developed protocol provides a reliable means of assessing the effects of protein-based bioinsecticides on *H. halys* and forms a basis for further screening of new candidates. Because the development of such agents requires

evaluation of risks to beneficial insects, we conducted acute and chronic feeding assays on adult bees and larvae of *A. m. carnica*. We tested the lectins MOA, AAL, CGL2, CGL3, CCL2, and the protease inhibitor CCP1. Kaplan–Meier tests and post hoc analyses of the acute exposure tests showed that none of the lectins reduced adult bee survival or affected their feeding relative to the negative control (PBS). However, no differences in larval survival were detected, and larval mass varied only minimally among treatments, without deviation from the negative control. The results indicate that, at the tested concentrations, the lectins are safe for *A. m. carnica* and show no efficacy against *H. halys*.

Preskus oralne toksičnosti sredstev za redčenje plodičev za marmorirano smrdljivko (*Halyomorpha halys*)

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Marmorirana smrdljivka (*Halyomorpha halys*) (Heteroptera: Pentatomidae) je invazivna, tujerodna in polifagna vrsta rastlinske stenice v Evropi, ki povzroča gospodarsko škodo v kmetijski pridelavi. Prehranjuje se z več kot 300 različnimi rastlinskimi vrstami iz številnih družin. Med sadnimi vrstami je jablana eden najpomembnejših gostiteljev, poleg hruške, breskve, kakija in aktinidije. Namen raziskave je bil preučiti, ali lahko sredstva, ki se spomladi uporabljajo za redčenje plodičev na jablani, vplivajo tudi na preživetje marmorirane smrdljivke. V laboratorijskih poskusih smo s prehranskimi testi ovrednotili oralno toksičnost sredstev za redčenje plodičev na nimfah *H. halys* larvalne stopnje L2-L3. Izbrali smo: NAA (1-naftilocetna kislina), ATS (amonijev tiosulfat), MM (metamitron), ETH (etefon), T20 (polisorbat 20), T80 (polisorbat 80) in BA (6-benziladenin). Kot pozitivno kontrolo smo uporabili insekticid Mospilan 0,1% (a.s. acetamiprid), kot negativno kontrolo pa vodovodno vodo. Poskus je potekal v štirih ponovitvah s po šestimi stenicami na ponovitev (24 stenic na obravnavanje) in je bil dvakrat neodvisno ponovljen. Preživetje nimf smo ocenjevali dnevno 15 dni. Poleg pozitivne kontrole (acetamiprid) je bila za nimfe stenic potrjena oralna toksičnost ATS (amonijev tiosuflat), MM (metamitron) ter T20 in T80 (polisorbat 20 in 80). Najvišja oralna toksičnost je bila zabeležena pri ATS. Skladno z rezultati smo izvedli poskus za določitev LC_{50} (oralna izpostavitev) ATS, z namenom iskanja alternativ kemičnim insekticidom. LC_{50} za ATS (95% interval zaupanja) je bila 0,05-0,25%. V prihodnosti bomo izvedli še poskus nanosa ATS s pršenjem na jajčeca in nimfe *H. halys*, da bomo ovrednotili tudi morebitno kontaktno toksičnost. Želimo namreč ugotoviti, ali bi ATS lahko posredno vplivala na preživetje *H. halys* v sadovnjakih oziroma ali bi uporaba ATS pri redčenju plodičev lahko uničila jajčeca in nimfe *H. halys*.

ABSTRACT

Evaluation of oral toxicity of fruitlet thinning Agents to the brown marmorated stink bug

The brown marmorated stink bug (*Halyomorpha halys*) (Heteroptera: Pentatomidae) is an invasive, non-native, polyphagous pest in Europe that causes economic damage to agricultural production. It feeds on more than 300 different host plants across numerous families. Among fruit crops, apple is one of its most important hosts, alongside pear, peach, persimmon, and kiwifruit. The aim of this study was to examine whether agents used for fruitlet thinning in apple orchards in spring may also affect the survival of *H. halys*. In laboratory diet incorporation bioassays, we evaluated the oral toxicity of fruitlet thinning agents on 2nd- and 3rd-instar nymphs (L2–L3) of *H. halys*. The following agents were selected: NAA (1-naphthalene acetic acid), ATS (ammonium thiosulphate), MM (metamitron), ETH (ethephon), T20 (polysorbate 20), T80 (polysorbate 80), and BA (6-benzyladenine). Mospilan 0.1% (a.i. acetamiprid) served as the positive control, and tap water was used as the negative control. The experiment included four replicates, each with six nymphs (24 nymphs per treatment), and was independently repeated twice. Nymph survival was assessed daily over a 15-day period. In addition to the positive control (acetamiprid), oral toxicity to *H. halys* nymphs was confirmed for ATS (ammonium thiosulphate), MM (metamitron), and T20 and T80 (polysorbate 20 and 80). The highest oral toxicity was observed for ATS. Based on these results, an additional experiment was conducted to determine the LC_{50} (oral exposure) of ATS, with the aim of identifying alternatives to chemical insecticides. The LC_{50} for ATS (95% confidence interval) ranged from 0.05 to 0.25%. In the future, an experiment involving spray application of ATS on eggs and nymphs of *H. halys* will be performed to evaluate potential contact toxicity. The objective is to determine whether ATS could indirectly affect the survival of *H. halys* in orchards and whether the use of ATS for fruit thinning could also destroy eggs and nymphs of *H. halys*.

Amonijev tiosulfat, sredstvo za redčenje plodičev jabolk, je oralno toksičen za plodovo vinsko mušico (*Drosophila suzukii*)

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Plodova vinska mušica (*Drosophila suzukii*, PVM) (Diptera: Drosophilidae) je invazivna, tujerodna vinska mušica, ki povzroča znatno gospodarsko škodo v sadjarstvu. Prehranjuje se z mnogimi pečkarji in koščičarji, zlasti je problematična v nasadih ameriških borovnic, češenj in malin. V številnih sodobnih intenzivnih sadovnjakih poleg omenjenih sadnih vrst pogosto gojijo tudi jablane. Namen raziskave je bil preučiti, ali sredstva, ki se spomladi uporabljajo za redčenje plodičev na jablani, vplivajo tudi na preživetje PVM. V laboratorijskih poskusih smo s prehranskimi testi ovrednotili toksičnost sredstev za redčenje plodičev na odraslih PVM. Izbrali smo: NAA (1-naftilocetna kislina), ATS (amonijev tiosulfat), MM (metamitron), ETH (etefon), T20 (polisorbat 20), T80 (polisorbat 80) in BA (6-benziladenin). Kot pozitivno kontrolo smo uporabili insekticid Laser Plus 0,1% (a.s. spinosad 48 mg ml^{-1}), kot negativno kontrolo pa vodovodno vodo. Poskus je potekal v štirih ponovitvah s po desetimi jajčeci PVM na obravnavanje in bil neodvisno ponovljen dvakrat (N=80 PVM na obravnavanje). Razvoj in preživetje PVM smo ocenjevali dnevno 21 dni. Poleg pozitivne kontrole (spinosad) je bila za PVM potrjena

oralna toksičnost tudi za sredstvo ATS (amonijev tiosulfat). Povprečna IC_{50} za ATS je znašala 0,09% (95% interval zaupanja: 0,07-0,11%). V prihodnosti bomo izvedli še poskus nanosa sredstva ATS s pršenjem na odrasle PVM, da bi preverili morebitno kontaktno toksičnost. Želimo namreč ugotoviti, ali bi sredstvo ATS – poleg redčenja plodičev – lahko uporabili tudi kot kontaktni insekticid za zatiranje PVM v sadovnjakih.

ABSTRACT

Ammonium thiosulphate, a fruit-thinning agent for apples, is orally toxic to the spotted wing drosophila (*Drosophila suzukii*)

Spotted Wing Drosophila, (*Drosophila suzukii*, SWD) (Diptera: Drosophilidae) is an invasive, alien fruit fly that causes significant economic damage in fruit production. It feeds on many stone and soft fruits, and is particularly problematic in plantations of blueberries, cherries, and raspberries. In modern intensive orchards, apples and pears are often grown alongside these fruit species. The aim of our study was to investigate whether substances used in spring for fruit thinning in apples also affect the survival of SWD. In laboratory experiments, we assessed the toxicity of fruit-thinning agents to adult SWD using feeding tests. We selected the following agents: NAA (1-naphthiacetic acid), ATS (ammonium thiosulphate), MM (metamitron), ETH (Ethephon 39 SL), T20 (polysorbate 20), T80 (polysorbate 80), and BA (6-benzyladenine). As a positive control, we used the insecticide Laser Plus 0.1% (a.i. spinosad 48 mg ml^{-1}), and as a negative control, we used tap water. The experiment was conducted in four replicates with ten SWD eggs per treatment and was independently repeated twice (N=80 SWD per treatment). We evaluated the development and survival of SWD daily for 21 days. In addition to the positive control (spinosad), oral toxicity to SWD was confirmed for ATS (ammonium thiosulphate). The average IC_{50} for ATS was 0.09% (95% confidence interval: 0.07–0.11%). In the future, we will conduct a spray application test of ATS on adult SWD to assess potential contact toxicity. We aim to determine whether ATS – besides its use for fruit thinning – could also be used as a contact insecticide for controlling SWD in orchards.

Množičen pojav azijskega ambrozijskega podlubnika *Xylosandrus crassiusculus* (Curculionidae: Scolytinae: Xyleborini) na kakiju (*Diospyros kaki*) kot posledica hude poznopomladanske pozebe v zahodni Sloveniji

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Azijski ambrozijski podlubnik (*Xylosandrus crassiusculus* Motschulsky, 1866) je izrazito polifagen hrošč azijskega izvora. Škodljivec iz družine rilčkarjev (Curculionidae) napada širok spekter listnatih dreves in grmovnic, med njimi tudi številne gospodarsko pomembne sadne in gozdne vrste. Samice v lesu pod lubjem gostiteljskih rastlin izvrtavajo rove in vanje vnesejo simbiotske ambrozijske glive, ki predstavljajo vir hrane tako za odrasle kot za njihove ličinke. Za vitalne rastline praviloma ne predstavlja visoke stopnje tveganja, medtem ko so napadu podlubnika bistveno bolj podvržene oslabljene ali poškodovane rastline, zato vrsto pogosto obravnavamo kot sekundarnega škodljivca. V Sloveniji je bil azijski ambrozijski podlubnik prvič najden leta 2017 v lovilnih pasteh za spremljanje

podlubnikov, ki so bile v zahodni Sloveniji postavljene v okviru uradnega nadzora karantenskih škodljivih organizmov. Vse nadaljnje najdbe do leta 2021 so bile omejene izključno na ulove v pasteh, medtem ko prisotnosti škodljivca neposredno na gostiteljskih rastlinah do takrat nismo potrdili. Avgusta 2021 smo v nasadu kakija (*Diospyros kaki*) v osrednjem delu Goriških Brd, ki ga je močno prizadela pozna spomladanska pozeba, prvič zabeležili napad podlubnika na gostiteljski rastlini. Na deblih in spodnjih vejah so bile vidne številne vhodne odprtinice in smolni izcedki, v lesu pa so bili rovi in odrasli hrošči. Istega leta smo podlubnika odkrili še na devetih lokacijah, v intenzivnih nasadih kakija na območju Goriških Brd in spodnje Vipavske doline, ki jih je prav tako prizadela pozeba. Škodljivec se je pojavljal izključno na pozeblih drevesih, v nobenem primeru se ni razširil na zdrava drevesa. V letih 2022 in 2023 smo v dveh napadenih nasadih kakija spremljali velikost populacije in sezonsko dinamiko azijskega ambrozijskega podlubnika. Spremljanje je potekalo s pomočjo pasti domače izdelave, pri čemer smo kot privabilo uporabljali 96-odstotni etanol. Rezultati spremljanja so pokazali postopno zmanjševanje populacije *X. crassiusculus* v prizadetih nasadih v letih po pozebi, hkrati pa smo tako v prvem kot tudi v drugem letu potrdili zastopanost dveh prekrivajočih se rodov. Aktivnost odraslih samic se je začela v maju, najvišji ulovi pa so bili zabeleženi v zgodnjem poletju, z izrazitim vrhom konec junija v letu 2022 ter nekoliko prej, v začetku junija v letu 2023. V nadaljevanju poletja so ulovi postopno upadali do začetka septembra, ko smo v pasteh zabeležili zadnje osebke. Poleg azijskega ambrozijskega podlubnika smo na obeh lokacijah ugotovili tudi prisotnost črnolesnega ambrozijskega podlubnika (*Xylosandrus germanus* Blandford, 1894) ter avtohtonega malega lesarčka (*Xyleborinus saxesenii* Ratzeburg, 1837). Kljub lokalno obsežnemu pojavu škodljivca so bile trajne poškodbe dreves redke, saj je do sušenja ali loma posameznih vej prihajalo le izjemoma. Kaki je trenutno edina sadna vrsta v Sloveniji, na kateri je bil potrjen napad azijskega ambrozijskega podlubnika, pri čemer pa škodljivec ni povzročil večje gospodarske škode.

ABSTRACT

Post-freeze outbreak of *Xylosandrus crassiusculus* (Curculionidae: Scolytinae: Xyleborini) in persimmon (*Diospyros kaki*) orchards in western Slovenia

The Asian ambrosia beetle (*Xylosandrus crassiusculus* Motschulsky, 1866) is a highly polyphagous species of Asian origin. This pest, belonging to the family Curculionidae, attacks a wide range of broadleaved trees and shrubs, including numerous economically important fruit and forest species. Females bore galleries in the wood beneath the bark of host plants and introduce symbiotic ambrosia fungi, which serve as a food source for both adults and larvae. Although it can attack healthy plants, infestations are most commonly associated with weakened or damaged hosts, therefore, the species is often regarded as a secondary pest. In Slovenia, *X. crassiusculus* was first found in 2017 in traps placed in western Slovenia as part of the official surveillance of quarantine pests. All subsequent records up to 2021 were limited to trap catches, and the presence of the pest on host plants had not been confirmed until then. In August 2021, the Asian ambrosia beetle was recorded for the first time attacking its host plant, persimmon (*Diospyros kaki*), in an orchard in the central Goriška Brda region that had been severely affected by a late spring frost. Numerous entrance holes and resin exudates were observed on trunks and lower branches, and galleries and adult beetles were found within the wood. In the same year, the beetle was detected at nine additional locations in intensive persimmon orchards in the Goriška Brda region and the lower Vipava Valley, which had also been affected by frost. The pest occurred exclusively on frost-damaged trees and did not spread to healthy trees in any of the cases. In 2022 and 2023, we monitored the population size and seasonal dynamics of the Asian ambrosia beetle in two infested persimmon orchards.

Monitoring was conducted using homemade traps with 96% ethanol. The results showed a gradual decline in the population of *X. crassiusculus* in the affected orchards in the years following the frost event, and in both years the presence of two overlapping generations was confirmed. Adult female activity began in May, and the highest catches were recorded in early summer, with a pronounced peak in late June in 2022 and slightly earlier, at the beginning of June, in 2023. During the remainder of the summer, catches gradually declined until early September, when the last individuals were recorded in traps. In addition to the Asian ambrosia beetle, the smaller alder bark beetle (*Xylosandrus germanus* Blandford, 1894) and the native species *Xyleborinus saxesenii* (Ratzeburg, 1837) were also detected at both locations. Despite the locally extensive occurrence of the pest, permanent damage to trees was rare, as dieback or breakage of individual branches occurred only exceptionally. Persimmon is currently the only fruit crop in Slovenia on which an attack by the Asian ambrosia beetle has been confirmed, and the pest has not caused significant economic damage.

Razbarvanje žil pri kosmuljah in ribezih: prvi dokazi o GVBaV v Sloveniji

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Gooseberry vein banding associated virus (GVBaV) je badnavirus iz družine *Caulimoviridae*, ki okužuje vrste iz rodu *Ribes*, kot so kosmulje in ribez. Ker je uvrščen med nadzorovane nekarantenske škodljive organizme, v sadilnem materialu ne sme biti prisoten. V Sloveniji smo virus prvič potrdili leta 2016 v dveh grmih rdečega ribeza iz zbirke Kmetijskega inštituta Slovenije (KIS) na Brdu pri Lukovici. Z analizo podatkov visokozmogljivega sekvenciranja (HTS) smo sestavili celoten genom virusa, ki kaže 97–99 % nukleotidno podobnost z že opisanimi izolati, pri čemer je največja podobnost z nizozemskim izolatom RC. Po začetnih najdbah smo izvedli širšo analizo zbirke kosmulj in ribezov na Kmetijskem inštitutu Slovenije. Bolezenska znamenja, značilna za GVBaV, predvsem razbarvanje žil, so bila opažena na kosmuljah in rdečem ribezu. Pri črnem ribezu pa kljub potrjeni okužbi simptomov nismo zaznali. Rezultati testiranja so pokazali precejšnjo okuženost rastlin: 65 % pri rdečem ribezu, 44 % pri kosmuljah in 17 % pri črnem ribezu. Pri nekaterih sortah kosmulj so bile okužene vse rastline, pri drugih pa le tiste s simptomi. V prispevku predstavljamo prvo poročilo o prisotnosti GVBaV v Sloveniji ter njegovo široko razširjenost v zbirki KIS. Rezultati poudarjajo pomen uporabe na viruse testiranega sadilnega materiala in rednega testiranja, saj je virus v certifikacijskih shemah naveden kot pomemben patogen vrst *Ribes*.

ABSTRACT

Vein discoloration in gooseberry and currants: first evidence of GVBaV in Slovenia

Gooseberry vein banding associated virus (GVBaV) is a badnavirus from the family *Caulimoviridae* that infects species of the genus *Ribes*, like gooseberry and currants. This

virus is classified as regulated non-quarantine pest on *Ribes* propagation material with 0 % tolerance. In Slovenia, we first confirmed the virus in 2016 in two redcurrant bushes from the collection plantation of the Agricultural Institute of Slovenia (KIS) at Brdo pri Lukovici. With HTS data analysis we assembled the complete genome of first Slovenian isolate, which showed 97–99% nucleotide identity with previously described isolates, with the highest similarity to the Dutch isolate RC. Following the initial findings, a broader survey of the collection was conducted. Disease symptoms typical of GVBaV, mainly discoloration along veins, were observed on gooseberry and redcurrant. In blackcurrant, however, no symptoms were detected despite positive PCR results. Testing results revealed a relatively high infection rate: 65% in red currant, 44% in gooseberry, and 17% in blackcurrant. In some gooseberry cultivars, all plants were infected, while in others only symptomatic plants tested positive. Here we present first report of GVBaV in Slovenia and confirm its widespread presence in the collection plantation of KIS. The results highlight the importance of using virus-tested propagation material and performing regular testing, as the virus is listed in certification schemes as a significant pathogen of *Ribes* species.

Raspberry Viruses in Bosnia and Herzegovina: Overview, Distribution, and Potential Vectors

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Red raspberry (*Rubus idaeus* L.) production in Bosnia and Herzegovina (BiH) is economically significant, yet viral diseases, including those associated with raspberry leaf blotch virus (RLBV) and raspberry mosaic disease (RMD) complex, pose under-explored threats to yield and fruit quality. Nevertheless, raspberry is susceptible to infection with more than 30 viruses, transmitted in different mode and includingsome quarantine and other regulated pests. In period from 2018 to 2022 intensive surveys were performed in main raspberry production centres in BiH in order to assess the viruses present in symptomatic plants. Using DAS-ELISA, conventional molecular methods samples were checked for the presence of nine viruses (raspberry leaf mottle virus - RLMV, rubus yellow net virus - RYNV, black raspberry necrosis virus - BRNV, RLBV, raspberry bushy dwarf virus - RBDV, tobacco ringspot virus - TRSV, cherry leaf roll virus - CLRV, tomato ringspot virus - ToRSV, arabis mosaic virus - ArMV and apple mosaic virus - ApMV. Additionally, presence of potential vectors was monitored during the vegetation and morphological and molecular keys were used for their identification. Finally, all amplification products from plants, insects and mites were Sanger sequenced and obtained sequences were deposited in GenBank. Analyses results showed that RLBV is the predominant virus present in 77% of the tested samples, followed by RYNV in 26,7 % samples and RLMV in 15,3% of samples. However, most of the tested samples contained double or triple infections, with RLBV and RYNV being the most common combination. Bioinformatics analyses that focused on RLBV, RYNV and RLMV suggests the homogeneous virus populations in material from sampled orchards. This pattern implies that the primary dissemination route of viruses is through infected planting material rather than localized spread alone. This indicates that systematic molecular screening is essential

for production of high quality virus tested planting material. The morphological and molecular analyses of sampled insects and mites identified potential vectors of detected viruses including aphids *Aphis idaei* and *Amphorophora idaei* the potential vectors of RYNV and RLMV and eriophyoid mite *Phyllocoptes gracilis* the vector of RLBV.

ABSTRACT

Virusi malin v Bosni in Hercegovini: pregled, razširjenost in možni prenašalci

Pridelava malin (*Rubus idaeus* L.) v Bosni in Hercegovini (BiH) je gospodarsko pomembna panoga, kljub temu pa je pomen virusnih bolezni, predvsem malinovega mozaika in virusa packavosti listov malinjaka (raspberry leaf blotch virus - RLBV) na pridelavo premalo raziskan. Poleg prej omenjenih je znano, da malino okužuje več kot 30 virusov, ki se prenašajo na različne načine, med njimi pa so tudi karantenski in drugi regulirani škodljivi organizmi. V letih 2018 do 2022 smo opravili preglede in vzorčenja v glavnih pridelovalnih območjih malin v BiH z namenom ugotoviti prisotnost virusov v simptomatičnih rastlinah. Vzorci smo analizirani s serološko metodo DAS-ELISA in klasičnimi molekularnimi metodami na 9 virusov (virus lisavosti listov malinjaka - RLMV, virus rumene mrežavosti robide - RYNV, virus nekroze črnega malinjaka - BRNV, RLBV, virus grmičavosti in pritlikavosti malinjaka - RBDV, virus obročkaste pegavosti tobaka - TRSV, virus zvijanja listov češnje (CLRV), virus obročkaste pegavosti paradižnika(ToRSV), virus mozaika repnjaka - ArMV in virus mozaika jablane (ApMV). Poleg tega smo med vegetacijo spremljali tudi prisotnost potencialnih prenašalcev virusov, za njihovo identifikacijo pa smo uporabili morfološke in molekularne metode. Vse dobljene produkte PCR smo sekvencirali, pridobljena zaporedja pa shranili v zbirki GenBank. Rezultati opravljenih analiz so pokazali, da je najbolj razširjen RLBV (77 % analiziranih vzorcev), sledita mu RYNV (26,7 %) in RLMV (15,3 %). V večini vzorcev smo potrdili sočasne okužbe z dvema ali tremi virusi, največkrat z RLBV in RYNV. Bioinformatske analize najpogosteje prisotnih virusov (RLBV, RYNV in RLMV), kažejo na genetsko zelo homogene populacije virusov v analiziranem materialu. To nakazuje, da je glavni vir virusnih okužb okužen sadilni material in ne lokalnim prenosom znotraj nasadov. Ti rezultati kažejo, da je sistematično molekularno testiranje ključno za pridelavo kakovostnega, na viruse testiranega sadilnega materiala. Z morfološkimi in molekularnimi analizami zbranih žuželk in pršic so potrdili prisotnost možnih prenašalcev najdenih virusov, med njimi listnih uši *Aphis idaei* in *Amphorophora idaei*, ki sta možna prenašalca RYNV in RLMV, ter pršice šiškarice *Phyllocoptes gracilis*, prenašalke RLBV.

Prva najdba glive *Neofusicoccum parvum* na gojenih borovnicah (*Vaccinium corymbosum*) in rdečem ribezu (*Ribes rubrum*) v Sloveniji

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V zadnjih letih opažamo povečan pojav odmiranja posameznih poganjkov ali celotnih grmov ameriške borovnice (*Vaccinium corymbosum*) in rdečega ribeza (*Ribes rubrum*) z

različnih območij pridelave na Dolenjskem. Simptomi se sprva kažejo na vršičkih poganjkov (ožig, venenje), ki se širijo navzdol po poganjkih. Na steblih se pojavijo lisaste proge, ob močni okužbi pa pride do sušenja in propada dela ali celotne rastline. V letu 2025 smo vzorca simptomatičnih rastlin ameriške borovnice in ribeza analizirali na prisotnost fitopatogenih gliv. S poganjkov smo na selektivnih gojišč direktno in po površinski sterilizaciji izolirali glive in jih glede na morfološke značilnosti opredelili kot predstavnike družine Botryosphaeriaceae. Izolatom smo nato ekstrahirali DNK, in v verižni reakciji s polimerazo pomnožili več črtnih kod, kot so ITS, LSU in TEF-1α in jih določili zaporedje pri komercialnem ponudniku sekvenciranja. Analiza pridobljenih zaporedij je razkrila, da je bila v vzorcih ameriške borovnice in rdečega ribeza v Sloveniji prvič potrjena gliva *Neofusicoccum parvum*. Gliva *Neofusicoccum parvum* okužuje širok nabor gostiteljskih rastlin, med njimi tudi gospodarsko pomembne kulture kot so vinska trta in jablane. Za vrsto *N. parvum* je v literaturi opisana visoka agresivnost pri okuževanju prevodnega tkiva. Rastlina se okuži preko trosov, ki vstopijo skozi rane ali naravne odprtine na poganjkih in se razrašča po rastlini, kar povzroča propadanje poganjkov, rakaste rane in gnitje plodov. Poročila o prvih najdbah te glive v Evropi v zadnjih letih kažejo na povečan pojav in resnost te bolezni na različnih rastlinskih vrstah. Po navedbah iz literature k širjenju in večji stopnji izraženosti bolezni prispeva tudi toplejše podnebje, kot posledica podnebnih sprememb. Aktivno spremljanje in iskanje rešitev za obvladovanje te bolezni bo v prihodnjih letih vse bolj pomembno.

ABSTRACT

First discovery of the fungus *Neofusicoccum parvum* on cultivated blueberries (*Vaccinium corymbosum*) and red currants (*Ribes rubrum*) in Slovenia

In recent years, an increased incidence of dieback of individual shoots or entire bushes of highbush blueberry (*Vaccinium corymbosum*) and red currant (*Ribes rubrum*) has been observed in various production areas in the Dolenjska region. The symptoms initially appear on shoot tips (blight, wilting) and progress downward along the shoots. Mottled streaks develop on the stems, and in cases of severe infection, partial or complete collapse of the plant occurs. In 2025, symptomatic samples of blueberry and currant plants were analysed for the presence of phytopathogenic fungi. Fungi were isolated from shoots on selective media, both directly and after surface sterilization, and were identified based on their morphological characteristics as members of the Botryosphaeriaceae. DNA was then extracted from the isolates, and several barcode regions, including ITS, LSU, and TEF-1α, were amplified by PCR and sequenced by a commercial sequencing provider. Analysis of the obtained sequences confirmed, for the first time in Slovenia, the presence of *Neofusicoccum parvum* in samples of highbush blueberry and red currant. *Neofusicoccum parvum* infects a broad range of host plants, including economically important crops such as grapevine and apple. The species is described in the literature as highly aggressive in colonizing vascular tissues. Infection occurs through spores that enter wounds or natural openings on shoots and subsequently spread through the plant, causing shoot dieback, cankers, and fruit rot. Reports of initial detections of this fungus in Europe in recent years indicate an increasing incidence and severity of the disease across various plant species. Published studies further suggest that warmer climatic conditions, possibly associated with climate change, contribute to its spread and more severe disease expression. Active monitoring and the development of effective management strategies will therefore become increasingly important in the coming years.

Uporaba antagonističnih gliv za zatiranje patogenov na žlahtnem jagodnjaku

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Zaradi pojava tolerance in odpornosti na fungicide pri nekaterih patogenih glivah ter vpliva fungicidov na okolje se je v zadnjem desetletju povečalo zanimanje za uporabo antagonističnih mikroorganizmov kot biotičnih agensov. Namen poskusov je bil ovrednotiti inhibitorno delovanje izbranih vrst in sevov antagonističnih gliv proti patogenim glivam (*Botrytis cinerea*, *Colletotrichum acutatum*, *Podosphaera aphanis*), ki povzročajo velike izgube pridelka na jagodičevju in drugih gostiteljskih rastlinah. Preizkusili smo učinkovitost različnih sevov antagonističnih gliv pri zatiranju patogenov v *in vitro* pogojih na različnih presejalnih testih ter v *in vivo* testih (na plodovih ali listih rastlin jagod), katerim bodo sledili poskusi *in planta* (v nasadu jagod). Izvedli smo tudi teste encimske aktivnosti antagonističnih gliv (amilazna, β-glukozidazna, celulazna, esterazna, hitinazna, ksilanazna, pektinolitična, poligalakturonazna, proteolitična aktivnost) ter test tvorbe sideroforov. V *in vitro* pogojih so bile za zatiranje rasti gliv *B. cinerea* in *C. acutatum* najučinkovitejše antagonistične glive iz rodov *Aureobasidium* in *Acaromyces.* V testu dvojnih kultur (DCP) je 40 % izolatov močno (nad 85 %) inhibiralo rast patogenov; v testu hlapnih organskih spojin (VOC) 10 do 33 %, v testu topnih organskih spojin (SOC) pa 64 do 83 % izolatov močno (nad 60 %) inhibiralo rast patogenov. Najučinkovitejši sevi iz rodu *Aureobasidium* so na plodovih jagod v testu dvojne inokulacije in hlapnih organskih spojin zmanjšali stopnjo okužbe (DSI) za več kot 52 %. Po inkubaciji testov encimskih aktivnosti in tvorbe sideroforov je nastanek barvnih sprememb okoli kolonij pokazal pozitivno encimsko aktivnost. Obseg encimske aktivnosti je bil količinsko izražen z encimskim indeksom (EI). Največji encimski indeks je bil ugotovljen pri glivah iz rodov *Aureobasidium* in *Acaromyces* za β-glukozidazno, celulazno, esterazno, hitinazno in pektinazno aktivnost. Nekateri izolati antagonističnih gliv so se izkazali za zelo učinkovite pri zatiranju rasti dveh glavnih bolezni (siva plesen in antraknoza) na rastlinah jagod. Ti so obetavni za nadaljnje raziskave mehanizmov antagonističnega delovanja in potencialno uporabo v biotičnem varstvu rastlin.

ABSTRACT

The use of antagonistic fungi to control pathogens on strawberry plants

Due to the emergence of tolerance and resistance to fungicides in some pathogenic fungi, as well as the environmental impact of fungicides, interest in using antagonistic microorganisms as biological agents has increased over the past decade. The aim of these experiments was to evaluate the inhibitory effect of selected species and strains of antagonistic fungi on pathogenic fungi (*Botrytis cinerea*, *Colletotrichum acutatum*, *Podosphaera aphanis*) that cause significant crop losses in berries and other host plants. We tested the effectiveness of different strains of antagonistic fungi in controlling pathogens *in vitro* using various screening tests and *in vivo* tests (on strawberry fruits or leaves), to be followed by *in planta* trials (in strawberry fields). We also performed tests of the enzymatic activity of antagonistic fungi (amylase, β-glucosidase, cellulase, chitinase, esterase, pectinolytic, polygalacturonase, proteolytic, xylanase activity) and their ability to form siderophores. In *in vitro* tests, the most effective antagonistic fungi for suppressing the growth of *B. cinerea* and *C. acutatum* were from the genera *Aureobasidium* and

Acaromyces. In dual culture tests (DCP), 40% of the isolates strongly (over 85%) inhibited pathogen growth; in volatile organic compound (VOC) tests, 10 to 33%; and in soluble organic compound (SOC) tests, 64 to 83% of isolates strongly (over 60%) inhibited pathogen growth. The most effective strains of the genus *Aureobasidium* reduced disease severity (DSI) by more than 52% on strawberry fruits in the dual inoculation and volatile organic compound tests. After incubation of enzyme activity and siderophore production tests, the formation of colour changes around the colonies indicated positive enzyme activity. The extent of enzyme activity was quantitatively expressed by the enzyme index (EI). The highest enzyme index was found in fungi from the genera *Aureobasidium* and *Acaromyces* for β-glucosidase, cellulase, chitinase, esterase, and pectinase activity. Some isolates of antagonistic fungi proved very effective in suppressing the growth of two major diseases (grey mould and anthracnose) on strawberry plants. These are promising for further research into the mechanisms of antagonistic action and potential use in biological plant protection.

Ocena tveganja za ostanke fitofarmacevtskih sredstev iz okolja v medu, vzorčenem v Sloveniji

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V letih 2024 in 2025 smo odvzeli 119 vzorcev medu: 111 slovenskih čebelarjev in 8 iz drugih držav. Vzorce smo analizirali na prisotnost 33 aktivnih spojin s plinskim kromatografom sklopljenim s tandemskim masnim spektrometrom z validirano metodo. 12 vzorcev od 111 slovenskih je bilo pozitivnih, kar predstavlja 10,8%. Vsak izmed 12 vzorcev je vseboval ostanek le ene aktivne snovi. V analiziranem medu smo našli dve različni aktivni snovi: en fungicid in en insekticid. Noben vzorec ni presegal Maksimalno dovoljeno količino ostankov (Maximum Residue Level, MRL). Na podlagi rezultatov smo izvedli izračun kronične in akutne izpostavljenosti potrošnikov, ki so uživali analizirani med. Izračune smo izvedli za potrošnika iz Evropske Unije z EFSA PRIMo modelom, ter za slovenskega potrošnika.

ABSTRACT

Risk assessment for environmental pesticide residues in honey sampled in Slovenia

In 2024 and 2025, we collected 119 honey samples: 111 from Slovenian beekeepers and 8 from other countries. The samples were analysed for the presence of 33 active substances using a gas chromatograph coupled with a tandem mass spectrometer, following a validated method. Twelve of the 111 Slovenian samples tested positive, representing 10.8%. Each of these 12 samples contained residues of only one active substance. Two different active substances were found in the analysed honey: one fungicide and one insecticide. No sample exceeded the Maximum Residue Level (MRL). Based on the results, chronic and acute risk assessments for consumers of the analysed honey were conducted. Calculations were performed for consumers in the European Union using the EFSA PRIMo model, as well as for consumers in Slovenia.

Ocena tveganja za ostanke fitofarmacevtskih sredstev v marmeladi s slovenskih trgovskih polic

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V letih 2024 in 2025 smo odvzeli 83 vzorcev marmelade s slovenskih trgovskih polic: 25 slovenskih in 58 iz drugih držav. Vzorce smo analizirali na prisotnost 40 aktivnih spojin s plinskim kromatografom sklopljenim s tandemskim masnim spektrometrom z validirano metodo. 52 vzorcev od 83 je bilo pozitivnih, kar predstavlja 62,7%. Največje število najdenih aktivnih snovi na vzorec je bilo 8. V analizirani marmeladi smo našli 14 različnih aktivni snovi: 12 fungicidov in 2 insekticida. Iz vsebnosti aktivnih snovi v marmeladi smo z upoštevanjem deleža sadja in faktorja procesiranja preračunali vsebnosti v sadju. Noben vzorec ni presegal Maksimalno dovoljeno količino ostankov (Maximum Residue Level, MRL) v sadju. Na podlagi izračunanih vsebnosti v sadju smo izvedli izračun kronične in akutne izpostavljenosti potrošnikov, ki so uživali analizirano marmelado. Izračune smo izvedli za potrošnika iz Evropske Unije z EFSA PRIMo modelom, ter za slovenskega potrošnika.

ABSTRACT

Risk assessment for pesticide residues in jam from Slovenian stores

In 2024 and 2025, we collected 83 jam samples from Slovenian stores: 25 from Slovenia and 58 from other countries. The samples were analysed for the presence of 40 active substances using a gas chromatograph coupled with a tandem mass spectrometer, following a validated method. Of the 83 samples, 52 tested positive, representing 62.7%. The highest number of active substances found in a single sample was 8. In the analysed jams, 14 active substances were found: 12 fungicides and 2 insecticides. The contents of active substances in the jams were used to calculate their concentrations in the fruit, based on the fruit portion and processing factor. No sample exceeded the Maximum Residue Level (MRL) in fruit. Based on the results, chronic and acute risk assessments for consumers of the analysed jams were conducted. Calculations were performed for consumers in the European Union using the EFSA PRIMo model, as well as for consumers in Slovenia.

Preživetje in možnost prenosa virusov v rastnem substratu

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Stabilni rastlinski virusi lahko v okolju preživijo zelo dolgo, kar predstavlja pomembno epidemiološko tveganje pri pridelavi paradižnika, paprike in drugih gostiteljskih rastlin. Doslej smo največ pozornosti namenili preživetju virusov v vodi, kjer smo eksperimentalno potrdili, da lahko infektivni delci nekaterih virusov vztrajajo več mesecev in ob ustreznih pogojih povzročijo okužbo novih rastlin. V nadaljevanju se raziskava osredotoča na rastni substrat – preučujemo, ali lahko tudi rastni substrat deluje kot rezervoar za stabilne rastlinske viruse ter kako dolgo ti virusi ostanejo infektivni po odstranitvi okuženih rastlin. Pozornost namenjamo predvsem virusu rjave grbančavosti plodov paradižnika (ToBRFV), virusu mozaika tobaka (TMV) in virusu grmičavosti in zakrnelosti paradižnika (TBSV). Poskuse izvajamo v kontroliranih pogojih, kjer v kontaminiran substrat sadimo zdrave sadike paradižnika ali sejemo semena ter s testi infektivnosti in z validiranimi molekularnimi metodami spremljamo morebitne okužbe. V prispevku bomo predstavili rezultate teh poskusov, ki osvetljujejo epidemiološko vlogo rastnega substrata kot potencialnega vira okužbe s stabilnimi rastlinskimi virusi ter prispevajo k oceni tveganj pri ponovni uporabi substratov v kmetijski pridelavi.

ABSTRACT

Survival and transmission potential of viruses in growing substrates

Stable plant viruses can survive in the environment for extended periods, posing a significant epidemiological risk to the production of tomato, pepper and other host plants. Until now, most attention has been directed on virus survival in water, where we have experimentally confirmed that infectious particles of certain viruses can persist for several months and, under suitable conditions, infect new plants. Our research now focuses on the growing substrate—specifically, whether it can act as a reservoir for stable plant viruses and how long these viruses remain infectious after the removal of infected plants. Particular attention is given to tomato brown rugose fruit virus (ToBRFV), tobacco mosaic virus (TMV), and tomato bushy stunt virus (TBSV). Experiments are conducted under controlled conditions, where healthy tomato seedlings or seeds are planted in contaminated substrate, and potential infections are assessed through infectivity assays and validated molecular methods. We will present experimental results demonstrating the epidemiological significance of growing substrates as potential reservoirs of stable plant viruses and their implications for risk assessment in substrate reuse within agricultural production.

Priprava zdravih testnih rastlin: praktična aktivnost, ki je ključna za tekočo in zanesljivo diagnostiko

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Zanesljiva diagnostika na področju varstva rastlin ni odvisna le od laboratorijskih metod, temveč tudi od razpoložljivosti zdravih rastlin v primerni razvojni fazi. Čeprav se to delo izvaja pred začetkom laboratorijskih postopkov, pomembno vpliva na hitrost, kakovost in ponovljivost nadaljnjih diagnostičnih in raziskovalnih dejavnosti. Prispevek predstavlja

praktične izkušnje iz vsakodnevne priprave rastlin. Delo zajema upravljanje raznolike zbirke semen, razkuževanje in obdelavo semen (po potrebi tudi z giberelinsko kislino), spremljanje kalitve ter zagotavljanje stabilnih pogojev za zgodnjo rast. Paradižnik, tobak, jajčevec, krompir in druge rastline se redno gojijo, saj se pozneje uporabljajo kot gostitelji v testih patogenosti, kjer se preverja sposobnost bakterijskih izolatov iz vzorcev, da povzročijo bolezen. Rastline služijo tudi kot modelni sistemi v raziskavah, vključno s preučevanjem interakcij med rastlinami in mikroorganizmi. Da bi se izognili zamudam v diagnostiki, nekatere rastline gojimo neprekinjeno, tako da so v ustrezni razvojni fazi na voljo vedno, ko sumljiv vzorec zahteva hitro nadaljnje testiranje. Takšna pripravljenost zahteva stalne cikle sejanja, mikropropagacije, sajenja, spremljanja in pravočasnega nadomeščanja rastlin. Pogosti izzivi vključujejo spremenljivo kalitev, nihanje temperature, vlage in svetlobe ter občasne težave s škodljivci. Pravočasno ukrepanje pomaga ohranjati enakomerno rast in zagotavlja, da so ves čas na voljo rastline v primerni fazi rasti. S poudarkom na vsakodnevni praksi in pomenu zgodnje oskrbe rastlin prispevek prikazuje, kako sistematična priprava podpira pravočasen, zanesljiv in dobro organiziran diagnostični ter raziskovalni potek dela. Poster bo vizualno prikazal primere dobrih praks ter pogostejše izzive pri rutinski pripravi rastlin.

ABSTRACT

Preparing Healthy Test Plants: Practical Activity Underpinning Timely and Reliable Diagnostics

Reliable plant health diagnostics depend on having healthy, uniform, well-prepared plants that are at the correct growth stage. Although this work takes place before laboratory testing begins, it strongly influences the timing, quality and consistency of subsequent diagnostic and research activities. This paper presents practical experience of routine plant preparation to support these workflows on a daily basis. This involves managing a diverse seed collection, disinfecting and treating seeds (including using gibberellic acid where necessary), monitoring germination and ensuring stable conditions for early growth. Tomato, tobacco, eggplant, potato and others are regularly grown because they are later used as hosts in pathogenicity confirmation tests, in which pure bacterial isolates are assessed for their ability to cause disease symptoms. Plants also serve as model systems in research, including studies of plant–microbe interactions. To avoid delays in diagnostics, some plant species are grown continuously, ensuring that plants at the appropriate developmental stage are always available for rapid follow-up testing of suspected positive samples. Maintaining such readiness requires ongoing cycles of sowing, micropropagation, planting, monitoring, and replacing plants. Common challenges in this preparatory work include variable germination, fungal contamination, temperature, humidity and light fluctuations, and the occasional pest issue. Addressing these promptly helps to maintain plant uniformity and ensures that suitable material is available whenever needed. By showcasing day-to-day practices and the significance of early-stage plant care, this contribution illustrates how systematic preparation can facilitate efficient, dependable, and well-organised diagnostic and research workflows. The poster will present examples of good practice and typical challenges encountered during routine plant preparation.

Od validacije do akreditacije in prenosa znanja za zanesljivo diagnostiko rastlinskih virusov

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Širitev globalnih transportnih poti in povečanje pretoka rastlinskega materiala pomeni večje tveganje za vnos in širjenje rastlinskih bolezni in škodljivcev. Da bi omogočili zgodnje in zanesljivo odkrivanje rastlinskih virusov, še posebej karantenskih, ki v EU niso navzoči ali so prisotni le v omejenem obsegu, smo diagnostični postopek visokozmogljivega sekvenciranja z nanoporami z uporabo naprave MinION (Oxford Nanopore Technologies) validirali na primeru določanja virusa blage lisavosti paradižnika (tomato mild mottle virus; rod *Ipomovirus*). Validacija je bila izvedena v skladu z mednarodnimi standardi (EPPO PM7/98 in PM7/151) in je omogočila oceno občutljivosti, specifičnosti, ponovljivosti in robustnosti postopka. Le-ta je tako vključen na seznam akreditiranih diagnostičnih postopkov po ISO 17025 in tako zagotavlja visoke standarde kakovosti, sledljivosti in strokovne usposobljenosti, kar je nujno za uporabo v diagnostiki uradnih vzorcev. Posebno pozornost namenjamo prenosu znanja, saj je uspešna implementacija metode mogoča le ob razumevanju njenih kritičnih točk. Rezultati validacije so prosto dostopni v EPPO podatkovni bazi (https://dc.eppo.int/validation_data/validationlist), diagnostični protokol je vključen v EPPO smernice kot primer dobre prakse, kar olajša uvajanje metode drugim diagnostičnim laboratorijem. Prek delavnic v okviru EU referenčnega laboratorija, usposabljanj in izmenjave izkušenj drugim laboratorijem prenašamo ključne kritične točke postopka, katerih natančno upoštevanje je nujno za doseganje zanesljivih rezultatov. Krepitev diagnostične zmogljivosti na širši ravni neposredno prispeva k hitrejšemu odkrivanju patogenov, boljšemu nadzoru njihovega širjenja in tako k večji varnosti globalne kmetijske pridelave in prehranske varnosti.

ABSTRACT

From validation to accreditation and knowledge transfer for reliable plant virus diagnostics

The expansion of global transport routes and the increased movement of plant material pose a greater risk of introducing and spreading plant diseases and pests. To enable early and reliable detection of plant viruses, especially quarantine viruses that are not present in the EU or are present only to a limited extent, we validated a diagnostic procedure for high-throughput nanopore sequencing using the MinION device (Oxford Nanopore Technologies) on the example of detecting tomato mild mottle virus (genus *Ipomovirus*) in tomato leaves. The validation was performed in accordance with international standards (EPPO PM7/98 and PM7/151) and enabled the assessment of the sensitivity, specificity, repeatability, and robustness of the procedure. The procedure has been included on the list of accredited diagnostic procedures under ISO 17025, ensuring high standards of quality, traceability, and technical competence, which are essential for use in the diagnostics of official samples. We place particular emphasis on knowledge transfer, as the successful implementation of the method is only possible when its critical points are

properly understood. The validation results are freely accessible in the EPPO database (https://dc.eppo.int/validation_data/validationlist), and the diagnostic protocol is included in the EPPO guidelines as an example of good practice, which facilitates the introduction of the method in other diagnostic laboratories. Through workshops within the EU Reference Laboratory, training activities, and the exchange of experiences, we transfer to other laboratories the key critical points of the procedure, the precise consideration of which is essential for achieving reliable results. Strengthening diagnostic capacity more broadly directly contributes to faster pathogen detection, improved control of their spread, and thus to greater security of global agricultural production and food safety.

ISO 17025 v praksi: vsakodnevni postopki kot temelj zanesljive laboratorijske diagnostike

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Zagotavljanje zanesljivih rezultatov v diagnostičnih laboratorijih na področju varstva rastlin ne temelji le na robustnih metodah, opremi in dobro izučenemu osebju, temveč je tesno povezano z doslednim izvajanjem vsakodnevnih postopkov, ki zagotavljajo zanesljive analize in izpolnjujejo zahteve standarda ISO/IEC 17025. V vsakodnevni praksi včasih spregledana, a zelo pomembna opravila – od pravilnega vodenja vzorcev do urejenega delovnega okolja, priprave materialov in preprečevanja kontaminacije – so ključna za ponovljive, sledljive in zanesljive rezultate. V prispevku predstavljamo šest sklopov aktivnosti, ki podpirajo kakovost diagnostičnega procesa. Poudarjamo pomen sledljivosti vzorcev, zagotavljanje ustreznega okolja v laboratoriju, rastnih komorah ter rastlinjaku, organizacije potrošnega materiala in opreme, zagotavljanja rastlin za izvajanje potrjevanja patogenosti izoliranih bakterij ter preprečevanja navzkrižne kontaminacije pri delu z rastlinskimi vzorci. Poleg tehničnih vidikov vključujemo tudi razmislek o kompetencah laboratorijskega osebja ter o tem, kako veščine, izkušnje in način učenja izvajalci prepoznavajo kot najbolj koristne za samozavestno, natančno in skladno izvajanje postopkov. Poster prikazuje praktičen pregled teh elementov ter služi kot orodje za ozaveščanje, usposabljanje in krepitev dobrih laboratorijskih praks v diagnostičnih in raziskovalnih okoljih.

ABSTRACT

ISO 17025 in practice: how everyday procedures ensure the quality of laboratory diagnostics

Ensuring reliable diagnostic results in plant health laboratories depends not only on robust methods and equipment, but also on the consistent execution of everyday procedures that ensure reliability of testing and meet the requirements of ISO/IEC 17025. In daily practice, tasks that may appear routine – from sample handling and preparation of materials to maintaining environmental conditions and preventing contamination – have a direct impact on the quality of results and help minimise errors, cross-contamination risks and unnecessary and time-consuming repetitions. In this contribution, we present key elements that support reliable diagnostics and can be easily overlooked despite forming

the foundation of accredited laboratory work. We illustrate examples of good practice in sample traceability, maintaining an appropriate laboratory environment, organising consumables and equipment, preventing cross-contamination, and preparing plant material for diagnostic procedures and pathogenicity tests. In addition to these technical aspects, we include reflections on the competencies of laboratory personnel and on which skills, experience and learning approaches they perceieve as significantly contributing to confident, consistent and ISO-compliant execution of procedures. The aim of the contribution is to emphasise that diagnostic quality relies not only on analytical methods, but also on well-structured everyday laboratory work that forms the backbone of reliable, reproducible and defensible results. The poster shows a practical overview of these elements and serves as a tool for awareness-raising, training and the improvement of laboratory practices in diagnostic and research settings.

Rastlinski virusi pod drobnogledom: nove zaznave in odkritja omogočena z visoko-zmogljivim sekvenciranjem

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Visoko-zmogljivo sekvenciranje (high-throughput sequencing, HTS) je bilo prvič uporabljeno za odkrivanje rastlinskih virusov leta 2009. Danes je HTS široko dostopno orodje, ki bistveno pospešuje raziskave viromov številnih rastlinskih vrst ter omogoča odkrivanje virusnih povzročiteljev bolezni, ki bi jih z običajnimi metodami pogosto spregledali. V okviru analiz uradnih vzorcev paradižnika, paprike, bučnic in nekaterih drugih rastlin v letih 2015–2024, smo s pomočjo HTS v Sloveniji odkrili številne viruse. HTS nam je omogočil hitro in zanesljivo identifikacijo virusnih nukleinskih kislin, medtem ko bi bil konvencionalni diagnostični pristop bistveno bolj dolgotrajen, posamezni virusi pa bi lahko ostali nezaznani. V tem obdobju smo tako s pomočjo HTS odkrili in nato z drugimi metodami potrdili veliko, za Slovenijo novih virusov, med drugim: watermelon crinkle leaf-associated virus 1 in 2 (WCLaV-1, WCLaV-2) v lubenici (Vučurović in sod., 2025), z listnimi ušmi prenosljivi virus rumenice buče (cucurbit aphid-borne yellows virus; CABYV) v bučnicah (Mehle in sod., 2020), virus bele lisavosti zlatice (ranunculus white mottle virus; RWMV) v paradižniku in papriki (Rivarez in sod., 2022), virus Y zelene (apium virus Y; ApVY) in virus ozkolistnosti korenja (carrot thin leaf virus; CTLV) v peteršilju (Mehle in sod., 2019) ter virus mozaika zobnika (henbane mosaic virus; HMV) v paradižniku (Pecman in sod., 2018). Visoko-zmogljivo sekvenciranje je izjemno učinkovito orodje za spremljanje prisotnosti virusov v rastlinah, omogoča pravočasno zaznavanje novih vnosov ter odkrivanje redkih ali nepričakovanih virusov. To pomembno prispeva k boljšemu razumevanju virusne pestrosti ter k zgodnjemu ukrepanju v varstvu rastlin. Rezultati poudarjajo potrebo po nadaljnji vključitvi HTS v rutinsko diagnostiko in nacionalne programe monitoringa.

ABSTRACT

Plant viruses under the spotlight: novel insights and discoveries enabled by high-throughput sequencing

High-throughput sequencing (HTS), was first applied for the detection of plant viruses in 2009. Today, HTS is a widely accessible tool that significantly accelerates the study of viromes in numerous plant species and enables the identification of viral pathogens that would often be overlooked using conventional methods. As part of analyses of official samples of tomato, pepper, cucurbits, and several other plant species performed between 2015 and 2024, we detected numerous viruses in Slovenia using HTS. HTS enabled rapid and reliable identification of viral nucleic acids, whereas conventional diagnostic approaches would have been considerably more time-consuming, and some viruses might have remained undetected. During this period, HTS enabled us to discover—and subsequently confirm using additional methods—a large number of viruses newly reported for Slovenia, including: watermelon crinkle leaf-associated virus 1 and 2 (WCLaV-1, WCLaV-2) in watermelon (Vučurović et al., 2025), cucurbit aphid-borne yellows virus (CABYV) in cucurbits (Mehle et al., 2020), ranunculus white mottle virus (RWMV) in tomato and pepper (Rivarez et al., 2022), apium virus Y (ApVY) and carrot thin leaf virus (CTLV) in parsley (Mehle et al., 2019), and henbane mosaic virus (HMV) in tomato (Pecman et al., 2018). High-throughput sequencing is an extremely effective tool for monitoring the presence of viruses in plants, enabling timely detection of new introductions and the discovery of rare or unexpected viruses. This significantly contributes to a better understanding of viral diversity and supports early interventions in plant protection. The results highlight the need for the continued integration of HTS into routine diagnostics and national monitoring programs.

Projekt občanske znanosti: virusi in viroidi pod drobnogledom - skupaj za varnejšo uporabo gnojil iz organskih odpadkov

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Naš projekt občanske znanosti temelji na projektu VIROKOMP ("Ocenjevanje tveganj povezanih s prisotnostjo in preživetjem rastlinskih virusov in viroidov v kompostu in drugih gnojilih iz organskih odpadkov", L4-60158, https://projects.nib.si/virokomp/), ki preučuje, kako rastlinski virusi in viroidi preživijo v kompostu ter drugih gnojilih na osnovi organskih odpadkov in kakšna tveganja predstavljajo za pridelke ter trajnost kmetijstva. Z vključevanjem državljanov širimo raziskovalno bazo in rezultate približujemo vsakodnevni vrtnarski in kmetijski praksi. Osrednja dejavnost projekta je spletna anketa, namenjena malim (zasebnim) uporabnikom in proizvajalcem komposta. Zbira praktične podatke, ki lahko vplivajo na preživetje ali širjenje virusov, kot so metode kompostiranja, uporabljeni materiali, načini ravnanja in skladiščenja. Ti neposredni vpogledi bodo raziskovalcem pomagali prepoznati kritične točke tveganja ter razviti varnejše smernice za pripravo oziroma uporabo organskih gnojil. Izbrani udeleženci bodo

imeli možnost poslati vzorec komposta na laboratorijsko analizo. Jasna navodila bodo zagotovila pravilno odvzemanje vzorcev, v laboratoriju pa bomo prisotnost rastlinskih virusov in viroidov v vzorcih preverili z molekularnimi testi ter s tem zagotovili dragocene podatke za znanost, prakso in upravljanje tveganj. To sodelovanje koristi vsem: raziskovalci pridobijo ključne informacije o uporabi komposta v slovenskih vrtovih in na kmetijah, medtem ko vrtnarji, kmetje in proizvajalci komposta prejmejo priporočila, ki temeljijo na dokazih in prispevajo k zmanjšanju tveganj povezanih z rastlinskimi virusi. Za večji učinek bo projekt rezultate, praktične nasvete in dostopna izobraževalna gradiva za ozaveščanje o varnem kompostiranju delil prek različnih komunikacijskih kanalov, vključno preko socialnih omrežij in projektne spletne strani.

ABSTRACT

Citizen science project: A closer look at viruses and viroids - Together for safer use of fertilizers from organic waste

Our citizen science project builds on the VIROKOMP project ("Estimating risks associated with the presence and survival of plant viruses and viroids in compost and other organic waste fertilisers", L4-60158, https://projects.nib.si/virokomp/), which studies how plant viruses and viroids survive in compost and other organic waste-based fertilisers, and the risks they pose to crops and agricultural sustainability. By inviting citizen participation, we expand the research base and make the findings more relevant to everyday horticultural and agricultural practice. The central activity of the project is an online survey aimed at small-scale (private) compost users and producers. It gathers practical details that may influence virus survival or spread such as composting methods, materials, handling practices, and storage. These first-hand insights will help researchers pinpoint risk points and develop safer guidelines for preparing and using organic fertilisers. Selected participants will also have the chance to send a compost sample for laboratory testing. Clear instructions will ensure proper sample collection, and in the laboratory, we will assess the presence of plant viruses and viroids in the samples using molecular testing, providing valuable data for science, practice and risk managers. This collaboration benefits everyone: researchers gain key information on how compost is used in Slovenian gardens and farms, while gardeners, farmers, and compost producers receive evidence-based recommendations that help reduce risks associated with plant viruses. To amplify impact, the project will share results, practical tips and accessible educational materials promoting awareness of safe composting through different communication channels including social media and project webpage.

Tehnični dejavniki škropljenja in njihova vloga pri pokritosti klasov ozimne pšenice (*Triticum aestivum*)

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V letu 2024 smo na laboratorijskem polju Biotehniške fakultete izvedli štiri poljske poskuse, katerih cilj je bil ovrednotiti vpliv izbranih tehničnih parametrov škropljenja na pokritost klasov ozimne pšenice v fenofazi cvetenja. Vozna hitrost (6 km/h) in tlak

škropljenja (3 bar) sta bila v vseh poskusih konstantna. Pokritost sprednje in zadnje strani klasa smo določali z uporabo na vodo občutljivih lističev. Odtise kapljic smo analizirali z merilno napravo Wise Node, pridobljene podatke pa statistično obdelali. Rezultati prvega poskusa so pokazali, da se s povečevanjem volumskega pretoka šob oziroma porabe vode statistično značilno povečuje povprečna pokritost tako sprednje kot tudi zadnje strani klasa pri uporabi odbojnih šob TFJ v izmenični postavitvi. Pri uporabi injektorske šobe z asimetričnim curkom Idta 04 (10° naprej in 50° nazaj) je bila dosežena večja pokritost klasa v primerjavi z uporabo odbojne šobe TFJ 04. Analiza vpliva višine škropljenja z odbojno šobo TFJ 04 je pokazala, da je bila povprečna pokritost klasa večja pri nižji višini škropljenja (10 cm). V zadnjem poskusu, v katerem smo preučevali vpliv različnih kotov nosilcev odbojnih šob TTI 02, se je izkazalo, da je bil kot 45° najmanj primeren za doseganje dobre povprečne pokritosti klasa v primerjavi s koti 0°, 15° in 30°. Ne glede na obravnavane dejavnike je bila v večini poskusov ugotovljena nižja povprečna pokritost zadnje strani klasa v primerjavi s sprednjo.

ABSTRACT

Technical spraying factors and their role in winter wheat (*Triticum aestivum*) head deposit coverage

In 2024, four field experiments were conducted at the experimental field of the Biotechnical Faculty with the aim of evaluating the effects of selected technical spraying parameters on the coverage of winter wheat ears during the flowering growth stage. Driving speed (6 km h^{-1}) and spraying pressure (3 bar) were kept constant across all experiments. Coverage of the front and rear sides of the ears was assessed using water-sensitive papers. Droplet imprints were analyzed with a Wise Node measuring device, and the obtained data were statistically processed. The results of the first experiment showed that increasing nozzle flow rate and application volume resulted in a statistically significant increase in average coverage of both the front and rear sides of the ear when TFJ deflector nozzles were used in an alternating arrangement. The use of an injector nozzle with an asymmetric spray pattern (IDTA 04; 10° forward and 50° backward) resulted in higher ear coverage compared with the TFJ 04 deflector nozzle. Analysis of spraying height using the TFJ 04 deflector nozzle indicated that average ear coverage was higher at the lower spraying height (10 cm). In the final experiment, which evaluated the effect of different holder angles of TTI 02 deflector nozzles, the 45° angle proved to be the least suitable for achieving good average ear coverage compared with angles of 0°, 15°, and 30°. Regardless of the factors examined, lower average coverage was observed on the rear side of the ear compared with the front side in most experiments.

Učinek višine škropilnih letev škropilnice na odnašanje škropilne brozge

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Namen poskusa je bil ovrednotiti možnosti za zmanjšanje odnašanja škropilne brozge pri uporabi poljske škropilnice z analizo vpliva izbranih tehničnih in okoljskih dejavnikov. Poskus smo izvedli na ravni in homogeni podlagi, kar je omogočilo primerljive pogoje meritev in zmanjšalo vpliv terenskih nepravilnosti na rezultate. Preučevali smo vpliv dveh

višin postavitve škropilnih šob, in sicer 0,50 m in 0,25 m nad tlemi, ter vpliv vetra, pri čemer smo meritve izvajali tako v brezvetrnih razmerah kot tudi v pogojih prisotnega vetra. Veter smo simulirali z uporabo nahrbtne bencinske škropilnice, s katero smo ustvarili usmerjen zračni tok v smeri škropljenja. Hitrost vetra smo sproti spremljali in merili z anemometrom, kar je omogočilo nadzor nad ponovljivostjo razmer med posameznimi meritvami. Poleg vpliva višine škropilnih šob in vetra smo v poskus vključili tudi primerjavo različnih tipov šob, saj imajo te pomembno vlogo pri oblikovanju kapljic in posledično pri potencialu za odnašanje škropilne brozge. Preizkusili smo tri tipe šob: standardno ploščato šobo Lechler ST 110-03 ter dve posebni antidriftni šobi, in sicer Albuz Awi-Twin 110-03 in Agrotop HiSpeed 110-03. Odnašanje škropilne brozge smo ugotavljali z uporabo na vodo občutljivih lističev, ki smo jih namestili v smeri vetra na razdalji 5 m od zadnje škropilne šobe, v medsebojnem razmiku 0,5 m. Takšna postavitev je omogočila zaznavanje razpršenih kapljic zunaj ciljnega območja škropljenja. Rezultati poskusa so pokazali, da je bilo odnašanje škropilne brozge izrazito manjše pri nižji višini škropilne letve (0,25 m) v primerjavi z višino 0,50 m. Prav tako so se kot najučinkovitejše izkazale šobe z zmanjšanim odnašanjem, pri čemer je šoba Agrotop HiSpeed dosegla najnižje vrednosti zaznanega odnašanja. Prisotnost vetra je v vseh obravnavanih primerih povečala razpršitev kapljic zunaj ciljnega območja, vendar je bil ta učinek manj izrazit pri uporabi antidriftnih šob in nižje postavitve škropilne letve. Na podlagi pridobljenih rezultatov lahko sklepamo, da je za zmanjšanje odnašanja škropilne brozge najbolj primerna uporaba nižje višine škropljenja (0,25 m nad ciljno površino), izvajanje škropljenja v brezvetrnih razmerah ter uporaba posebnih šob, zasnovanih za zmanjševanje odnašanja. Takšna kombinacija tehničnih nastavitev predstavlja učinkovit ukrep za zmanjševanje izgub fitofarmacevtskih sredstev in negativnih vplivov na okolje.

ABSTRACT

Spray drift as affected by sprayer boom height

The aim of the experiment was to evaluate possibilities for reducing spray drift during the application of a field sprayer by analyzing the effects of selected technical and environmental factors. The experiment was conducted on a level and homogeneous surface, which ensured comparable measurement conditions and minimized the influence of terrain irregularities on the results. The effects of two spray nozzle heights, 0.50 m and 0.25 m above the ground, as well as the effect of wind were investigated. Measurements were carried out under both calm (no-wind) conditions and in the presence of wind. Wind was simulated using a backpack petrol sprayer to generate a directed airflow in the spraying direction. Wind speed was continuously monitored and measured with an anemometer, allowing control over the repeatability of conditions during individual measurements. In addition to nozzle height and wind, the experiment also included a comparison of different nozzle types, as nozzle design plays a key role in droplet formation and, consequently, in spray drift potential. Three nozzle types were tested: a standard flat-fan nozzle (Lechler ST 110-03) and two drift-reducing nozzles, Albuz Awi-Twin 110-03 and Agrotop HiSpeed 110-03. Spray drift was assessed using water-sensitive papers, which were placed downwind at a distance of 5 m from the last spray nozzle, with a spacing of 0.5 m between individual papers. This arrangement enabled the detection of dispersed droplets outside the target spraying area. The results showed that spray drift was substantially lower at the lower boom height (0.25 m) compared with the 0.50 m height. Drift-reducing nozzles proved to be the most effective, with the Agrotop HiSpeed nozzle achieving the lowest measured drift values. The presence of wind increased droplet dispersion outside the target area in all tested scenarios; however, this effect was less pronounced when drift-reducing nozzles were used in combination with a lower spray boom height. Based on the obtained results, it can be concluded that the most

suitable approach for reducing spray drift involves applying sprays at a lower height (0.25 m above the target surface), performing applications under calm wind conditions, and using nozzles specifically designed to reduce drift. This combination of technical settings represents an effective measure for minimizing losses of plant protection products and reducing negative environmental impacts.

Primerjava dveh konstrukcijsko različnih pršilnikov pri varstvu vinske trte na terasah

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V letu 2022 smo v času vegetacije vinske trte opravili primerjavo dveh konstrukcijsko različnih pršilnikov pri varstvu vinske trte. V primerjavi smo ocenjevali kakovost nanosa fitofarmacevtskih sredstev (FFS) v terasasto zasajenem vinogradu, storilnost, porabo goriva in stroške uporabe strojev. Primerjali smo klasični aksialni pršilnik z možnostjo škropljenja levo in desno (Friuli Sprayers ATV 1000) in radialni pršilnik s štirimi usmerjevalniki zraka (Friuli Sprayers Compact 1000 T4) z možnostjo škropljenja štirih sten vinske trte. Za spremljanje nanosa FFS na krošnjo vinske trte smo uporabili vodno občutljive lističe. Z njimi smo določili odstotek pokritosti in število odtisov kapljic na cm^2. Z uporabo pršilnika Compact smo dosegli večjo pokritost in število odtisov kapljic na zunanji in notranji steni robnih vrst na terasi. Pri uporabi pršilnika Compact, je poraba goriva večja zaradi radialnega ventilatorja, ki zahteva večjo pogonsko moč. Kljub temu pa lahko z njim dosežemo večjo storilnost, ki je ključna pri večjih vinogradniških površinah.

ABSTRACT

Comparison of different air-assisted sprayers designs when spraying grapevines on terraces

In 2022, during the grapevine vegetation, we compared two air-assisted sprayers with different constructions for grapevine protection. The quality of pesticides application in a terraced vineyard, productivity, fuel consumption and the cost of using machines were evaluated. A classic axial air-assisted sprayer with the possibility of spraying left and right (Friuli Sprayers ATV 1000) and a radial air-assisted sprayer with four air deflectors (Friuli Sprayers Compact 1000 T4) with the possibility of spraying four walls canopy of the vine were included in the comparison. The percentage of coverage was determined with the help of water-sensitive papers. Greater coverage on the outer and inner walls of the edge rows on the terrace was achieved by using the Compact air-assisted sprayer. When using the Compact air-assisted sprayer, fuel consumption is higher due to the radial fan, which requires more drive power. Nevertheless, it can be used to achieve greater productivity, which is crucial for larger vineyard areas.

Kategorizacija gozdnih karantenskih škodljivih organizmov na podlagi tveganja vnosa v slovenske gozdove

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Slovenski gozdovi pokrivajo več kot 58 % površine države in zagotavljajo ključne ekološke, socialne in lesnoproizvodne funkcije. Vnos karantenskih škodljivih organizmov predstavlja pomembno grožnjo za stabilnost ekosistemov. Njihovo širjenje je tesno povezano z naraščajočo mednarodno trgovino, mobilnostjo ljudi, podnebnimi spremembami in pogostejšimi ekstremnimi vremenskimi pojavi, ki ustvarjajo ugodne pogoje za pojav novih vrst. V ta namen smo izvedli kategorizacijo na podlagi seznama karantenskih škodljivih organizmov za Evropsko unijo (Izvedbena uredba komisije (EU) 2019/2072; Priloga 2, del A in B; glive in oomicete, insekti in pršice). Kategorizacija je bila omejena na vrste, katerih gostitelji so prisotni v slovenskih gozdovih, in temelji na uteženih kazalnikih, kot so razširjenost organizmov, načini širjenja, uvoz gostiteljskega materiala in deleži gostiteljev v lesni zalogi, itd. S kategorizacijo pridobimo prilagojen seznam vrst, razvrščenih od najbolj do najmanj tveganih. To omogoča strateško usmerjanje državnih naporov, načrtovanje fitosanitarnih ukrepov, razvoj diagnostičnih metod in laboratorijskih kapacitet za zgodnje odkrivanje ter osredotočanje monitoringa in nadzora na najbolj tvegana območja in gostitelje. Dinamična narava baze omogoča sprotno posodabljanje glede na nove podatke, kar krepi odpornost slovenskih gozdov proti vplivom globalne trgovine, podnebnih sprememb in novih škodljivih organizmov ter podpira trajnostno gospodarjenje z gozdovi.

ABSTRACT

Categorization of forest quarantine pests based on the risk of introduction into Slovenian forests

Slovenian forests cover more than 58 % of the country's area and provide key ecological, social, and timber production functions. The introduction of quarantine pests represents a significant threat to ecosystem stability. Their spread is closely linked to increasing international trade, human mobility, climate change, and more frequent extreme weather events, which create favorable conditions for the emergence of new species. To address this, we carried out a categorization based on the list of union quarantine pests for the European Union (Commission Implementing Regulation (EU) 2019/2072; Annex 2, Parts A and B; fungi and oomycetes, insects, and mites). The categorization was limited to species whose hosts are present in Slovenian forests and is based on weighted indicators such as species distribution, type of spread, import of host material, and the proportion of hosts in the timber stock, among others. This categorization produces a tailored list of species ranked from highest to lowest risk, enabling strategic targeting of national efforts, planning of phytosanitary measures, development of diagnostic methods and laboratory capacities for early detection, and focused monitoring and surveillance of the most vulnerable areas and hosts. The dynamic nature of the database allows continuous updates based on new information, strengthening the resilience of Slovenian forests against the impacts of global trade, climate change, and emerging pests, while supporting sustainable forest management.

Spremljanje patogenov v zraku s pomočjo eDNA iz pajčevin na primeru jesenovega ožiga (*Hymenoscyphus fraxineus*)

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Hymenoscyphus fraxineus je zaprtotrosnica, ki je za Slovenijo in Evropo invazivna tujerodna vrsta. Povzroča bolezen jesenov ožig, ki je za jesene pogubna, najbolj sta za okužbo dovzetni vrsti poljski (*Fraxinus angustifolia*) in veliki jesen (*Fraxinus excelsior*). Na odpadlih jesenovih listnih pecljih gliva tvori apotecije. Askospore, ki se sproščajo iz apotecijev, se na daljše razdalje širijo z vetrom. Zgodnje in zanesljivo spremljanje prisotnosti in količine spor v zraku je ključno za napovedovanje ter obvladovanje bolezni dreves, vendar je klasično lovljenje spor logistično zahtevno. Na primeru *H. fraxineus* smo ovrednotili učinkovitost pajčevin kot pasivnih vzorčevalcev okoljske DNA (eDNA). V gozdnem sestoju velikega jesena (*Fraxinus excelsior*) in črne jelše (*Alnus glutinosa*) smo vzorčili dve vrsti pajčevin (kolesaste in baldahinaste) in jih primerjali s konvencionalnim pasivnim vzorčevalcem, t.j. filter papir v petrijevki. Izpostavitve filter papirja so bile usklajene s kolesastimi pajčevinami (24 ur) in baldahinastimi pajčevinami (7 dni). DNA smo analizirali s specifičnim qPCR testom za *H. fraxineus* in splošnim glivnim testom. Rezultati so v vseh 28 vzorcih potrdili prisotnost glivne DNA. Pri večini vzorcev pajčevin smo zaznali nižje Cq vrednosti (višja količina DNA) kot na filter papirju. Ob tedenski izpostavitvi (baldahinaste pajčevine) smo zaznali bistveno višje signale kot ob dnevni izpostavitvi (kolesaste pajčevine), kar je skladno s pričakovano akumulacijo spor. Rezultati potrjujejo, da so lahko pajčevine zanesljiv, cenovno ugoden in enostaven pasivni vzorčevalec eDNA. Pri detekciji *H. fraxineus* in skupne glivne DNA so pajčevine uspešnejše od filter papirja in imajo velik potencial za zgodnje opozarjanje in napovedovanje bolezni v gozdnih habitatih.

ABSTRACT

Spider webs as samplers of airborne pathogen *Hymenoscyphus fraxineus*

Hymenoscyphus fraxineus is an ascomycete fungus that is an invasive alien species in Slovenia and across Europe. It causes ash dieback disease, which is lethal to ash trees. The fungus produces apothecia on fallen ash leaf stalks, which serve as the primary source of spore dispersion via wind. Early and reliable monitoring of the presence and quantity of spores in the air is crucial for predicting and controlling tree diseases, but traditional spore collection is logistically demanding. Using *H. fraxineus* as an example, we evaluated the utility of spider webs as passive samplers of environmental DNA (eDNA). In a forest stand composed primarily of European ash (*Fraxinus excelsior*) and

common alder (*Alnus glutinosa*), we collected two types of spider webs (orb webs and sheet webs) and compared their performance with a conventional passive sampler - filter paper placed in Petri dish. Filter paper exposure intervals were matched to the web sampling: 24 hours for orb-webs and 7 days for sheet webs. DNA extracts were analyzed using a specific qPCR assay for *H. fraxineus* and a general fungal qPCR assay. Fungal DNA was detected in all 28 samples. In most cases, spider webs yielded lower Cq values (indicating higher DNA quantities) than filter paper. Weekly exposure of sheet webs produced significantly stronger signals than daily exposure of orb webs, which is consistent with the expected accumulation of airborne spores. These findings demonstrate that spider webs are reliable, cost-efficient, and simple passive samplers of airborne eDNA. Their effectiveness suggests substantial potential for early detection and prediction of forest pathogens, including *H. fraxineus*, in natural habitats.

Ksilofagni hrošči na urbanih zelenih površinah v Bordeauxu, Francija

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Urbana okolja postajajo vse bolj pomembna za razumevanje ekologije in potencialnega širjenja avtohtonih in tujerodnih vrst ksilofagnih hroščev z gospodarskim in ekološkim pomenom. Mestna in primestna drevesa zagotavljajo pomembne ekološke, kulturne in družbenogospodarske koristi, kot so uravnavanje mikroklime in ustvarjanje prostora za rekreacijo. Prepoznavanje potencialnih groženj za mestna drevesa je zato prednostna naloga, zlasti ob vse pogostejših vnosih tujerodnih vrst. Poleg tega urbana območja pogosto predstavljajo ključne vstopne točke za tujerodne škodljivce in bolezni. Razumevanje, kako značilnosti zelenih površin in njihova razporeditev v mestnem prostoru oblikujejo združbe hroščev je ključno za ocenjevanje potencialnih poti širjenja invazivnih vrst, napovedovanje nadaljnjega širjenja ter izboljšanje strategij spremljanja vrst, ki lahko ogrožajo zdravje gozdov in mestnih dreves. Za preučevanje teh dinamik smo izvedli poskus s pastmi na mestnih in primestnih zelenih površinah različnih velikosti v mestu Bordeaux v Franciji. Hrošče smo odlovili z uporabo zelenih večlijakastih pasti, na katere smo kot vabo namestili etanol in α-pinen. Predstavljamo sestavo in razširjenost glavnih skupin ksilofagnih hroščev; kozličkov (Cerambycidae), podlubnikov (Curculionidae, Scolytinae) in krasnikov (Buprestidae) v mestu Bordeaux. Pridobljeni podatki zagotavljajo celovit pregled prisotnosti vrst v urbanih habitatih in poudarjajo sposobnost nekaterih vrst, da naselijo tudi majhne, izolirane zelene površine. Ugotovitve prispevajo k razumevanju ekologije ksilofagnih hroščev v urbanih okoljih ter nudijo pomembne informacije za razvoj strategij zgodnjega zaznavanja in upravljanja urbanih gozdov, s ciljem ohranjanja zdravja dreves in biotske raznovrstnosti v mestih.

ABSTRACT

Wood-boring beetles across urban green spaces in Bordeaux, France

Urban environments are becoming increasingly recognized as important landscapes for understanding the ecology and potential spread of wood-boring beetles, including both native or alien species of economic and ecological importance. Urban and peri-urban trees provide essential ecological, cultural, and socio-economic benefits, such as microclimate regulation, and recreational value. Identifying potential threats to urban trees is therefore a priority, particularly in light of rising introductions of non-native species. Moreover, urban areas often serve as key entry points for non-native forest pests and diseases. Understanding how green space characteristics and their distribution in the city shape beetle communities are essential for assessing potential invasion pathways, predicting the spread of newly introduced species, and improving monitoring strategies for species posing forestry or urban tree health risk. To investigate these dynamics, we conducted a trapping experiment across urban and peri-urban green areas of varying sizes in Bordeaux, France, using green multifunnel traps baited with ethanol and α-pinene. Here we present the composition and distribution of the key wood-boring groups; longhorn beetles (Cerambycidae), bark beetles (Curculionidae, Scolytinae), and jewel beetles (Buprestidae) in Bordeaux. The resulting dataset provides a comprehensive overview of species presence across urban habitats and highlights the ability of certain species to inhabit even small, isolated green spaces. These findings contribute to our understanding of beetle ecology within urban environments and offer valuable insights for the development of early-detection monitoring strategies and urban forest management aimed at preserving tree health and urban biodiversity.

Ugotavljanje entomopatogenih gliv na hrastovi čipkarkI (*Corythucha arcuata*) v Sloveniji

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Hrastova čipkarka (*Corythucha arcuata* (Say)) je tujerodna stenica, ki se je po letu 2016 postopoma razširila po vsej Sloveniji. Velike populacije najdemo na hrastih v naravnih habitatih, drevesnicah in urbanih območjih. S sesanjem stenice povzročajo prezgodnje rjavenje hrastovih krošenj, v naseljenih območjih pa so tudi moteče za ljudi. Glede na hitro širjenje in množičnost sklepamo, da v novih okoljih vrsta še nima dovolj naravnih sovražnikov. Ti v Sloveniji doslej še niso bili predmet raziskav. Z namenom ugotavljanja navzočnosti entomopatogenih gliv (EPG) smo od avgusta do oktobra 2025 zbirali vzorce stenic v primorsko-notranjski, osrednjeslovenski in pomurski regiji. Vzorci so bili veje hrasta z osebki hrastove čipkarke različnih razvojnih stopenj. V Laboratoriju za varstvo gozdov smo pregledali 1750 osebkov. Iz mrtvih osebkov z vidnimi znamenji okužbe smo glive izolirali neposredno po vzorčenju ali po različnih obdobjih inkubacije in različnih načinih površinskega razkuževanja žuželk. Največje število izolatov EPG smo dobili pri postopkih gojenja in inkubacije nerazkuženih čipkark skupaj z listi hrasta. Postopoma smo odbirali naravno poginule žuželke z znamenji mikoze in glive s pomočjo stereomikroskopa izolirali na gojišče. Med pridobljenimi izolati smo opredelili sedem morfotipov gliv s potencialnim entomopatogenim delovanjem. Največkrat so bile ugotovljene glive iz rodov *Beauveria*, *Akanthomyces* in *Samsoniella*. Kljub temu, da je bila dokazana stopnja smrtnosti hrastovih čipkark zaradi glivnih okužb v tej začetni raziskavi nizka, raznolikost

EPG nakazuje, da bi te lahko bile eden od naravnih regulatorjev populacije te tujerodne vrste.

ABSTRACT

Detection of entomopathogenic fungi on the oak lace bug (*Corythucha arcuata*) in Slovenia

The oak lace bug (*Corythucha arcuata* (Say)) is an invasive insect species that has progressively spread throughout Slovenia since 2016. Large populations are now established on oaks in natural habitats, nurseries, and urban areas. By feeding, the species cause premature browning of oak canopies, and in residential areas they also pose a nuisance to people. It is assumed that the species lacks sufficient natural enemies in the newly colonized environments given its rapid expansion and high abundance. The natural enemies have not been studied in Slovenia yet. To determine the presence of entomopathogenic fungi (EPF), we collected oak lace bug samples from August to October 2025 in locations covering the Primorska region, Central Slovenia, and Prekmurje. Samples consisted of oak branches bearing individuals of various developmental stages. In total, 1,750 individuals of the oak lace bug were examined in the Laboratory of Forest Protection. Fungi were isolated from dead specimens showing visible signs of mycosis, either immediately after sampling or following different incubation periods and surface-sterilization treatments. The highest number of EPF isolates was obtained by rearing and incubating non-sterilized lace bugs together with oak leaves. Naturally deceased insects with symptoms of mycosis were successively collected and observed under the stereomicroscope. The potentially EPF were isolated on nutrient medium. Seven fungal morphotypes with potential entomopathogenic activity were identified among the isolates. The most frequently detected fungi belonged to the genera *Beauveria*, *Akanthomyces*, and *Samsoniella*. Although the confirmed mortality rate in this initial study was relatively low, the diversity of EPF associated with the oak lace bug may indicate that these fungi could serve as one of the natural population regulators of this invasive species.

Kako ostajamo v formi: recept za strokovno odličnost Nacionalnega referenčnega laboratorije za glive in oomicete v Sloveniji

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V Sloveniji Nacionalni referenčni laboratorij za glive in oomicete deluje kot konzorcij treh laboratorijev: Gozdarskega inštituta Slovenije, Kmetijskega inštituta Slovenije ter Inštituta za hmeljarstvo in pivovarstvo Slovenije. Vsak laboratorij je specializiran za določene skupine gostiteljskih rastlin (več na https://www.nrl-glive.si/), pri čemer se v primeru prekrivanja področij med laboratoriji dogovorimo za ustrezno razdelitev nalog. Zaradi

omejene razpoložljivosti formalnih preskusov usposobljenosti smo uvedli letne medlaboratorijske primerjalne preskuse , ki temeljijo bodisi na identifikaciji kultur gliv in oomicet na osnovi določanja črtnih kod DNA ali na identifikaciji vrst v specifičnih reakcijah PCR. Od leta 2019 vsako leto eden od laboratorijev prevzame vlogo organizatorja in iz referenčne zbirke izbere izolate nekarantenskih vrst gliv. Kodirani vzorci (ekstrakti DNA ali čiste kulture) se nato analizirajo po rutinskih, validiranih protokolih sodelujočih laboratorijev. Glavni poudarek teh preskusov je na pravilni identifikaciji na ravni vrste, a omogoča še oceno npr. učinkovitosti ekstrakcije DNA in ovrednotenje lastne usposobljenosti v kontekstu uporabljenih metod. Medlaboratorijski primerjalni preskus se zaključi s strokovno delavnico, namenjeno izmenjavi dobrih praks, razpravi o tehničnih izzivih ter uskladitvi interpretacije rezultatov. Takšen pristop omogoča zgodnje prepoznavanje morebitnih pomanjkljivosti in ciljno usmerjeno izboljševanje postopkov, pomembno prispeva k večji primerljivosti diagnostičnih rezultatov, krepi medsebojno razumevanje ter spodbuja dolgoročno sodelovanje med partnerji konzorcija.

ABSTRACT

How We Stay in Shape: A Recipe for Professional Excellence at the National Reference Laboratory for Fungi and Oomycetes in Slovenia

In Slovenia, the National Reference Laboratory for Fungi and Oomycetes operate as a consortium of three laboratories: the Slovenian Forestry Institute, the Agricultural Institute of Slovenia, and the Institute of Hop Research and Brewing of Slovenia. Each laboratory is specialized in specific groups of host plants (see https://www.nrl-glive.si/), and in cases of overlapping areas, tasks are allocated through mutual agreement. Due to the limited availability of formal proficiency testing schemes, annual interlaboratory comparisons (ILC) have been implemented, based either on the identification of fungal and oomycete cultures using DNA barcoding or on species identification in specific PCR assays. Since 2019, one of the participating laboratories annually takes over the organization of ILC and selects isolates of non-quarantine fungal species from its reference collection. Coded samples (DNA extracts or pure cultures) are then analysed by the participating laboratories using their routine, validated protocols. The main focus of these tests is accurate species-level identification, but they also allow assessment of DNA extraction efficiency and evaluation of laboratory competence in the context of applied methods. each interlaboratory comparison concludes with an expert workshop aimed at exchanging good practices, discussing technical challenges, and harmonizing result interpretation. This approach enables early identification of potential shortcomings, supports targeted procedural improvements, enhances comparability of diagnostic results, strengthens mutual understanding, and promotes long-term collaboration among consortium partners.

Parazitoidi kaparjev (Coccoidea) v Sloveniji

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Kaparji so gospodarsko pomembni škodljivci številnih sadnih in okrasnih rastlin. Škodo povzročajo neposredno s sesanjem, z izločanjem medene rose na katero se naselijo glive sajavosti ter prenosom rastlinskih patogenov. Za zatiranje kaparjev se v svetu uporablja tako insekticide kot tudi biotične agense, med njimi parazitoidi iz reda kožekrilcev (Hymenoptera) pa tudi plenilci (predvsem polonic Cocinellidae). Na seznamu domorodnih vrst organizmov imamo za zatiranje kaparjev trenutno le 2 polonici, medtem ko je na seznamu tujerodnih vrst organizmov še vedno veliko vrst parazitoidov. V zadnjih letih smo vzorčili najbolj pogoste vrste kaparjev na gojenih rastlinah in potrdili prisotnost nekaterih vrst parazitoidov kaparjev. Preliminarni rezultati kažejo na prisotnost 5 rodov parazitoidov iz 3 družin; Aphelinidae (rodova *Encarsia* in *Coccophagus*), Encyrtidae (rodova *Metaphycus* in *Microterys*) ter Pteromalidae (rod *Scutellista*).

ABSTRACT

Scale insect (Coccoidea) parasitoids in Slovenia

Scale insects are economically important pests attacking a wide range of fruit and ornamental plants. They cause damage directly by sucking plant sap, by secreting honeydew on which sooty mold fungi settle but also by transmitting severe phytopathogens. Worldwide, the control of scale insects primarily involves synthetic insecticides but biotic agents, including parasitoids (Hymenoptera: Parasitica) and predators (mainly Coleoptera: Coccinellidae) can successfully reduce pest populations. The Slovenian list of native organism species currently include only 2 ladybug species (Coccinellidae) related to scale insects and this contrasts with the enormous range of parasitoids species reported from elsewhere. In recent years, the most common scale insects attacking cultivated plants in Slovenia have been sampled and emerging insect parasitoid collected and eventually characterized. Preliminary results indicate the presence of 5 genera of parasitoids from 3 families: Aphelinidae (genera *Encarsia* and *Coccophagus*), Encyrtidae (genera *Metaphycus* and *Microterys*), and Pteromalidae (genus *Scutellista*).

Vpliv različnih načinov obdelave tal na pojavnost koruzne vešče (*Ostrinia nubilalis*) in pridelek koruze

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Koruzna vešča (*Ostrinia nubilalis*) ima več kot 250 rastlinskih gostiteljev, največjo gospodarsko škodo pa povzroča na koruzi. Med pomembnejšimi dejavniki, ki vplivajo na populacijsko dinamiko koruzne vešče je obdelava tal, saj je upravljanje rastlinskih ostankov koruze in obdelave tal povezano s prezimitvijo ličink v tleh. Z namenom preučitve vpliva obdelave tal in upravljanja z ostanki koruze na pojavnost koruzne vešče smo v letu 2025 na poskusnem polju Kmetijskega inštituta Slovenije v Jabljah pri Mengšu izvedli poljski poskus. Raziskava je potekala na trajnem poskusu z različno intenzivnostjo

obdelave tal – konvencionalne, minimalne (ohranitvene) ter postopka brez obdelave (no-till). V obdobju od začetka vzpostavitve poskusa v letu 2018 do leta 2025 smo koruzo pridelovali trikrat, po vsaki žetvi koruze pa je bila koruznica pomulčena. Vzorčenje koruze smo izvedli v oktobru, kjer smo iz vsakega postopka obdelave tal naključno odvzeli 50 koruznih storžev, jih vizualno ocenili glede na stopnjo poškodovanosti ter rezultate statistično ovrednotili. Povprečni pridelki suhega zrnja koruze so se med različnimi načini obdelave značilno razlikovali. V sistemu brez obdelave tal je bil pridelek 10,2 t/ha, pri ohranitveni obdelavi 14,3 t/ha, pri konvencionalni obdelavi pa 12,9 t/ha. Naši rezultati so pokazali, da je bilo v letu 2025 relativno velik delež poškodovanih storžev. Najnižji delež poškodovanih storžev smo zabeležili v sistemu brez obdelave tal (19,5%), najvišjo pa pri konvencionalni obdelavi tal (75%). Pri ohranitveni obdelavi je delež poškodovanih storžev znašal 42,5%. Naši rezultati nakazujejo, da je poleg dobre prakse upravljanja z rastlinskimi ostanki koruze na lokalni ravni še več dejavnikov kot so bližina sosednjih njiv ter mikroklimatske razmere in določajo razvoj populacije koruzne vešče.

ABSTRACT

The impact of different soil tillage systems on the occurence of the European corn borer (*Ostrinia nubilalis*) and maize yield

The European corn borer (*Ostrinia nubilalis*) has more than 250 host plant species, but causes the greatest economic damage to maize. Among the most important factors influencing the population dynamics of the European corn borer is tillage, as the management of maize residues and soil cultivation is closely linked to larval overwintering survival. To investigate the effects of soil tillage and maize residue management on the occurrence of the European corn borer, a field experiment was conducted in 2025 at the experimental field of the Agricultural Institute of Slovenia in Jablje. The study was carried out within a long-term experiment involving different tillage intensities—conventional, conservation, and no-till systems. From the establishment of the experiment in 2018 until 2025, maize was grown three times, and after each maize harvest the crop residues were mulched. Maize sampling was conducted in October, when 50 maize ears were randomly collected from each tillage treatment, visually assessed for the degree of damage, and the results were statistically analyzed. Average dry grain maize yields differed significantly among the different tillage systems. In the no-till system, the yield was 10.2 t/ha, in the conservation tillage system 14.3 t/ha, and in the conventional tillage system 12.9 t/ha. Our results showed that in 2025 there was a relatively high proportion of damaged ears. The lowest proportion of damaged ears was recorded in the no-till system (19.5%), while the highest was observed under conventional tillage (75%). In the conservation tillage system, the proportion of damaged ears was 42.5%. Our results suggest that, in addition to good practices of maize residue management at the local level, several other factors—such as the proximity of neighboring fields and microclimatic conditions—also play an important role in determining the development of European corn borer populations.

Učinkovitost izbranih herbicidnih sredstev za zatiranje plevelne vegetacije na železniški infrastrukturi

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Zatiranje plevelne vegetacije na železniški infrastrukturi po letu 2021, ko je v Sloveniji v veljavo stopila prepoved uporabe fitofarmacevtskih sredstev (FFS) na javni infrastrukturi, predstavlja poseben izziv zaradi zakonsko omejenega nabora dovoljenih sredstev, visoke stopnje zapleveljenosti ter heterogenih rastnih razmer. S koncem leta 2022 je začel veljati nov pravilnik o pravilni uporabi FFS, ki za zatiranje plevelne vegetacije na železniških površinah dovoljuje omejen nabor aktivnih snovi. V tem okviru smo v letu 2023 na lokaciji Ljubljana–Zalog, na stranskem tiru z gosto in vrstno raznoliko plevelno združbo, izvedli poskus z namenom primerjalne ocene učinkovitosti dovoljenih herbicidnih aktivnih snovi in njihovih kombinacij pri zatiranju plevelne vegetacije na železniški infrastrukturi. V preizkušanje so bili vključeni glifosat (kot referenčna aktivna snov, uporabljana več desetletij pred uveljavitvijo prepovedi leta 2021), flazasulfuron (herbicid, ki v Sloveniji ni dovoljen, vendar se uporablja v nekaterih drugih državah), pelargonska kislina ter herbicidi z aktivnimi snovmi 2,4-D, MCPA, dikamba in fluroksipir. Preizkušene so bile tudi različne kombinacije pripravkov, vključno z dodatkom graminicidov na osnovi fluazifop-p-butila in propakvizafopa za zatiranje ozkolistnih plevelov. Aplikacije so bile izvedene v dveh terminih (zgodnja aplikacija v aprilu in pozna aplikacija v maju 2023). Učinkovitost zatiranja je bila ocenjena vizualno v več časovnih presledkih po aplikaciji. Najvišje skupne učinkovitosti so bile zabeležene pri postopkih z uporabo glifosata (87–90 %) ter pri nekaterih kombinacijah, ki so vključevale flazasulfuron, kjer so učinkovitosti v zgodnjih terminih ocenjevanja dosegale 80–87 %. Pelargonska kislina kot samostojen pripravek je izkazala nizko začetno učinkovitost (do 15 %) in izrazito kratkotrajen učinek. Pri večini postopkov je bil v kasnejših terminih ocenjevanja zaznan upad učinkovitosti, kar je sovpadalo z novim vznikom plevelnih rastlin. Dodatek graminicida je prispeval k izboljšanemu zatiranju trav, pri čemer so bile učinkovitosti kombinacij praviloma višje kot pri samostojni uporabi herbicidov brez graminicidne komponente.

ABSTRACT

Effectiveness of selected herbicides for weed control on railway infrastructure

Weed control on railway infrastructure after 2021, when in Slovenia the ban on the use of plant protection products (PPPs) on public infrastructure came into force, represents a particular challenge due to the legally restricted range of authorized products, high weed infestation levels, and heterogeneous site conditions. At the end of 2022, a new regulation on the proper use of PPPs entered into force, permitting a limited number of active substances for weed control on railway surfaces. Within this framework, a field trial was conducted in 2023 at the Ljubljana–Zalog site, on a siding characterized by a dense and species-rich weed community, with the aim of comparatively evaluating the efficacy of authorized herbicidal active substances and their combinations for weed control on railway infrastructure. The trial included glyphosate (as a reference active substance used for several decades prior to the 2021 ban), flazasulfuron (a herbicide not authorized in Slovenia but used in some other countries), pelargonic acid, and herbicides containing the active substances 2,4-D, MCPA, dicamba, and fluroxypyr. Various product combinations were also tested, including the addition of graminicides based on fluazifop-P-butyl and propaquizafop for the control of grass weeds. Applications were carried out at two timings (an early application in April and a late application in May 2023). Weed control efficacy was assessed visually at several time intervals after application. The highest overall efficacies were recorded for treatments using glyphosate (87–90%) and for certain combinations including flazasulfuron, where efficacies in early assessment periods

reached 80–87%. Pelargonic acid applied as a standalone product showed low initial efficacy (up to 15%) and a distinctly short-term effect. For most treatments, a decline in efficacy was observed at later assessment dates, coinciding with new weed emergence. The addition of a graminicide improved grass weed control, with combination treatments generally achieving higher efficacy than herbicides applied without a graminicidal component.

Vpliv funkcionalne in vrstne pestrosti mešanic dosevkov na produkcijo rastlinske biomase in zapleveljenost

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Pozitivni učinki prekrivnih dosevkov, kot so izboljšanje talnih lastnosti in zmanjševanje zapleveljenosti, so v slovenskem kmetijstvu dobro poznani, zato jih vse več kmetov vključuje v poljedelske kolobarje. Kljub temu vloga pestrosti in funkcionalne sestave mešanic dosevkov še ni povsem pojasnjena. V poljskem poskusu, izvedenem na Kmetijskem inštitutu Slovenije, smo primerjali osnovne in pestre mešanice prekrivnih dosevkov, razvrščene v štiri funkcionalne skupine: kompetitivne vrste, metuljnice za vezavo dušika, vrste, prilagojene sušnim razmeram, ter cvetoče mešanice z visokim potencialom za prehrano opraševalcev, pri čemer so bile mešanice oblikovane na dveh nivojih pestrosti: osnovne (5 vrst) in pestre (7–9 vrst). V več časovnih točkah skozi rastno dobo smo spremljali pokrovnost dosevkov, nadzemno biomaso in relativno učinkovitost zatiranja plevelov (RWSE). Zgodnja pokrovnost (17 dni po setvi, DAS) je znašala od 1,3 do 12,4 %, pri čemer so najvišje vrednosti dosegale kompetitivne mešanice. Ob koncu rastne dobe (72 DAS) se je pokrovnost povečala na 18–70 %, kompetitivne mešanice pa so ohranile najvišjo povprečno pokrovnost (okoli 60 %). Produkcija biomase se je jasno razlikovala med funkcionalnimi skupinami in je v povprečju znašala 2,74 ± 0,35 t ha^{-1} pri kompetitivnih mešanicah, 2,44 ± 0,25 t ha^{-1} pri mešanicah metuljnic, 2,10 ± 0,10 t ha^{-1} pri cvetočih mešanicah ter 1,57 ± 0,24 t ha^{-1} pri suši prilagojenih mešanicah. Vpliv pestrosti mešanic je bil odvisen od funkcionalne skupine: bolj pestre mešanice so dosegle večjo biomaso pri mešanicah z metuljnicami, suši prilagojenih in cvetočih mešanicah (0,35–0,81 t ha^{-1}), medtem ko je bila biomasa pri pestri kompetitivni mešanici v primerjavi z osnovno manjša (–1,1 t ha^{-1}). RWSE je ob koncu rastne dobe znašala od 32 do 90 %, pri čemer so najvišjo učinkovitost zatiranja plevelov dosegale kompetitivne mešanice (90 %), slabše pa so plevelom konkurirale predvsem dušik vezoče in cvetoče mešanice. Rezultati kažejo, da sta funkcionalna zasnova mešanic dosevkov in produkcija biomase pomembnejša dejavnika zatiranja plevelov kot sama pestrost mešanic.

ABSTRACT

Effects of Functional and Species Diversity of Cover Crop Mixtures on Plant Biomass Production and Weed Infestation

The positive effects of cover crops, such as improvements in soil properties and reductions in weed infestation, are well recognized in Slovenian agriculture, and their use in arable crop rotations is steadily increasing. However, the role of species diversity and

functional composition of cover crop mixtures is still not fully understood. In a field experiment conducted at the Agricultural Institute of Slovenia, we compared basic and diverse cover crop mixtures classified into four functional groups: competitive species, nitrogen-fixing legumes, drought-adapted species, and flowering mixtures with high potential for pollinator resources, with mixtures established at two diversity levels: basic (5 species) and diverse (7–9 species). Cover crop cover, aboveground biomass, and relative weed suppression efficiency (RWSE) were assessed at multiple time points throughout the growing season. Early cover crop cover (17 days after sowing, DAS) ranged from 1.3 to 12.4 %, with the highest values observed in competitive mixtures. By the end of the growing season (72 DAS), cover increased to 18–70 %, and competitive mixtures maintained the highest average cover (approximately 60 %). Biomass production differed markedly among functional groups, averaging 2.74 ± 0.35 t ha^{-1} in competitive mixtures, 2.44 ± 0.25 t ha^{-1} in legume mixtures, 2.10 ± 0.10 t ha^{-1} in flowering mixtures, and 1.57 ± 0.24 t ha^{-1} in drought-adapted mixtures. The effect of mixture diversity depended on functional group: diverse mixtures produced higher biomass in nitrogen-fixing, drought-adapted, and flowering mixtures (0.35–0.81 t ha^{-1}), while biomass in the diverse competitive mixture was lower compared with the basic mixture (–1.1 t ha^{-1}). RWSE at the end of the season ranged from 32 to 90 %, with the highest weed suppression observed in competitive mixtures (90 %), whereas nitrogen-fixing and flowering mixtures were less competitive against weeds. These results indicate that functional composition and biomass production are more important drivers of weed suppression than mixture diversity alone.

Vpliv sorte semenskega krompirja na učinkovitost kemičnih in nekemičnih postopkov uničenja krompirjeve cime

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Uničenje krompirjeve cime je pomembno za zmanjšanje količine organske mase pred spravilom, zmanjšanje poškodb kožice gomoljev ter zmanjšanje okužb z glivičnimi in bakterijskimi boleznimi, v semenskih nasadih pa predvsem za omejevanje okužb z virusi, ki ključno vplivajo na kakovost semenskega krompirja. Leta 2019 je stopila v veljavo prepoved uporabe sredstva dikvat, zato je nabor kemičnih možnosti za učinkovito uničenje krompirjeve cime postal precej omejen. Raziskava je bila zato usmerjena v preučevanje učinkovitosti različnih načinov uničenja krompirjeve cime glede na zmanjšanje biomase in ponovno obraščanje. V ta namen je bil leta 2025 na Spodnjem Brniku zasnovan bločni poskus, ki je vključeval tri različne strategije uničenja krompirjeve cime pri desetih poznih sortah krompirja. V prvem postopku smo dne 25. 8. 2025 uporabili samo specialni dvovrstni mulčer za krompir, v drugem postopku pa je en dan po mulčenju sledila uporaba herbicida karfentrazon-etil (60 g/ha). Tretji, nekemični pristop je vključeval mulčenje, dva dni zatem pa smo krompirjevo cimo toplotno uničili še s strojem HOAF KB 1,5 Twin. Ta stroj združuje inovativen pristop klasičnega ožigalnika s plameni in zaprto komoro z dodatnim infrardečim sevanjem. Vizualno ocenjevanje deleža uničene cime in števila

ponovno obraščenih rastlin je bilo opravljeno 4. 9. 2025. Naši rezultati so pokazali, da samo mulčenje ni bilo dovolj učinkovito, saj so se obraščale vse preučevane sorte, s povprečjem 47,1 % ponovno obraščenih rastlin. Tudi z uporabo kombinacije mulčenja in ožiganja obraščanja nismo preprečili pri nobeni sorti, je bil pa delež obraslih rastlin krompirja bistveno nižji (13,7 %). Najučinkovitejša je bila kombinacija mulčenja in uporabe karfentrazon-etila, kjer sta se obraščali le še sorti Russet (1,9 %) in Peter Pan (16,7 %). Naši rezultati nakazujejo velike razlike v občutljivosti posameznih sort na preučevane načine uničenja cime ter potrebo po nadaljnjih raziskavah možnosti nekemičnega uničenja krompirjeve cime.

ABSTRACT

Effect of seed potato cultivar on the performance of mechanical and chemical potato haulm destruction methods

Potato haulm destruction is important for reducing the amount of aboveground biomass prior to harvest, minimizing tuber skin damage, and decreasing infections by fungal and bacterial diseases. In seed potato production, it is particularly critical for limiting virus infections that strongly affect seed tuber quality. In 2019, the ban on the use of diquat entered into force, substantially restricting the range of chemical options available for effective potato haulm destruction. This study therefore focused on evaluating the effectiveness of different haulm destruction strategies in terms of biomass reduction and haulm regrowth. In 2025, a block experiment was established in Slovenia, at Spodnji Brnik in seed potatoes including three different haulm destruction strategies tested across ten late-maturing potato cultivars. In the first treatment, only mulching was applied on 25 August 2025 using specialized two-row potato flail mower. In the second treatment, mulching was followed the next day by chemical desiccation using carfentrazone-ethyl (60 g ha^{-1}). The third, non-chemical approach combined mulching with additional thermal haulm destruction using the HOAF KB 1.5 Twin machine two days later. This system integrates a conventional flame weeder with a closed chamber providing supplementary infrared radiation. Visual assessments of the proportion of destroyed haulm and the number of regrowing plants were conducted on 4 September 2025. Our findings indicate that mulching alone did not provide sufficient control, as regrowth was observed in all evaluated cultivars, with a mean regrowth of 47.1 %. Although the mulching–flaming combination did not completely eliminate regrowth, it substantially reduced regrowth to 13.7 %. The highest level of control was achieved with the combination of mulching and carfentrazone-ethyl application, under which regrowth was detected only in the cultivars Russet (1.9%) and Peter Pan (16.7%). Our findings indicate substantial cultivar-specific differences in sensitivity to the evaluated haulm destruction methods and highlight the need for further research into non-chemical approaches for potato haulm destruction.

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