



DRUŠTVO ZA VARSTVO RASTLIN SLOVENIJE

Izvečki referatov / Abstract volume

**13. SLOVENSKO POSVETOVANJE O VARSTVU RASTLIN
Z MEDNARODNO UDELEŽBO**

***13TH SLOVENIAN CONFERENCE ON PLANT PROTECTION WITH
INTERNATIONAL PARTICIPATION***

7.–8. marec 2017, Rimske Toplice, SLOVENIJA

**Društvo za varstvo rastlin Slovenije
*Plant Protection Society of Slovenia***



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Izdajatelj Društvo za varstvo rastlin Slovenije

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Use of plant disease models and decision support systems in Integrated Pest Management

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Traditionally, disease control in vineyards is based on calendar applications of fungicides, in such a way to keep the plants constantly protected. Vine growers strongly rely on chemical pesticides, so that viticulture accounts for a relevant part of the pesticides used in Europe. Directive 128/2009/EC makes integrated pest management (IPM) mandatory across Europe in such a way to reduce the negative impacts of pesticides on human health and the environment. A key principle of IPM is to protect crops only when it is necessary, i.e., when there is the risk for pathogens to develop, infect plants and cause damage.

Weather is one of the main drivers for disease development. The study of the relationships between weather conditions and diseases is a long lasting story. First disease forecasters have been developed in the middle of '900 following an empirical approach, with simple tools showing relationships between particular stages of the pathogen and the concomitant weather conditions.

The so called 3 10 rules for predicting first seasonal infection of grape downy mildew is an example of this empirical approach for understanding relationships between pathogens, plants and the environment. By using this approach, the model is developed by searching mathematical or statistical relationships between field collected data and these relationships do not necessarily have cause-effect meaning. Lack of knowledge, accuracy and, especially, robustness are the main weaknesses of these models, which impose accurate validation and, usually, proper calibration when these models are used in different environments or under changing climate. Recent methods of data analysis, like for instance neural networks, improved the capability of searching the mathematical structure of the model, but they do not overcome the above-mentioned weaknesses.

Developments in weather monitoring and automatic data processing had a relevant role in increasing numbers of the forecasting models and their complexity. Nevertheless, empiricism predominated for long time. In recent years, new research approaches have increased our ability to investigate and understand these complex relationships. Relevant improvements were obtained with the mechanistic dynamic models.

Mechanistic models are a new class of models based on knowledge of biological and epidemiological behaviour of the system under study. These models explain the pathosystem on the basis of what is known about how the system works in relation to the influencing variables (weather conditions, host characteristics, control measures, etc.). Mechanistic models are dynamic, because they analyse the changes over time of the components of an epidemic due to the external, influencing variables. Dynamic modelling is based on the assumption that the state of the pathosystem in every moment can be quantitatively characterised and that changes in the system can be described by mathematical equations. These models overcome most of the weakness of the empirical models. Accuracy and robustness of these models significantly increased compared to the empiric ones. For instance, compared to the 3 10 rule, a mechanistic model for grape downy mildew increased the overall accuracy of the predictions by ~60% to ~90%.

Advances in information and communication technologies (ICTs) made it possible to incorporate models into Decision Support Systems (DSSs) and to effectively deliver these systems to growers. In the past, there was a poor uptake of DSSs, because of different reasons: (i) failure to support more than one or a few problems; (ii) lack of a computer familiarity among the population; (iii) system complexity; (iv) use of inputs that the grower cannot easily provide; (v) difficult to show cost-benefits.

Modern DSSs are able to overcome these "implementation problems" and are useful tools for supporting informed decision-making in plant protection. For instance, a new DSS, named *vite.net*^{*}, was developed within the EC funded project MoDeM for sustainable management of vineyards and is intended for the vineyard manager (the person who makes decisions about the vineyard management or suggests the proper actions to the grape-grower). The DSS has two main parts: (i) an integrated system for real-time monitoring of the vineyard components (air, soil, plants, pests, and diseases) and (ii) a web-based tool that analyses these data by using advanced modelling techniques and then provides up-to-date information for managing the vineyard in the form of alerts and decision supports. The information is tailored to a vineyard, or part of a vineyard, or a number of vineyards that

are uniformly managed throughout the season. In the design and development of vite.net[®], the so-called 'problem of implementation' which frequently leads to under-utilization of the DSSs was specifically addressed by different solutions, including involving potential users during vite.net[®] development and testing.

During the development of the DSS, selected end-users (i.e., leading grape-growers and advisors belonging to grower associations) in Europe have contributed to seminars and participated in visits to demonstration vineyards. Involving the end-users in these activities: (i) enabled researchers to obtain information about how the end-users usually make decisions and manage the vineyard, e.g., it clarified criteria and methods used by end-users and time needed to make decisions concerning vineyard management; (ii) demonstrated to end-users how vite.net[®] works and its potential advantages; (iii) facilitated the collection of end-user opinion on the usability of the DSS compared to their standard methods and tools; and (iv) provided information on end-user willingness to pay for and use the DSS.

Twenty-one organic farmers were involved in the evaluation phase of the DSS in Italy, i.e., they participated as testers. Most of the testers consulted the DSS regularly, and most increased their use over the season; none stopped using or reduced their use of the DSS. Concerning the effect of the DSS on the decision-making process, about one-half of the testers reported a reduction in the time spent making decisions, and most indicated that decision making was made easier (and was better supported by an understanding of the underlying biological processes) by use of the DSS. All the testers declared that the use of DSS improved their decisions. DSS alarms and decision supports were evaluated as user-friendly, easy to understand, and explicit. All the testers indicated that they wanted to continue using the DSS and they were willing to pay an annual fee.

The DSS vite.net[®] has been commercially available since January 2013. More than 300 users used the DSS in 2016, in more than 10,000 ha of vineyards across Italy. The DSS is also used in Spain and Portugal. The use of the DSS made it possible a reduction of the pesticide use till 50%, an increase of the farmer income and a reduction of the negative impacts on human health and the environment, which were measured by specific indicators developed within the EC funded project Innovine.

Statistics about the use of the DSS by these users based on their access to the web portal of vite.net[®] as well as the feedback collected during the regular contacts with the growers suggested that the 'implementation problem' had been solved by the solutions used for development and delivery of the DSS to end-users.

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IZVLEČEK

Uporaba modelov za napoved pojava bolezni in sistemov podpore pri odločanju v integriranemu varstvu rastlin

Po tradiciji je obvladovanje bolezni v vinogradu temeljilo na koledarskih terminih nanosa fungicidov z namenom, da so bile rastline stalno zavarovane. Vinogradniki so se močno zanašali na uporabo fitofarmaceutskih sredstev (FFS), zato ima varstvo vinske trte pomemben delež pri uporabi le-teh v Evropi. Z direktivo 128/2009/EC je integrirano varstvo rastlin (IVR) na območju Evrope postalo obvezno z namenom zmanjšanja negativnih učinkov FFS na zdravje ljudi in okolje. Ključni princip IVR je varstvo rastlin samo v primeru, kadar je to nujno potrebno, oz. takrat kadar obstaja tveganje za razvoj patogena, okužbo in povzročitev škode.

Vreme je eden izmed glavnih dejavnikov za razvoj bolezni. Raziskave razmerij med vremenskimi razmerami in boleznimi rastlin trajajo že dolgo časa. Prve modele za napoved pojava bolezni rastlin so razvili že v sredini 20. stoletja. Sledili so empiričnemu pristopu s preprostimi orodji, s katerimi so fitopatologi prikazali povezave med določenimi stadiji patogena in sočasnimi vremenskimi pogoji.

Tako imenovana pravila 3-10 (Baldacci 1947) za napoved prve sezonske okužbe s peronsporo vinske trte je primer empiričnega pristopa za razumevanje razmerja med patogenom, rastlino in okoljem. Z uporabo tega pristopa, model, razvit z iskanjem matematičnih ali statističnih povezav med podatki, zbranimi na terenu in razmerji med patogenom, rastlino in okoljem, ne da nujno vzročno-posledičnega pomena. Pomanjkanje znanja, natančnosti in še posebej robustnost, so glavne pomanjkljivosti empiričnih modelov, ki zahtevajo natančno validacijo in navadno tudi ustrezno kalibracijo, kadar se ti modeli uporabljajo v različnih okoljih ali v spremenljivih vremenskih

razmerah. Zadnje metode analiz podatkov, kot so npr. nevronske mreže, sicer izboljšujejo zmogljivost iskanja ustrezne matematične strukture modelov, vendar še vedno ne morejo mimo zgoraj navedenih slabosti.

Razvoj v spremljanju vremenskih razmer in avtomatski obdelavi podatkov je imel pomembno vlogo v povečevanju števila prognostičnih modelov in njihove kompleksnosti. Kljub temu je na tem področju empirizem prevladoval dolgo časa. V zadnjih letih so novi pristopi v raziskavah povečali našo sposobnost preučevanja in razumevanja kompleksnih razmerij med različnimi dejavniki. Pomemben napredek je bil dosežen z mehanističnimi dinamičnimi modeli.

Mehanistični modeli predstavljajo novi razred modelov, ki temeljijo na poznavanju biološkega in epidemiološkega obnašanja sistema, ki ga preučujemo. Ti modeli pojasnjujejo sistem delovanja patogena na osnovi tega, kar je znano o njegovem delovanju v razmerju z vplivnimi spremenljivkami (vremenske razmere, lastnosti gostitelja, ukrepi varstva,...). Mehanistični modeli so dinamični, ker analizirajo spremembe epidemiološke komponente skozi čas na račun zunanjih vplivnih spremenljivk. Dinamično modeliranje je zasnovano na predpostavki, da je stanje delovanja sistema patogena v vsakem trenutku mogoče kvantitativno opredeliti in da se dajo spremembe opisati z matematičnimi enačbami. Ti modeli tako premagujejo večino šibkih točk empiričnih modelov. Natančnost in robustnost teh modelov je značilno večja v primerjavi z empiričnimi. Tako je npr. mehanistični model v primerjavi s pravili 3-10 za napoved peronosporne vinske trte povečal celotno natančnost napovedi za 60 do 90 %.

Napredek v informacijsko-komunikacijskih tehnologijah (IKT) je omogočil vključitev modelov v sisteme za podporo pri odločanju (SPO) in učinkovit prenos teh sistemov do kmetijskih pridelovalcev. V preteklosti so bili ti sistemi slabo izkoriščeni zaradi različnih razlogov: (i) reševali so lahko samo enega ali le nekaj problemov, (ii) pomanjkanje računalniške pismenosti, (iii) kompleksnost sistema, (iv) pridelovalci so težko zagotovili vhodne podatke, (v) stroški in koristi so bili težko predstavljeni.

Sodobni SPO premagujejo te izvedbene probleme in predstavljajo uporabna orodja za podporo pri sprejemanju odločitev v varstvu rastlin. Na primer, znotraj projekta MoDeM za trajnostno upravljanje z vinogradi, ki je bil financiran s strani Evropske komisije je bil razvit novi SPO poimenovan vite.net[®], namenjen za upravljalca vinograda (oseba, ki sprejema odločitve o gospodarjenju z vinogradom ali predlaga ustrezne ukrepe vinogradniku). SPO ima dva glavna sklopa: (i) integriran sistem za spremljanje spremenljivk vinograda v realnem času (zrak, tla, rastline, bolezni in škodljivci) in (ii) spletno orodje, ki analizira te podatke z uporabo naprednih tehnik modeliranja in nato poda ažurno informacijo za sprejemanje ukrepov v obliki opozoril in podpore pri odločanju. Informacija sistema je prilagojena na vinograd, del vinograda ali na število vinogradov z notnim upravljanjem/gospodarjenjem skozi sezono. Pri zasnovi in razvoju sistema vite.net[®], so bile tako imenovane izvedbene težave, ki pogosto vodijo v prenizko izkoriščenost SPO, posebej obravnavane z različnimi rešitvami vključno z vključitvijo potencialnih uporabnikov v proces razvoja in testiranja sistema.

Skozi razvoj SPO so izbrani končni uporabniki (t.j. vodilni vinogradniki in svetovalci iz združenj pridelovalcev) v Evropi sodelovali pri seminarjih in ogledih demonstracijskih vinogradov. Vključevanje končnih uporabnikov v te aktivnosti je (i) omogočilo raziskovalcem, da so pridobili informacijo o tem, kako končni uporabniki običajno sprejemajo odločitve in upravljaajo z vinogradom, npr. dobili so pojasnilo kriterijev in metod, ki jih uporabljajo končni uporabniki in čas potreben za sprejemanje odločitev glede upravljanja z vinogradom; (ii) predstavilo končnim uporabnikom delovanje sistema vite.net[®] in njegove potencialne koristi (iii) olajšalo zbiranje mnenj končnih uporabnikov o uporabnosti SPO v primerjavi z njihovimi običajnimi metodami in orodji in (iv) podalo informacijo o pripravljenosti končnih uporabnikov za plačilo in uporabo SPO.

V fazo ocenjevanja SPO v Italiji je bilo vključenih 21 ekoloških pridelovalcev, ki so sodelovali v testiranju sistema. Večina od njih je v času testiranja uporabljala SPO redno in večina od njih je povečala njegovo uporabo tekom sezone, nihče od njih ni prenehal ali zmanjšal uporabo tega sistema. Kar zadeva vpliv SPO na proces sprejemanja odločitev, je polovica pridelovalcev poročala o zmanjšanju časa potrebnega za sprejemanje odločitev, večina pridelovalcev je nakazala, da je bilo sprejemanje odločitev izvedeno lažje (in bilo boljše podprto z razumevanjem osnovnih bioloških procesov) z uporabo SPO. Vsi testerji so izjavili, da je uporaba SPO izboljšala njihove odločitve. Opozorila in podpora pri odločitvah podana iz SPO so bila ocenjena kot uporabnikom prijazna, enostavna za razumevanje in jasna. Vsi testerji so nakazali, da želijo še naprej uporabljati SPO in da so pripravljeni za sistem plačevati letno članarino.

SPO vite.net[®] je bil komercialno dosegljiv od januarja 2013. V letu 2016 je v Italiji sistem uporabilo več kot 300 uporabnikov na več kot 10.000 ha vinogradov. SPO se uporablja tudi v Španiji in na Portugalskem. Uporaba

sistema je omogočila možnost zmanjšanja uporabe FFS do 50%, povečanja prihodka pridelovalca in zmanjšanje negativnega vpliva na zdravje ljudi in okolja kar je bilo izmerjeno s specifičnimi indikatorji razvitimo znotraj evropskega projekta Innovine.

Statistika uporabnikov sistema izdelana na osnovi njihovih dostopov do spletnega portala vite.net® kot tudi povratna informacija zbrana skozi redne kontakte z uporabniki, kaže, da so bile izvedbene težave rešene z rešitvami uporabljenimi za razvoj in dostavo SPO končnim uporabnikom.

Zahvala: Projekta MoDeM in Innovine sta bila podprta s strani Evropske komisije skozi Sedmi okvirni program pod številka 262059 in 311775.



Geostatistical tools for the study of insect spatial distribution: practical implications in the integrated management of orchard and vineyard pests

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Spatial heterogeneity in agricultural systems is recognised as an important source of variability to be investigated. In the evolution of Integrated Pest Management (IPM), patterns and processes that influence spatio-temporal dynamics in insect populations tend to assume more importance compared to the classical theory. Geostatistics represent a valuable tool to investigate the spatial pattern of insect populations and to support pest control. After an explanation of the geostatistical analysis, in the present presentation we provided an overview of practical applications in managing pests, focusing on fruit orchards and vineyards (e.g. considering *Grapholita funebrana*, *Cydia pomonella*, *Grapholita molesta*, *Anarsia lineatella*, *Lobesia botrana* and *Ceratitidis capitata*). The utility of geostatistical tools is illustrated with examples taken from field studies, with attention to the analysis of spatial patterns, monitoring schemes, use of traps, scale issues, precision targeting, and risk assessment maps. Potential approaches in the context of IPM are discussed in relation to future perspectives.

IZVLEČEK

Geostatistična orodja za preučevanje prostorske razporeditve škodljivcev: praktična uporaba obvladovanja škodljivcev pri integriranem varstvu sadovnjakov in vinogradov

Prostorska heterogenost v kmetijskih sistemih je poznana kot pomemben vir variabilnosti, ki jo je potrebno raziskati. Pri razvoju integriranega varstva rastlin (IVR) imajo vzorci in procesi, ki vplivajo na prostorsko-časovno dinamiko populacij škodljivcev navadno večji pomen kot pri konvencionalnem varstvu rastlin. Geostatistika predstavlja dragoceno orodje pri proučevanju prostorske razporeditve populacij škodljivcev in predstavlja dobro podporo pri zatiranju škodljivcev. V prispevku so predstavljene osnove geostatističnih analiz in njihova praktična uporaba pri obvladovanju škodljivcev, s poudarkom na škodljivcih v sadovnjakih in vinogradih, kot so: češpljev zavijač (*Grapholita funebrana*), jabolčni zavijač (*Cydia pomonella*), breskov zavijač (*Grapholita molesta*), breskov molj (*Anarsia lineatella*), križasti grozdni sukač (*Lobesia botrana*) in breskova muha (*Ceratitidis capitata*). Uporabnost geostatističnih orodij je ponazorjena s primeri iz terenskih raziskav, s poudarkom na analizi prostorskih vzorcev škodljivcev, sistemih za njihovo spremljanje, uporabi vab, težavah z določanjem merila, t.i. natančnem varstvu, in na izdelavi kart z oceno tveganja. V prispevku bo tekla razprava o uporabi geostatistike v perspektivah IVR v prihodnje.



Sistem prognoze bolezni in škodljivcev rastlin kot pomemben del integriranega varstva rastlin

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V skladu z določbami zakona o fitofarmaceutskih sredstvih integrirano varstvo rastlin pomeni skrbno upoštevanje vseh razpoložljivih metod varstva rastlin in povezovanje ustreznih ukrepov za preprečevanje razvoja škodljivih organizmov rastlin. Uporaba fitofarmaceutskih sredstev mora biti na ekonomsko in ekološko upravičeni ravni, s ciljem zmanjševanja tveganja za zdravje ljudi in okolje. Za odločitve o ustreznih ukrepih varstva rastlin so ključni podatki in ugotovitve iz spremljanja razvoja škodljivih organizmov in praga škodljivosti. V Sloveniji že več kot petnajst let deluje prognostična služba za varstvo rastlin kot del javne službe zdravstvenega varstva rastlin. Ukvarja se s spremljanjem, opazovanjem in napovedovanjem pojava škodljivih organizmov na podlagi meteoroloških, biotičnih in drugih podatkov. Na podlagi tega določa optimalne roke za zatiranje škodljivih organizmov ter o tem obvešča pridelovalce in jih usmerja k primernim varstvenim ukrepom za omejevanje širjenja škodljivih organizmov. Prognostična služba za varstvo rastlin je organizirana v petih centrih (Kmetijski inštitut Slovenije, Inštitut za hmeljarstvo in pivovarstvo Slovenije in KGZS – kmetijsko gozdarski zavodi Nova Gorica, Novo mesto in Maribor). Za izvajanje opazovalno napovedovalne dejavnosti se uporabljajo različni pripomočki za spremljanje škodljivih organizmov, od lovilcev spor, svetlobnih vab, feromonskih vab, lepljivih plošč do novejših tehnik daljinskega spremljanja. Potrebna je tudi različna strojna, programska in druga oprema, ki omogoča meritve različnih parametrov, zbiranje in analiziranje ter dostopnost podatkov in meritev. Zato se napovedi za varstvo rastlin pred glavnimi gospodarsko škodljivimi organizmi v vinogradništvu, sadjarstvu, hmeljarstvu, oljkarstvu, poljedelstvu in vrtinarstvu izvajajo s pomočjo uporabe meritev iz agrometeoroloških postaj. Prve tovrstne postaje so bile v Sloveniji postavljene že leta 1998. Postaje so povezane v agrometeorološko mrežo, ki zagotavlja dostopnost podatkov preko spletnega portala (<http://agromet.mko.gov.si>). Za analizo podatkov so vključene tudi referenčne postaje Agencije Republike Slovenije za okolje (ARSO) za uporabo v kmetijstvu, ki so sicer prikazane na spletnih straneh ARSO. V agrometeorološko mrežo je vključenih 86 postaj. Nove informacijske tehnologije so omogočile natančnejše spremljanje pojava škodljivih organizmov z uporabo neposrednih meritev iz postaj, prognostičnih modelov, geografskega informacijskega sistema ter prognostičnih obvestil. V letu 2015 je bil v celoti prenovljen sistem Prognostičnih obvestil, ki omogoča neposreden dostop do prognostičnih obvestil preko spletnega portala Agromet, preko elektronske pošte oziroma SMS sporočil. Pomemben del sistema prognoze škodljivih organizmov predstavljajo tudi različne oblike usposabljanj pridelovalcev kmetijskih rastlin v zvezi z upoštevanjem napovedi pojava škodljivih organizmov, prognostičnih obvestil ter odgovorne in pravilne uporabe fitofarmaceutskih sredstev.

ABSTRACT

The forecasting system of diseases and pests of plants as an important part of integrated pest management

In accordance with the provisions of the Plant Protection Products Act, integrated pest management means careful consideration of all available plant protection methods and integration of appropriate measures to prevent the development of organisms harmful to plants. The use of plant protection products must be on economically and ecologically acceptable level, with the aim of reducing risks to human health and the environment. For the decision on the appropriate plant protection measures are crucial data and findings from the monitoring of harmful organisms and threshold. In Slovenia, for more than fifteen years, forecasting plant protection service have been operating as part of public plant health service. It deals with the monitoring, observing and forecasting the occurrence of harmful organisms using meteorological, biological and other data. On this basis, it provides the optimum time for control of harmful organisms, informs growers and guides them to the appropriate protection measures to limit the spread of harmful organisms. Forecasting plant protection service is organized in five centers (Agricultural Institute of Slovenia, Institute for Hop Research and Brewing of Slovenia and CAFS - Agricultural and Forestry Institute Nova Gorica, Novo mesto and Maribor). For monitoring and forecasting activities, various tools are used, such as air spores traps, light traps, sex pheromone traps, sticky traps to the use of newer techniques such as remote sensing for monitoring. It also requires the various hardware, software and

other equipment, which allows measurement of various parameters, data collection and analysis and availability of data and measurements. Therefore, the forecasting for major harmful organisms of economic importance in viticulture, fruit production, hops production, olive production, agriculture and horticulture is carried out with the use of measurements within the agro-meteorological stations. The first such stations have been set up in Slovenia already in 1998. Stations are connected in the agrometeorological network, which ensures availability of information through a web portal (<http://agromet.mko.gov.si>). For data analysis also the data of the reference meteorological stations of the Environment Agency are used. In the agrometeorological network, 86 stations are included. New information technologies have enabled more accurate monitoring of harmful organisms using direct measurements from the stations, forecast models, geographic information systems and forecast notices. In 2015, the system of forecast information was fully renovated and now provides direct access to forecast information through the web portal Agromet, via e-mail or SMS messages. An important part of the forecasting of harmful organisms are various forms of training growers, how to take into the consideration early warnings, forecast information and on responsible and correct use of plant protection products.



Deciphering the plant microbiome to protect crops against stress

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Multiple challenges of climate change, reduced water supplies, and declining soil fertility in many regions of the world require new approaches to produce climate resilient crops. The plant microbiome was identified as a crucial factor for this resilience. All plants are meta-organisms or so called holo-bionts characterized by a close symbiotic relationship with their microbiome as well as a functional interplay of all organisms. One of the main functions of the plant microbiome of crops (oilseed rape, lettuce) and model plants (mosses), which was discovered by metagenomic approaches, is stress protection against biotic as well as abiotic stress. To identify the functional key players within these processes, we used a combination of different cultivation-dependent and independent methods. Examples for the selection of biocontrol agents (BCAs) against soil-borne pathogens, e.g. *Rhizoctonia solani* and *Verticillium dahliae*, and stress protection agents (SPAs) against drought stress will be presented and discussed. Furthermore, the global importance of next-generation bio-products for sustainable agriculture will be assessed.

ABSTRACT

Preučevanje rastlinskega mikrobioma za varovanje rastlin pred stresom

Podnebne spremembe, pomanjkanje vode in zmanjševanje rodovitnosti tal zahtevajo v mnogih delih sveta uvajanje novih pristopov pri vzgoji rastlin. Rastlinski mikrobiom ima pri tem pomembno vlogo, saj bistveno prispeva k odpornosti rastlin na stresne razmere. Rastline so meta-organizmi oz. holobionti, za katere velja simbiotski odnos njihovega mikrobioma z ostalimi organizmi v ekosistemu. Raziskave z uporabo metagenomskih orodij kažejo, da je ena od glavnih funkcij mikrobioma rastlin obramba pred biotičnim in abiotičnim stresom. Z namenom določanja ključnih organizmov v tem obrambnem procesu se uporabljajo različne tehnike določanja. V prispevku bo predstavljen zglede določanja in izkušnje z biotičnimi agensi (angl. biocontrol agents - BCA) za preprečevanje okužb s talnimi organizmi, kot sta *Rhizoctonia solani* in *Verticillium dahliae* ter zglede določanja protistresnih agensov (angl. stress protection agents - SPA) na modelu sušnega stresa. Predstavljena bo tudi ocena pomembnosti uporabe nove generacije biotičnih pripravkov v integrirani pridelavi rastlin.



Nacionalni akcijski program za doseganje trajnostne rabe FFS – Poročilo 2013-2015

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Evropska okoljska politika se je po letu 1970 hitro razvijala na osnovi razumevanja, kako je človek odvisen od zdravega okolja. V okviru Šestega okoljskega akcijskega programa Sveta in Parlamenta je Evropska Komisija v letih 2005 in 2006 sprejela 7 tematskih strategij, ki so bili osnova za vodenje okoljske politike in sprejemanje boljših predpisov za varovanje okolja v EU. Ena od teh strategi je Tematska strategija o trajnostni rabi pesticidov (druge pokrivajo kakovost zraka, morsko okolje, trajnostno rabo virov, ravnanje z odpadki in recikliranje, kakovost zemlje in urbano okolje). Cilji Tematske strategije o trajnostni rabi pesticidov so zmanjšanje tveganja za zdravje in okolje zaradi uporabe pesticidov, izboljšanje nadzora nad rabo in distribucijo pesticidov, zmanjšanje rabe najbolj nevarnih snovi in zamenjava z manj nevarnimi alternativami, vzpodbujanje pridelave z minimalno ali ničelno rabo pesticidov ter vzpostavitev transparentnega sistema poročanja in spremljanja napredka pri uresničevanju ciljev strategije. Strategiji je sledil 'pesticidni paket' zakonodaje: Uredba (EC) 1107/2009 o dajanju FFS v promet, Uredba EC 1185/2009 o statistiki pesticidov, Direktiva 2009/127/EC o zahtevah za nove naprave za nanašanje pesticidov in direktiva 2009/128/EC o določitvi okvira za ukrepe Skupnosti za doseganje trajnostne rabe pesticidov.

Uredba (EC) 1107/2009 o dajanju fitofarmacevtskih sredstev v promet in Direktiva 2009/128/EC o trajnostni rabi pesticidov sta prenešeni v slovenski pravni red z Zakonom o fitofarmacevtskih sredstvih (Uradni list RS, št. 83/12). Oba zakonodajna dokumenta povzemata cilje Tematske strategije o trajnostni rabi pesticidov. Uredba (EC) 1107/2009 zaostrojuje pogoje za odobritev snovi z uvedbo izločitvenih kriterijev za snovi z najbolj nevarnimi lastnostmi. Direktiva 2009/128/EC določa zakonski okvir za doseganje trajnostne rabe pesticidov. Z Nacionalnimi akcijskimi programi (NAP) so morale države članice določiti cilje, ukrepe in roke za zmanjšanje tveganj zaradi uporabe pesticidov za zdravje in okolje ter za vzpodbujanje razvoja alternativnih metod varstva rastlin, ki bi zmanjšale odvisnost kmetijstva od uporabe pesticidov. NAP so morale države članice poslati Komisiji do konca leta 2012. Slovenska Vlada je decembra 2012 sprejela NAP za področje fitofarmacevtskih sredstev, to je pesticidov, ki se uporabljajo v kmetijstvu. NAP vsebuje ukrepe na področju usposabljanja, prodaje FFS, osveščanja uporabnikov FFS, pregleda naprav za nanašanje FFS, prepovedi tretiranja iz zračnih plovil, informiranja javnosti, ukrepe za varovanje vodnega okolja in pitne vode ter posebnih območij, pravilnega skladiščenja in za ravnanje z odpadnimi FFS in embalažo, integriranega varstva rastlin in kazalcev tveganja. Za leta od 2013 do 2015 je bilo pripravljeno Poročilo o napredku, v katerem so povzeti podatki o aktivnostih, ukrepih in kazalcih tveganja glede prodaje in uporabe FFS, ostankov v hrani in vodi, usposabljanju, napravah za nanašanje FFS in zastrupitvah s FFS. To obdobje je prekratko za določitev statističnih trendov, je pa dobra osnova za primerjavo podatkov v naslednjih letih in revizijo NAP, ki se po zakonodaji opravi vsakih 5 let. Poročilo je na razpolago na spletnih straneh MKGP in UVHVVR.

V okviru Šestega okoljskega programa sprejeta zakonodaja je imela signifikanten vpliv na zmanjšanje onesnaževanja zraka, vode in zemlje v EU v preteklih desetletjih. S Sedmim okoljskim programom do leta 2020 pa bo Komisija skrbela za boljše izvajanje sprejete zakonodaje s cilji varstva in ohranjanja narave, razvijanja zelene ekonomije z učinkovito rabo virov in varovanja zdravja prebivalcev EU.

Vir: Spletne strani Evropske Komisije: <http://ec.europa.eu/environment/action-programme/>

ABSTRACT

The National Action Plan to achieve the sustainable use of pesticides (NAP) - Report 2013-2015

European environment policy has evolved significantly since the 1970s. It has given the EU a better understanding

of our dependence on a healthy environment. Under the Sixth Environment Action Programme adopted by the EU Council and the Parliament (6th EAP) the Commission adopted seven thematic strategies in 2005 and 2006. These were key mechanisms for environment policy making and adoption of better regulations for environment protection in the EU. One of these was the Thematic strategy on sustainable use of pesticides (others address air quality, the marine environment, the sustainable use of resources, waste prevention and recycling, soil quality and the urban environment). Its objectives were to minimise the hazards and risks to health and the environment resulting from the use of pesticides; to improve controls in the use and distribution of pesticides; to reduce the use of harmful substances and substitution with less harmful alternatives; to encourage low input or pesticide free cultivation and to establish a transparent system for reporting and monitoring the progress made in achieving the objectives of the Strategy. The 'pesticide package' legislation followed: Regulation (EC) 1107/2009 on placing PPP on the market, Regulation (EC) 1185/2009 on statistics of pesticides, Directive 127/2009/EC regarding the machinery for application and Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides.

Regulation (EC) 1107/2009 concerning placing PPP on the market and Directive 2009/128/EC on sustainable use of pesticides have been implemented in the RS by Act on plant protection products (UL RS 83/12). These two regulations address the objectives of the Thematic strategy on sustainable use of pesticides. Regulation (EC) 1107/2009 consists of approval criteria for active substances, which prevent certain substances with certain harmful properties from being approved. Directive 2009/128/EC established the legal framework for achieving a sustainable use of pesticides. Member States were obliged to design their National Action Plans (NAP) with goals, measures and timetables to reduce risks and impacts of pesticide use on human health and the environment; and the development of non-chemical alternatives in order to reduce dependency on the use of pesticides. Member States had to send their NAPs to the Commission by the end of 2012. The Slovenian Government adopted the Slovenian NAP in December 2012 for the field of plant protection products, which are agricultural pesticides. This NAP comprises the measures in training, requirements for sales of PPPs, awareness raising, inspection of equipment in use, aerial spraying, information to the public, measures to protect the aquatic environment, drinking water and specific areas, handling and storage, managing the packaging and remnants, integrated pest management and risk indicators. The report on the progress has been elaborated for the years 2013 – 2015. In the report the data on activities, measures and risk indicators concerning the sale and use of PPP, pesticide residues in food and water, training, PPP application equipment and poisoning incidents are gathered. Three-year period is too short for defining significant trends. However, the report is a good basis for comparing with the data in the following years and for the revision of the NAP, which has to be performed every 5 years. The report has been published on web pages of both Ministry of agriculture, forestry and food and the Administration of RS for food safety, veterinary and plant protection.

The legislation adopted within sixth EAP had a significant impact on reduction of air, water and soil pollution in the EU over the past decades. Seventh EAP will be guiding the EU environment policy until 2020 in terms of better implementation of the legislation, with goals to protect natural capital, to turn the EU into a resource-efficient, green, and competitive low-carbon economy and to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing.



Crop protection industry contribution to sustainable agriculture

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The Crop protection industry is committed to answer the challenges of the sustainable agriculture thanks to innovation and responsible use of crop protection solutions. Significant progress have been made regarding

product profile and advice during the use phase for a sustainable use; Current EU regulation driven by hazard-based (versus risk management) and precautionary principle is putting agriculture at risk in terms of competitiveness. Farmers and agri food-chain actors provide Europe with plentiful supply of safe, healthy and affordable food. Consumers, accustomed to the ready availability of food are often unaware of the enormous challenges facing agriculture. Food production will need to increase by around 70% to satisfy the demands of a population which is expected to grow by more than a third (2.3 billion more people) between 2009 and 2050.

The EU is a major contributor to global food security and a key player in efforts to reach the millennium goals on combating hunger. However, society's demands on agriculture don't stop at food-supply; the sector is expected to contribute to economic prosperity, support the social wellbeing of rural areas and help preserve natural resources including biodiversity. Crop protection products (pesticides) have a key role to play to reach those objectives, but they are perhaps one of the most misunderstood technologies used in modern agriculture. On many uses, there are currently no viable alternatives to chemical crop protection, and in spite of frequent misinformation, we need to remember that when the product is used correctly, pesticides offer safe and effective protection for both conventional and organic crops. The crop protection industry invests a close to 8% of sales in Europe in new product development. There is a constant drive to deliver better solutions on the market, these include: better profiles for chemical substances, biocontrol solutions, services including decision-making tools, new varieties for members involved in seed breeding and research. Significant achievements have been made. Today's chemical solutions are more targeted on the actual problem of pest, disease or weeds and are at the same time more environmentally and human friendly.

Policy makers should embrace science and innovation, and pursue smart policies that ensure appropriate balance between economic, social and environmental needs. These are timely considerations as the European Commission conducts fitness checks on important regulation, in particular those specific to the crop protection sector. The current regulation (EC) 1107/2009 is not working and innovation is at risk, limiting the farmer's toolbox and as a consequence crop productivity can decline, which will put EU competitiveness in danger. We are calling for an approach-based on benefit/risk analysis and considerations. In spite of this difficult context, the crop protection industry is committed to pursue the efforts regarding the promotion of good practices along the product life cycle and the Hungry for Change initiative involves many actors, including farmers, in the areas of food quality production, water, health and biodiversity protection.

Among the current running projects the **Container Management System** initiative is a key one: Empty containers for crop protection products can pose a significant source of waste, and even more can add to environmental contamination. In European countries where no official collection systems are established yet, industry along with private partners and authorities try to develop such a recycling scheme. Industry aims for more than 70% recollection rate all over Europe to establish a cleaning concept on farm level (triple rinsing). We all recognize the paramount importance of safeguarding human health and the environment, and the need for all parties to continue to work together to find safe, sustainable and effective solutions to pest problems. IPM (Integrated Pest management) implementation will contribute to that objective

IZVLEČEK

Prispevek fitofarmacevske industrije k trajnostnemu kmetijstvu

Fitofarmacevska industrija si z inovacijami in postopki varne rabe fitofarmacevskih sredstev (v nadaljevanju FFS) prizadeva ponuditi odgovore na izzive trajnostnega kmetijstva. Pri izboru in postopkih varne rabe je dosežen velik napredek. Obstoječi postopki registracije FFS v EU, ki temeljijo na oceni nevarnosti in previdnostnih predpostavkah namesto na oceni tveganja, predstavljajo velik izziv za konkurenčnost kmetijske pridelave. Kmetje in ostali člani živilske verige zagotavljajo EU potrebne količine zdrave in cenovno dostopne hrane. Potrošniki, navajeni na stalno dostopno hrano, se pogosto ne zavedajo velikih izzivov, ki jih to predstavlja za kmetijstvo. Pridelavo hrane bo potrebno povečati za okoli 70 %. Ocenjuje se, da se bo svetovno prebivalstvo med letoma 2009 in 2050 povečalo za več kot tretjino (za 2,3 milijarde).

EU pomembno prispeva k globalni prehranski varnosti in je ključni akter v prizadevanjih za doseg glavnega cilja tisočletja, to je izkoreninjenju lakote. Vendar pa družba od kmetijstva zahteva tudi prispevek h gospodarski in družbeni blaginji podeželja in sodelovanje pri ohranjanju naravnih virov, vključno z biotsko raznovrstnostjo.

FFS imajo ključno vlogo za doseg te ciljev pri tem, da so ena od najbolj napačno razumljenih tehnologij, ki se uporabljajo v sodobnem kmetijstvu. V mnogih primerih imamo na voljo le kemično varstvo rastlin in kljub pogostim napačnim informacijam, se moramo zavedati, da ustrezná uporaba FFS zagotavlja varno in učinkovito varstvo rastlin tako v konvencionalni kakor tudi v ekološki pridelavi. Fitofarmaceutska industrija v EU vlaga okoli 8 % svojih prihodkov v razvoj novih snovi. Stalno se iščejo nove in boljše rešitve: boljše kemijske snovi, snovi, ki ponujajo biološke rešitve, storitve in orodja za odločanje, nove varietete sort za člane, ki sodelujejo pri vzgoji semen in raziskavah. Sodobne kemične rešitve so bolj usmerjene v zatiranje škodljivcev, bolezni ali plevelov in so hkrati bolj prijazne ljudem in okolju. Nosilci političnih odločitev bi morali združiti znanost in inovacije, ki zagotavljajo ustrežno ravnovesje med ekonomskimi, socialnimi in okoljskimi potrebami. Te ugotovitve so pomembne ravno v času, ko EU komisija preverja ustreznosti veljavnih predpisov, zlasti tistih, ki so pomembni za varstvo rastlin.

Sedanja uredba (ES) 1107/2009 je pomanjkljiva. Ne podpira inovacij in omejuje pridelovalce, saj jim ne omogoča dostopa do potrebnih orodij. S tem vpliva na zmanjšanje produktivnosti in ogroža konkurenčnost evropskega kmetijstva. Pozivamo k spremembi tega predpisa, ki naj temelji na oceni tveganja in premisleku. Kljub velikim zahtevam, se je fitofarmaceutska industrija zavezala, da bo nadaljevala s spodbujanjem dobrih praks varstva rastlin znotraj celotnega življenjskega cikla izdelka. V okviru iniciative „Hungry for change - za spremembo lačni“ je združila veliko akterjev vključno s kmeti, na področju pridelave kakovostne hrane, varovanja voda, zdravlja ljudi in varovanja biotske raznovrstnosti.

Med tekočimi projekti velja projekt “Ravnanje z odpadno embalažo FFS” za ključnega. Prazne plastenke FFS predstavljajo pomemben vir odpadkov, ki lahko onesnažijo okolje. V državah članicah, kjer ni predpisan sistem zbiranja odpadne embalaže, poskuša industrija skupaj z zasebnimi partnerji in državnimi organi razviti sistem recikliranja teh odpadkov. Cilj industrije je zbrati vsaj 70 % odpadne, trikrat izprane embalaže FFS. Vsi se zavedamo pomena varovanja zdravlja ljudi in okolja ter nujnosti medsebojnega sodelovanja pri zagotavljanju varnih, trajnostnih in učinkovitih postopkov varstva rastlin. Uvajanje Integriranega varstva rastlin (IPM) bo prispevalo k temu cilju.



Fitofarmaceutska sredstva - včeraj, danes, jutri

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Prvi znani viri o uporabi fitofarmaceutskih sredstev (FFS) za zatiranje škodljivih organizmov so sumerski zapisi o uporabi žvepla za zatiranje pršic in žuželk iz 4500 p. n. št. Antični zapisi poročajo tudi o uporabi verskih in drugih obrednih običajev kakor tudi o uporabi kemijskih postopkov, predvsem dima, za zatiranje škodljivih organizmov. Že v antiki so v ta namen uporabljali tudi bordojsko brozgo. V srednjem veku so uporabljali arzen, živo srebro in srebro, pozneje tudi izvlečke listov tobaka in piretrin. Do 1940 so bila v uporabi anorganska FFS kot npr. natrijev klorat, žveplove kisline, organska FFS naravnega izvora ter FFS kot stranski produkt pri proizvodnji plinskega olja: nitrofenol, klorofenol, naftalen, amonijev sulfat, natrijev arzenat... Leto 1940 je bilo prelomno leto za proizvodnjo sintetičnih FFS z odkritjem delovanja DDT, aldrina, dieldrina, kaptana, klordana, parationa in 2,4 D. Uporaba FFS je bistveno pripomogla k višjim pridelkom in pridelavi kakovostne ter zdrave hrane. Imela pa je tudi neposreden vpliv na zdravje ljudi kot npr. na alergijske reakcije na toksine gliv in cvetnega prahu nekaterih plevelov. Izkoreninjena je bila smrtna bolezen ergotizem. Do sredine 20. stoletja se ljudje niso ozirali na škodljive učinke pesticidov. Po letu 1960 pa so začela prihajati prva opozorila o pomenu pravilne uporabe FFS. Pomen varne in odgovorne rabe FFS je postalo ključno vodilo proizvajalcev FFS. Za izboljšanje varnosti vlagajo danes proizvajalci FFS veliko napora in denarja v vseh državah članicah. V Sloveniji smo tako v zadnjih 10 letih vzpostavili sistem ravnanja z odpadno embalažo in ostanki FFS. V okviru projekta »Iniciativa varne rabe FFS« osveščamo uporabnike o varnih postopkih ravnanja s FFS. V okviru projekta TOPPS vzpodbujamo postopke ravnanja, s katerimi preprečujemo točkovno onesnaženje, površinsko razlivanje in zanašanje FFS.

Tudi postopek registracije FFS je sledil željam po varnosti FFS in njihovim vplivom na okolje in zdravje ljudi in

postajal čedalje zahtevnejši. Na ravni EU se je tako v zadnjih 25 letih število registriranih aktivnih snovi (AS) več kot prepolovilo. V EU je danes registriranih okoli 400 AS, v Sloveniji le 230. Trend zmanjševanja števila registracij se nadaljuje predvsem na račun določanja lastnosti hormonskih motilcev, vplivov na čebele in necljne organizme ter ostankov v pitni vodi. Po grobi oceni bi na ta račun v prihodnjih letih izgubili na EU ravni še najmanj 75 AS, v nevarnosti pa je celotna skupina insekticidov. Posebnost EU v primerjavi z drugimi deli sveta je v tem, da o registraciji AS namesto stroke čedalje bolj odloča politična javnost. Izgube registracij FFS so na ta račun nepredvidljive. Število novih AS, ki prihajajo na trg, ne sledi hitrosti izgube števila obstoječih snovi. Stroški razvoja nove AS znašajo cca. 280 mio €, razvoj pa traja več kot 11 let. Delež razvoja novih AS se je v EU v primerjavi z drugimi deli sveta v zadnjih 10 letih prepolovil. Razvoj in uvajanje biotičnih FFS ne bo moglo nadomesti izpada sintetičnih FFS. Od cca. 52 milijard €, kolikor je prodaja FFS na svetovnem trgu (od tega v članicah EU 9,6 milijard € v 2015), je obseg prodaje biotičnih FFS manj kot 4 %. Ocenjujemo, da je prihodnost sintetičnih FFS negotova, kakor je tudi negotova prihodnost varstva rastlin in zagotavljanje ustreznih količin hrane za naraščajoče svetovno prebivalstvo.

ABSTRACT

Plant protection products - yesterday, today and tomorrow

The first known resources on the use of plant protection products (PPP) for pest control are the Sumerian records on the use of sulphur for control of mites and insects from 4500 BC. Ancient records also report on the use of religious and other ritual practices as well as the use of chemical processes, especially smoke, for pest control. At that time, also the use of Bordeaux mixture was known. In the Middle Ages, they used arsenic, mercury and silver, later also extracts of tobacco leaves and pyrethrin. Up to 1940 inorganic PPP's were used like. sodium chlorate, sulfuric acid, organic pesticides of natural origin and PPP's as a by-product in the production of gas oil: nitrophenol, chlorophenol, naphthalene, ammonium sulphate, sodium arsenate... The year 1940 was a landmark year for the production of synthetic pesticides with the discovery of the functioning of DDT, aldrin, dieldrin, captan, chlordane, parathion and 2,4 D.

Using PPP's was a key contributor to higher yield and production of quality and healthy food. It also had a direct impact on human health, such as allergic reactions to toxins of fungi and pollen of some weeds. It eradicated the fatal disease ergotism. By the mid-20th century people were ignoring the harmful effects of pesticides. After 1960 first warnings about the importance of proper use of PPPs started to come. The importance of safe and responsible use of pesticides has become a key leading issue for manufacturers of PPP's. To improve the security, manufacturers of PPP's are starting to put a lot of efforts and money in all Member States. In Slovenia in the last 10 years a system of waste packaging management and a system of PPP's residues management were established. Within the framework of the ECPA (European crop protection association) project "«Safe use initiative» PPP's users are informed on safe working procedures by dealing with PPP. Also the ECPA project TOPPS is introduced in Slovenia- a project which is encouraging PPP's users to proper handling procedures, which prevent point contamination, surface leakage and drift of PPP's.

The procedure of registration of PPP has followed the wishes of the safety of pesticides and their impact on the environment and human health and becoming more and more demanding. At EU level in the last 25 years, the number of approved active substances (AS) have more than halved. Now there are only 400 AS registered, in Slovenia even only 230. The trend of decreasing the number of registrations continues - mainly due to the determination of endocrine disrupting effects, effects on bees and non-target organisms and residues in drinking water. By a rough estimation on this account we will lose in the coming years at the EU level at least 75. Beside this the entire group of insecticides is in danger of losing them. Specialty of EU in comparison with other parts of the world lies in the fact that the registration of AS instead of the scientific studies is increasingly determined by the political public. Losses of registrations of PPP's on this account are unpredictable. The number of new coming PPP's on the market does not follow the speed of losses of the existing substances. Cost for the development of a new AS is approx. 280 million €, development of an AS takes more than 11 years. The proportion of new AS development in the EU compared with other parts of the world in the last 10 years was halved. Development and introduction of biological pesticides will not be able to compensate the loss of synthetic pesticides. From about € 52 billion of sales of PPP's products on the world market (EU € 9.6 billion in 2015), the sales volume of bio-pesticides is less than 4%. We estimate that the future of synthetic pesticides is uncertain, as also the future of plant protection. Providing adequate quantities of food for a growing world population will be a challenge for the future.

Varstvo sadnega drevja in jagodičevja



Omejevanje širjenja vrtnega zavrtača (*Xyleborus dispar* [Fabricius 1792]) v jablanovih nasadih jugovzhodne Slovenije z alkoholnimi vabami

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Vrtni zavrtač (*Xyleborus dispar* [Fabricius, 1792]) spada v družino rilčkarjev (Curculionidae), ki napadajo širok spekter rastlinskih vrst, med njimi tudi sadne vrste. Ker vrtni zavrtač večino svojega življenjskega kroga preživi v rastlini, je njegovo zatiranje s znanimi metodami zelo oteženo. V ta namen smo v okviru dveletnega poskusa preučili možnost omejevanja njegovega širjenja z alkoholnimi vabami. Ocenjevali smo privabilnost dveh tipov barvnih vab, in sicer Rebell Roso in Rebell Amarillo, ter privabilnost prozornih Csalomon Palx vab. Kot privabilno smo pri barvnih ploščah uporabili 20 % raztopino etanola, pri vabah Csalomon Palx pa 20 % in 50 % raztopino etanola. Poskus je bil izveden na dveh lokacijah (Otočec in Dvor). Na vsako lokacijo smo postavili po 12 vab; na lokaciji Otočec po 6 rumenih in 6 rdečih vab, na Dvoru pa po 6 Csalomon Palx vab z 20 % raztopino etanola in 6 vab s 50 % raztopino etanola. V letu 2006 smo vabe postavili konec marca, leta 2007 pa v sredini marca. Največji ulovi so se začeli pojavljati v sredini aprila. Leta 2006 smo na obeh lokacijah zabeležili dva vrhova pojavljanja, leta 2007 pa samo na lokaciji Otočec. Ulov hroščev smo beležili vse do avgusta, kar pomeni, da je vrsta zaradi dolgotrajnosti pojava lahko zelo škodljiva. V poskusu smo potrdili, da rdeča barva lepljivih plošč bolj privablja hrošča kot rumena. Ravno tako je večjo privabilnost pokazal alkohol z večjo alkoholno raztopino.

ABSTRACT

Limiting the spread of the European shot-hole borer (*Xyleborus dispar* [Fabricius 1792]) in apple orchards in southeast Slovenia with ethanol-baited traps

The European shot-hole borer (*Xyleborus dispar* [Fabricius, 1792]) belongs to the family of Curculionidae, which can attack a wide range of plant species, including fruit species. Since the European shot-hole borer spends most of its life in a plant, it is very difficult to control it with known methods. In our two-year experiment, we have examined the possibility of restricting it by means of ethanol traps. We examined the acceptance of two types of coloured baits, i.e. Rebell Roso and Rebell Amarillo, and colourless Csalomon Palx baits. We used a 20 % ethanol solution in the coloured traps and 20 % and 50 % ethanol solutions in the Csalomon Palx traps. The experiment was carried out in two locations, Dvor and Otočec. We set 12 traps on each location. We placed 6 yellow and 6 red traps in Otočec and 6 Csalomon Palx lures with a 20 % ethanol solution as well as 6 baits with a 50 % ethanol solution in Dvor. We set the baits in the end of March 2006 and in the middle of March 2007. The highest catches occurred in the middle of April. We recorded two peaks of occurrence at both locations in 2006, whereas in 2007, this was noted only in Otočec. In this experiment, we confirmed that red sticky traps attracted a higher number of beetles than the yellow ones and that the higher percentage of alcohol was more attractive than the lower one.



Preizkušanje različnih načinov zatiranja plodove vinske mušice (*Drosophila suzukii*) z entomopatogenimi in talnimi glivami

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Varstvo plodove vinske mušice (PVM) *Drosophila suzukii* Matsumura (Diptera: Drosophilidae) je problematično, ker ima vrsta izjemen razmnoževalni potencial, je polifagna in ima ostro nazobčano leglico, s katero lahko predre povrhnjico zdravih plodov, v katere nato izleže jajčeca. Poleg tega se odrasle žerke lahko zabubijo v tleh, kjer so zavarovane pred insekticidi. Naša hipoteza je bila, da bodo entomopatogene (EPF) in talne glive različno vplivale na stopnjo izleganja muh iz bub PVM v okuženem substratu. Zato smo poleg klasičnih EPF (*Metarhizium brunneum* (izolata H.J.S. 1154 in 1868), *Beauveria bassiana* (2121 in 2122)), preskušali tudi talne glive, patogene za muhe (*Trichoderma atroviride* (1873) in *Clonostachys rosea* (1884)). Bube PVM smo tretirali z glivami v substratu okuženim s konidiji gliv in z neposrednim nanosom suspenzije gliv na bube. Nadalje smo domnevali, da bodo imele glive različen vpliv na različne razvojne stopnje škodljivca. Zato smo izbrane patogene glive preskusili tudi proti odraslim osebkom s pršilno aplikacijo. V nadaljevanju poskusov smo preverjali, če se lahko glivna okužba horizontalno prenaša. Preskusili smo tudi 'privabi in okuži' strategijo, kjer smo EPF nanесли na umetno hrano PVM. Gliva *M. brunneum* izolat 1154 je značilno zmanjšala izleganje bub PVM v okuženem substratu (za 15 %), bioinsekticid Naturalis (na osnovi *B. bassiana*) pa v poskusih neposredne izpostavitve bub (za 21 %). Več izolatov je značilno povišalo smrtnost muh po pršilni aplikaciji. Povprečni LT₅₀ za *M. brunneum* (1154) je bil 9.4 d, za *M. brunneum* (1868) 10.9 d, za *B. bassiana* (2121) 16.6 d, za Naturalis 24.6 d, za negativno kontrolo 29.2 d, in 0.9 d za bioinsekticid Laser (na osnovi spinosada). Opazili smo tudi osamljene primere horizontalnega prenosa okužbe. Ko smo muhe izpostavili EPF prek okužene umetne hrane PVM smo zabeležili še višjo virulenco. Povprečni LT₅₀ za *M. brunneum* (1154) je bil 4.5 d, za *M. brunneum* (1868) 5.6 d, za *B. bassiana* (2121) 2.2 d, in za negativno kontrolo 21.6 d. Zaključujemo, da so odrasli osebki bolj dovzetni za glivno okužbo kot bube. Menimo, da je razvojna stopnja bube PVM prekratka, da bi glive lahko močno vplivale na izleganje PVM. Visoka virulenca v poskusih neposrednega pršenja in 'privabi in okuži' obeta uporabljivost tovrstnih aplikacij EPF za zatiranje PVM, in nakazuje potrebo preskusa v poljskih poskusih.

ABSTRACT

Evaluation of different strategies employing entomopathogenic and soil fungi against spotted wing drosophila (*Drosophila suzukii*)

Spotted wing drosophila *Drosophila suzukii* Matsumura (Diptera: Drosophilidae) management is difficult mainly because of its short generation time, polyphagy and serrated ovipositor, but also because its larvae can pupate in the orchard soil and are thus protected from insecticide applications. Further, many insecticides are not allowed in organic fruit production and may be disruptive to beneficial agroecosystem services and human health, therefore new biocontrol solutions are sought for. We hypothesized that entomopathogenic and soil fungi (EPF) would express different pathogenicity against *Drosophila suzukii pupae* in soil environment. Hence, in addition to known entomopathogens (*Metarhizium brunneum* (isolates H.J.S. 1154 and 1868), *Beauveria bassiana* (2121 and 2122)), also soil fungi (*Trichoderma atroviride* (1873) and *Clonostachys rosea* (1884)), were tested against pupae in conidia-spiked soil and via direct conidial applications against pupae. Further, we hypothesized that different life stages of the pest would vary in their susceptibility to infection. Therefore, a selection of most pathogenic strains was also assessed against imagoes through direct spraying. Within these experiments also horizontal transmission of fungal infection was investigated. We also tested a potential attract and infect strategy, in which the flies were exposed to EPF growing on the *D. suzukii* artificial media. *M. brunneum* strain H.J.S. 1154 significantly reduced fly emergence in conidia spiked soil (by 15 %), and product Naturalis (based on *B. bassiana*, strain ATCC 74040) in direct pupal exposure tests (by 21 %). Several strains caused significant mortality in sprayed flies: The average LT₅₀ was 9.4 d for *M. brunneum* (1154), 10.9 d for *M. brunneum* (1868), 16.6 d for *B. bassiana* (2121), 24.6 d for Naturalis, 29.2 d for negative control, and 0.9 d for insecticide Laser (based on spinosad) treated flies. Horizontal transmission of fungal infection was observed, however it occurred rarely. The EPF-infected food caused even higher virulence than direct imago spraying: The average LT₅₀ was 4.5 d for *M. brunneum* (1154), 5.6 d for *M. brunneum* (1868), 2.2 d for *B. bassiana* (2121) and 21.6 d for negative control. We conclude that the imagoes were generally more susceptible to fungal infection than pupae. Most probably, the pupal stage is too brief to allow entomopathogens to cause a significant reduction of fly emergence. The high virulence obtained in direct spraying and attract and infect experiments shows promise in a potential EPF-based *D. suzukii* management strategy and will be further evaluated under field conditions.



Razvoj ameriškega kaparja (*Diaspidiotus perniciosus* [Comstock]) in njegova porazdelitev v nasadih jabolane

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Poznavanje razvoja ameriškega kaparja je ključnega pomena pri iskanju ustreznih rešitev za omejevanje njegovega gospodarskega pomena. Bionomijo smo preučevali v treh nasadih jabolane v štiriletnem obdobju med 2012 in 2015. Obravnavani nasadi so v treh različnih načinih pridelave: v ekstenzivni nasad, v intenzivni nasad v ekološki pridelavi in intenzivni nasad jabolane v integrirani pridelavi. Pri spremljanju razvoja smo izvajali periodične preglede ščitkov in beležili razvojne stopnje ličink in odraslih samic. Pojav samčkov smo ugotavljali z lovom na lepljive pasti s feromonskimi privabili. Za spremljanje populacijske dinamike smo se poslužili opisnega rangiranja različnih stopenj napada. Ugotovili smo, da ameriški kapar na območju JV Slovenije prezimi večinoma v stadiju 'črnega ščitka', a tudi v drugih stopnjah ličink. Ličinke prvega rodu se začnejo izlegati v zadnjih dneh maja in v začetku junija. Drugi rod je manj izrazit in se pojavlja od druge polovice julija dalje. V obdobju 2012-2015 se je pojavljal tudi tretji rod škodljivca. Različni rodovi se med rastno dobo večinoma prikrivajo. Hkrati smo z opisnim rangiranjem stopnje napada nasada ugotovili, da se populacija škodljive vrste žuželk v ekstenzivnem nasadu visokodebelnih jablan ne spreminja; medtem ko je po vnosu kaparja v nasad v ekološki pridelavi napad vztrajno napredoval. Po drugi strani smo v intenzivnem nasadu z integriranim načinom pridelave, pri opustitev varstva z insekticidom na osnovi aktivne snovi piriproksifen, zaznali hitro odražanje populacijskih sprememb. V vseh treh tipih nasadov smo sledili tudi parazitoidne vrste.

ABSTRACT

Development of San José Scale (*Diaspidiotus perniciosus* [Comstock]) and its distribution in apple orchards

Knowledge of the development of San José Scale is crucial in finding appropriate solutions to limit its economic importance. Bionomy was studied in three apple orchards during a four-year period between 2012 and 2015. The monitored plantations are in three different production systems: the extensive apple orchard, intensive apple orchard under organic production and intensive apple orchard under integrated plant management production. When monitoring the development, we conducted periodic inspections of the scales and recorded the development stages of larvae and adult females. The emergence of males was determined by trapping on the sticky trap with pheromone attractant. We used descriptive ranking to monitor the population dynamics. We found that San José Scale spends the winter in SE Slovenia mainly in the 'black cap' stage, but also in other stages of larvae preserve. First-generation larvae hatch in the last days of May and beginning of June. The second generation is less pronounced and occurs in the second half of July. In the period 2012-2015 the third generation developed. During the growing season generations usually overlap. At the same time we have demonstrated that in extensive plantation no changes in the population was detected; while after pest entry in organic orchard the attack promoted persistently. In the integrated pest management orchard San José Scale proliferated shortly after pyriproxyfen active substance based insecticide was terminated. In all three types of plantations San José Scale parasitoids were monitored.



Populacijska dinamika škržatka *Orietus ishidae* Matsumura v nasadih jablan v letih 2015 in 2016

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Vzhodnjaški škržatek (*Orietus ishidae* Matsumura 1902) je vzhodno palearktična vrsta, ki je bila v Evropi prvič zaznana v letu 2002. V Sloveniji je bila potrjena leta 2004, od takrat pa se nezadržno in hitro širi po nižinskem delu države. V nasadih jablan (Hoče, 46°30'21.29"N 15°37'35.26"E) in Ptujška Gora (46°21'17.94"N 15°45'47.51"E) smo ga v letih 2015 in 2016 sistematično spremljali z rumenimi lepljivimi vabami v obdobju od 1. maja do 30. septembra. Ulov na vabe kaže, da se odrasli škržatki začnejo pojavljati konec prvega tedna junija, da populacija doseže višek v drugem in tretjem tednu julija in da je konec pojava škržatkov v zadnjem tednu septembra. Sklepamo, da se izleganje iz prezimelih jajčec začne v sredini ali v zadnjem tednu maja. Glede na možne velike migracije škržatkov iz robnega rastlinstva (*Alnus*, *Betula*, *Salix*, *Rubus*, *Ailanthus*, *Carpinus*, *Corylus*, ...) ni bilo mogoče ugotoviti, kolikšen del škržatkov izvira iz jajčec, ki prezimijo na jablanah in kolikšen del se preseli iz robnega rastlinstva. Odlaganja jajčec na jablano v raziskavi nismo potrdili. Ugotavljamo, da je jablana zelo dober gostitelj japonskega škržatka, saj je na netretiranem drevju v juniju in juliju mogoče najti veliko nimf in ulovi odraslih osebkov so večkrat presegle šteto 30 na vabo na dan. Zaradi velikih populacij in podatkov iz literature, ki kažejo, da je potencialen prenašalec fitoplazm skupine 16SrV, ga je potrebno obravnavati tudi kot možnega prenašalca fitoplazme »*Candidatus Phytoplasma mali*« v nasadih jablan.

ABSTRACT

Population Dynamics of the Leafhopper *Orietus ishidae* Matsumura in Apple Orchards in Seasons 2015 and 2016

The mosaic leafhopper (*Orietus ishidae* Matsumura 1902) is an eastern Palaearctic species, recorded in Europe in 2002 for the first time. Its occurrence in Slovenia has been confirmed in 2004 and has been spreading rapidly in the lowlands across the country. During the seasons 2015 and 2016 its population dynamics was monitored from 1. May till 30. September in apple orchards at the locations Hoče (46°30'21.29"N 15°37'35.26"E) and Ptujška Gora (46°21'17.94"N 15°45'47.51"E) using yellow sticky traps. This monitoring has shown that first adults appear at the end of the first week of June, a peak of population is reached in the second and third week of July, and a total decline of population appears in the last week of September. We estimate that the hatching of larvae from the overwintered eggs starts in the middle or in the last week of May. Because of a possible large migration of adults from the boundary vegetation (*Alnus*, *Betula*, *Salix*, *Rubus*, *Ailanthus*, *Carpinus*, *Corylus*, ...) into apple plantations, an exact determination of proportions of adults deriving from eggs on apple trees and those being moved from the adjacent vegetation, was not possible. The oviposition on the apple trees was not confirmed in our study. We estimate that the apple is a good host for the mosaic leafhopper, since a large number of nymphs could be found feeding on trees left free without insecticide treatments in June and July. The number of adults caught per day exceeded the number of 30 per trap many times. Due to the large populations and data from the literature which suggest that the mosaic leafhopper is a potential vector of phytoplasmas of 16SrV group, it should also be considered as a possible vector of phytoplasma "*Candidatus Phytoplasma mali*" in apple orchards.



Črna figova muha - *Silba adipata* McAlpine zastopana tudi v Sloveniji

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Črna figova muha - *Silba adipata* McAlpine (Diptera, Lonchaeidae) postaja vedno bolj pomemben škodljivec fig. Razširjena je na območju Sredozemlja in Balkana, v državah Bližnjega vzhoda ter na skrajnem jugu Afrike. Pri nas smo jo prvič zaznali leta 2001 na območju Nove Gorice in Goriških Brd. Je, monofagna, multivoltilna vrsta, letno lahko razvije od 4 do 6 rodov. Samice običajno odlagajo jajčeca v še povsem nezrele plodove divjih ali gojenih sort fig (*Ficus carica* L.). Ličinke vrtajo rove v nezrelih plodovih, zaradi česar ti predčasno odpadajo. Pri napadu zorečih plodov nastaja škoda zaradi črvičnosti. Čeprav se črna figova muha v Sloveniji pojavlja že zadnjih 15 let, so podrobnosti o njenem razvojnem krogu in sezonski populacijski dinamiki v naših podnebni razmerah zelo slabo poznane. V zadnjih nekaj letih opažamo povečan pojav škodljivca in škodo na pridelku, zlasti pri drugem rodu fig. Predčasno odpadanje poškodovanih nezrelih plodov se pri nas pojavlja od sredine julija do sredine avgusta. Poškodbe zrelih plodov in črvičnost fig opažamo od začetka septembra naprej. Največ škode je doslej povzročila v Slovenski Istri, Goriških Brdih in Vipavski dolini na temno obarvanih sortah: 'Miljski figi', 'Kamberji' in 'Flazani'. Posamezne najdbe črne figove muhe so bile zabeležene tudi izven Primorske, v Beli Krajini, na Dolenjskem, v Posavju in na Štajerskem. V prispevku predstavljamo podatke o pojavu in razširjenosti črne figove muhe v Sloveniji. Opisujemo tudi morfološke in biološke značilnosti vrste ter poškodbe plodov in škodo na pridelku fig.

ABSTRACT

Mediterranean black fig fly, *Silba adipata* McAlpine present also in Slovenia

The black fig fly (BFF), *Silba adipata* McAlpine (Diptera: Lonchaeidae) is becoming increasingly important pest of figs. It is widespread in the Mediterranean area, in Balkans, in the Near Eastern countries and in the southernmost parts of Africa. In 2001, BFF was found for the first time in Slovenia, in the area of Nova Gorica and Goriška Brda. It is monophagous, multivoltine species with 4 to 6 generation per year. The females usually lay eggs in unripe fruits of wild and cultivated varieties of figs (*Ficus carica* L.). The larvae bore galleries inside of the fruits, which results in premature fruit drop. During the harvest season the damage is caused by the larvae feeding inside the fruits. Although the pest has been present in Slovenia for 15 years the life cycle and seasonal dynamics of BFF in the climate of Slovenia are still poorly known. In the last few years the population growth was noticed and also damage in fig production, especially on the second crop. Premature fruit drop occurs in the period from mid-July to the mid-August. Injuries and damage on mature fruits are visible from the beginning of September onwards. So far, the most serious damage has been recorded in the area of Slovenska Istra, Goriška Brda and Vipava Valley particularly on dark fig varieties: 'Miljska figa', 'Kamberji', 'Flazani'. Occasional occurrences of BFF have been also noticed outside Primorska region, in Bela Krajina, Dolenjska, Posavje and Štajerska region. The data on BFF occurrence and distribution in Slovenia will be presented in the paper. There will be also described morphological and biological characteristics of the species, fruit injuries and damage on fig fruits.



Strategija zatiranja bolšice *Cacopsylla melanoneura* Foer. za omejevanje razširjanja fitoplazme »Candidatus Phytoplasma mali« v nasadih jablan

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V nasadih jablan so bili izvedeni poljski poskusi v katerih smo preučevali učinkovitost insekticidov za zatiranje bolšice *Cacopsylla melanoneura* Foer. v 4 različnih fenoloških obdobjih (BBCH 04-05, 10-55, 55-58 in 65). Testirali

smo učinkovitost naslednjih aktivnih snovi: abamektin, acetamprid, etofenproks, fenoksikarb, flonikamid, flupiradifuron, fosmet, kalijeve soli maščobnih kislin, kaolin, klorpirifos, klorpirifos-metil, lambda-cihalotrin, naravni piretrini, ogrščično olje, parafinsko olje, rastlinski izločki, piriproksifen, spinosad, tau-fluvalinat in taikloprid. Na podlagi analize stopnje učinkovitosti insekticidov in njihovega odziva na vremenske razmere so predstavljene različne možne strategije uporabe v različnih obdobjih (februar – april) v nasadih z integrirano ali ekološko pridelavo jabolk.

ABSTRACT

A Strategy of psyllid *Cacopsylla melanoneura* Foer. control for the Prevention of a phytoplasma »Candidatus Phytoplasma mali « spread in Apple Orchards

Field trials were carried out at apple plantations to study the efficacy of insecticides applied at 4 different phenological growth stages of apples (BBCH 04-05, 10-55, 55-58 and 65) to control psyllid *Cacopsylla melanoneura* Foer. The following insecticide active substances were tested: abamectin, acetamprid, etofenprox, fenoxicarb, flonicamid, flupiradifuron, fosmet, potassium salts of fatty acids, kaolin clay, chlorpyrifos, chlorpyrifos-methyl, lambda-cihalotrin, natural piretrins, canola oil, paraffin oil, vegetable extracts, pyriproxyfen, spinosad, tau-fluvalinate and thiacloprid. Based on the analysis of the insecticide efficacy level and their responses to weather conditions, a variety of different psyllid control strategies has been developed for psyllid control in different phenological periods (February-April) in plantations with integrated or organic apple production.



Vpliv tehnologije pridelovanja jablan (*Malus domestica* Borkh.) na izgube pridelka povzročene od okužb s fitoplazmo 'Candidatus Phytoplasma mali'

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Pri drevesih jablan, sort 'Fuji', 'Braeburn', 'Gala', 'Elstar', 'Jonagold', 'Zlati delišes' in 'Idared', gojenih v posebej prirejenem poskusnem mrežniku na polju, smo v dveletnem poskusu preučevali vpliv intenzivnosti rezi, intenzivnosti gnojenja ter uporabe regulatorja rasti proheksadion-Ca na izražanje simptomov boleznih ter na izgube pridelka pri drevesih, okuženih s fitoplazmo povzročiteljico metličavosti jablan v primerjavi z neokuženimi drevesi. Skozi obdobje izvajanja poskusa smo drevesa opazovali in beležili delež metličavih poganjkov na drevo ter opravili meritve in ocenjevanja naslednjih parametrov: število socvetij na drevo, skupno število plodov na drevo, skupna masa plodov na drevo, delež plodov I. kakovostnega razreda, obarvanost plodov ter vsebnost sladkorja in kislin v plodovih. Zmanjšana intenzivnost rezi, manjše gnojenje z dušikom in uporaba rastnega regulatorja proheksadion-Ca so pri okuženih drevesih povzročili spremembe v preučevanih parametrih rodnosti in rasti. Odziv sort je bil različen, zato so preučevani dejavniki na posamezne parametre pri nekaterih sortah imeli statistično značilen vpliv, pri nekaterih pa ne. Zaključimo lahko, da s tem, ko spremenimo pridelavo na način, da se zmanjša intenzivnost rasti in uporabi rastni regulator ob nezmanjšanem gnojenju z dušikom, pri večini sort sicer lahko značilno povečamo pridelok, ne moremo pa značilno povečati kakovost plodov (deleža I. razreda). Največje izboljšanje kakovosti plodov lahko dosežemo pri sortah 'Jonagold' in 'Idared', med tem, ko pri ostalih, kakovosti ne moremo značilno izboljšati bodisi zaradi tega, ker po junijskem trebljenju na drevju ostane preveč plodov ali pa zaradi pomanjkanja barve. S prej omenjeno kombinacijo ukrepov lahko delno izboljšamo vsebnost tope suhe snovi in kislin plodov ter količino pridelka okuženih dreves, vendar ne v tolikšni meri, da bi zagotovili ekonomsko rentabilnost pridelave pri okuženih drevesih.

ABSTRACT

The influence of apple production technology (*Malus domestica* Borkh.) on yield loss caused by infection with phytoplasma 'Candidatus *Phytoplasma mali*'

Trees of the apple varieties 'Fuji', 'Braeburn', 'Gala', 'Elstar', 'Jonagold', 'Zlati delišes' and 'Idared' were grown in a special trial net house and a two-year study was carried out to observe the impact of the pruning intensity, intensity of fertilization and use of growth regulator proheksadion-Ca on the expression of symptoms of disease and also on the yield losses in trees which were infected with apple proliferation Phytoplasma (AP), in comparison with healthy uninfected trees. We had six different treatments according to the combination of studied factors (intensive or minimal pruning, normal or reduced fertilization, use of growth regulator – yes/no). During the period of the trial we have monitored and recorded the proportion of shoots showing typical AP symptoms (so called »witches brooms«) per tree and we also evaluated the following parameters: number of flower clusters per tree, total number of fruits per tree, total mass of fruits per tree, proportion of the fruits which are ranked as first class quality, coloring of the fruits, and content of the sugar and acids in the fruits. A reduced intensity of pruning and fertilization with the nitrogen and use of growth regulator proheksadion-Ca caused changes in infected trees in expression of disease symptoms and examined parameters of growth and fertility. The reactions of the individual varieties were different. In some of the studied varieties, the tested factors had a statistically distinctive influence, but not in other varieties. The conclusion is, that with the change of production system in the way that we reduced intensity of pruning and use growth regulator and standard fertilization with nitrogen, we can in the majority of varieties, significantly increase the yield. The biggest improvement of fruit quality can be achieved in the varieties 'Jonagold' and 'Idared'. We cannot distinctively improve the fruit quality in others studied varieties, and the reasons are twofold; either because of a limited natural fruit fall, the so called »June thinning«, where too many fruits remain on trees, or because of a lack of colour. With the before mentioned combination of production measures we can partly improve the fruit's content of soluble dry matter (sugars), acids and the yield on infected trees, but not to an extent where an economically profitable production on infected trees could be ensured.



Molekulska raznolikost izolatov fitoplazem 'Candidatus *Phytoplasma mali*' in 'Ca. *P. prunorum*' v Sloveniji

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Filogenetsko zelo sorodni fitoplazmi 'Candidatus *Phytoplasma mali*' in 'Ca. *P. prunorum*' povzročata ekonomsko pomembni bolezni sadnega drevja, metličavost jablan (AP) in leptonekrozo koščičarjev (ESFY). Rezultati raziskave kažejo, da je genska raznolikost obeh fitoplazem v Sloveniji zmerna. Na osnovi gena *aceF* lahko pri 'Ca. *P. mali*' razlikujemo pet genotipov, šest na osnovi gena *secY*, tri na osnovi *pnp* in sedem na osnovi gena *imp*. S sekvenčno večlokusno analizo smo pokazali, da je v Sloveniji prisotnih 16 različnih haplotipov. Pri 'Ca. *P. prunorum*' lahko razlikujemo štiri genotipe na osnovi gena *aceF*, dva na osnovi gena *secY*, enega na osnovi *pnp* in pet na osnovi *imp*. Za 'Ca. *P. prunorum*' smo našli sedem različnih haplotipov.

ABSTRACT

Molecular diversity of 'Candidatus *Phytoplasma mali*' and 'Ca. *P. prunorum*' isolates in Slovenia

Phylogenetically closely related phytoplasmas from the AP group 'Candidatus *Phytoplasma mali*' and 'Ca. *P. prunorum*' are the causal agents of economically important diseases of temperate fruit trees apple proliferation (AP) and European stone fruit yellows (ESFY), respectively. The results of this study demonstrate that in Slovenia

the genetic diversity of both phytoplasmas is moderate. Five different 'Ca. P. mali' genotypes can be distinguished based on the *aceF* gene, six genotypes based on the *secY* gene, three genotypes based on *pnp* and seven different genotypes based on the *imp* gene. Based on the multi locus sequence analysis 16 different haplotypes are present in Slovenia. For 'Ca. P. prunorum' four genotypes can be discriminated on the basis of the gene *aceF*, two on the basis of *secY*, one based on *pnp* and five based on *imp*. With a multilocus sequence analysis seven different haplotypes were found.



Možnosti obvladovanja sadnih gnilob pri breskvah in nektarinah – tudi z uporabo FFS

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V zadnjih letih sadna monilija (*Monilinia fructigena*) in plodova monilija (*Monilinia fructicola*) pridelovalcem breskev, nektarin in drugega koščičastega sadja povzročata večjo škodo in občuten izpad pridelka. Poleg tehničnih in tehnoloških rešitev (kapljično namakanje in ustrezna higiena v nasadih), ki bodo za uspešno obvladovanje gnilob nujne, težavo pri obvladovanju gnilob predstavlja tudi odpornost monilij na nekatere fungicide in premajhna učinkovitost registriranih fungicidov na sadne gnilobe. Z namenom ugotavljanja dejanske učinkovitosti FFS na sadno in plodovo monilijo, smo v letu 2016 izvedli škropilni poskus v nasadu breskev, kjer smo v prejšnjih letih zaznali močan pojav sadnih gnilob. Preizkušali smo nekatere registrirana FFS v Sloveniji in nekatera FFS, ki so za te namene registrirana v sosednjih državah. V prispevku so predstavljeni rezultati poskusa, njihova primerjava z podobnim poskusom v Italiji in strategija obvladovanja sadnih gnilob v nasadih breskev in nektarin v prihodnje.

ABSTRACT

Possibilities of controlling brown fruit rots on peaches and nectarines - also with the use of PPPs

In recent years, brown fruit rots (*Monilinia fructigena* and *Monilinia fructicola*) causes significant damage and significant crop failure on peaches, nectarines and other stone fruits. Beside technical and technological solutions (drip irrigation and appropriate hygiene measures in plantations) which will be necessary for successful controlling of brown rots, the main open question in the control of brown rots represents also resistance on some fungicides and lack of effectiveness of fungicides against brown rots. In order to evaluate the actual effectiveness of PPP, efficacy field trial against brown rots was conducted during 2016 in one peach orchard where we noticed powerful fruit rots infestation in previous years. We tested some fungicides approved in Slovenia and some fungicides approved for the control of brown fruit rots in neighbouring countries. The paper presents the results of the experiment, their comparison with similar attempts in Italy and strategy control of fruit rots in the peach and nectarine orchards in the future.



Vpliv mehaničnega odstranjevanja listja na zmanjšanje infekcijskega potenciala jablanovega škrlupa

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V letih 2015 in 2016 smo preizkušali mehanično metodo zmanjšanja infekcijskega potenciala jablanovega škrlupa. Primerjani so bili štiri postopki: metoda zgrabljanja listja izpod dreves z mulčenjem v kombinaciji z rednim škropljenjem in brez škropljenja, redno škropljenje brez odstranjevanja listja in neškropljeno brez odstranjevanja listja. V letu 2016 smo preizkusili metodo odstranjevanja listja še v kombinaciji s pripravkom Cuprablau Z 35 WP, s pripravkom Cuprablau Z 35 WP z dodatkom gnojila Urea ter pripravkom Cuprablau Z 35 WP, Urea in pripravkom Boom efekt. Pripravek Cuprablau Z 35 WP in gnojilo Urea sta bila tretirana foliarno, pripravek Boom efekt pa talno. Škropljenja so bila opravljena jeseni 2015. V letu 2015 je bila stopnja okužbe v kontroli - neškropljeno brez odstranjevanja listja; na listju 76,83 %, na plodovih 79,43%, v kontroli - neškropljeno z odstranjevanjem listja na listju; 27,08 %, na plodovih 34,03%. V postopku škropljeno z odstranjevanjem listja je bila stopnja okužbe na listju 0,12%, na plodovih 0,12%, v postopku škropljeno brez odstranjevanja listja na listju 4,18%, na plodovih 1,04%. V letu 2016 je bila stopnja okužbe na listju v postopku kontrola - neškropljeno z odstranjevanjem listja 28,2%, v postopku kontrola - neškropljeno brez odstranjevanja listja pa 57,4%. Najnižja stopnja okužbe je bila ugotovljena pri dveh postopkih: a) odstranjevanje listja v kombinaciji s pripravkom Cuprablau Z 35 WP - 0,3%; b) odstranjevanje listja v kombinaciji s pripravkom Cuprablau Z 35 WP, gnojilom Urea in pripravkom Boom Efekt - 0,59%.

ABSTRACT

Effect of mechanical leaf removal to reduce the infection potential of apple scab

In the years 2015 and 2016, we tested the mechanical method of reducing the infection potential of apple scab. The leaves were destroyed with interline sweeper and lawnmower mounted on the tractor. We compared the four methods: the method of mechanical destroying of the leaves in combination with spraying and no spraying, spraying without destroying the leaves and unsprayed control without destroying the leaves. In 2016 we tested method of mechanical destroying of the leaves in combination with the fungicide Cuprablau Z 35 WP and with the fungicide Cuprablau Z 35 WP with the addition of Urea fertilizer and fungicide Cuprablau Z 35 WP with addition of fertilizer Urea and herbicide Boom effect. In 2015, the level of infection in unsprayed control without destroying the leaves was on leaves 76.83% and on the fruits 79.43%. In unsprayed control with destroying the leaves, the level of infections on leaves was 27.08% and on fruits 34.03%. Level of infection on spraying with destroying the leaves was on the leaves 0.12% and on fruits 0.12%, in spraying without destroying the leaves was on leaves 4.18% and 1.04% on fruits. In 2016, the level of infection on the leaves in the unsprayed control with destroying the leaves was 28.2%, in unsprayed control without destroying the leaves was 57.4%. The lowest level of infection was observed in the following methods: a) destroying the leaves in combination with the fungicide Cuprablau Z 35 WP - 0.3%; b) destroying the leaves in combination with the fungicide Cuprablau Z 35 WP, Urea fertilizer and herbicide Boom effect - 0.59%.



Meritve hitrosti zraka in točnosti manometrov pri pršilnikih

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V letu 2016 smo na pršilnikih z aksialnimi ventilatorji in na pršilnikih z radialnimi ventilatorji izvedli meritve hitrosti zraka in točnosti manometrom. Za meritev hitrosti zraka smo uporabili merilno napravo Almemo 2290-2/3 in merilnik hitrosti vetra Schiltknecht. Točnost manometrov smo preverili z merilno napravo AAMS. Po opravljenih meritvah smo opravili smo v nasadu jablan opravili še škropljenje z aksialnim pršilnikom. Pozneje smo analize odtisov kapljic opravili na Inštitutu za hmeljarstvo in pivovarstvo Slovenije.

ABSTRACT

Measurements of air velocity and manometer accuracy by orchard sprayers

In 2016 the measurements of air velocity and manometer accuracy were performed by orchards sprayers with axial fans and with radial fans. Measuring device Almemo 2290-2/3 and air velocity tester Schiltknecht were used for air velocity measurements. Accuracy of manometers was measured with AAMS manometer tester. After the measurements were finished, spraying with orchard sprayer with axial fan was carried on in the apple orchard. Later on deposit analysis were made in Slovenian Institute of Hop Research and Brewing.

Varstvo vrtnin, okrasnih rastlin in oljk



Stopnja zmanjšanja okužb od povzročiteljev bolezni čebule pri uporabi EM™ mikrobnih pripravkov za krepitev rastlin

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V poljskem poskusu izvedenem v nasadu čebule sorte Ptujška rdeča smo opravili primerjavo med stopnjo zmanjšanja okužb od povzročiteljev bolezni (*Peronospora*, *Alternaria*, *Fusarium*, *Stemphylium*, *Botrytis*, *Erwinia* in *Burkholderia*) pri uporabi pripravkov EM™ (EM-5, EM-Ogrod in EM-Naturalny), ki temeljijo na združitvi mikrobov in rastlinskih izvlečkov in stopnjo zmanjšanja napada pri enem ekološkem škropilnem programu in treh integriranih škropilnih programih. Ekološki škropilni program je temeljil na uporabi kombinacij bakrovih pripravkov, fosfonatov, karbonatov in izvlečkov alg. Integrirani škropilni programi so temeljili na pogosti uporabi novejših konvencionalnih fungicidov. Škropilni programi, ki so temeljili zgolj na uporabi pripravkov EM™ so v primerjavi z neškropljeno kontrolo napad od povzročiteljev bolezni zmanjšali za 20 do 45 %, ekološki program za 50 do 90 % in integrirani programi za 70 do 96 %.

ABSTRACT

The Level of Onion Pathogen Attack Rate Reduction in the Application of EM™ Microbial-based Plant Strengtheners

The field experiment was carried out at a plantation of Ptujška rdeča onion. Comparisons on the level of reduction of pathogen attack rate (*Peronospora*, *Alternaria*, *Fusarium*, *Stemphylium*, *Botrytis*, *Erwinia* and *Burkholderia*) were carried out between three types of spray programs (EM, organic, integrated). The EM™ spray program was based on the application of plant strengtheners (EM-5, EM-Ogrod in EM-Naturalny), containing microbes and plant extracts. The organic spray program consisted of sprays of copper, phosphonate and carbonate fungicides combined with sea weed extracts. The plots with the integrated spray program were frequently sprayed with novel conventional fungicides. Spraying programs, which were based solely on the EM™ preparations, compared with the unsprayed control plots, reduced the pathogen attack rate by 20 to 45%, in the organic program for 50 to 90% and in the integrated spray programs for 80 to 96%.



Validacija in kalibracija modela Zwipero, za napovedovanje pojava čebulne plesni

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Čebulna plesen je ena od najpomembnejših bolezni rastlin v našem okolju. Čeprav redko uniči celoten pridelek, izredno zmanjša količino in kakovost pridelka. Ob prvem pojavu spor lahko pride do okužbe še isti dan, bolezenska znamenja pa se pojavijo po približno 11 dneh. Ob ugodnih vremenskih razmerah (temperatura, zračna vlaga, omočenost listov) si lahko sledi več zaporednih generacij, ki razmeroma hitro okužijo večje površine. Zato je pravočasno ukrepanje ključnega pomena. V skladu s principi integriranega varstva rastlin je za pravočasno aplikacijo fitofarmaceutskih sredstev priporočljivo uporabljati modelne napovedi pojavljanja škodljivcev. Model Zwipero uporablja dejanske in napovedne vremenske podatke za določanje nevarnosti sporulacije in infekcije glive *Peronospora destructor* pri čebuli. Osnovni podatki, ki jih model uporablja, so temperatura, zračna vlaga, močenost listov in padavine. Uporablja urne podatke pridobljene z vremenskih postaj in 3-dnevno vremensko

napoved. Ker slednja ne vključuje napovedi omočenosti listov, smo razvili tudi novo metodo za napovedovanje le-te z uporabo standardnih vremenskih podatkov (temperatura, zračna vlaga, padavine). Tako urejene podatke nato preračunamo na višino 20 cm nad tlemi. Program za izvajanje modela Zwipero se izvaja dnevno in je deljen na šest delov: (1) Prezem in urejanje vremenskih podatkov z agrometeoroloških postaj, (2) prevzem 3 dnevne vremenske napovedi in urejanje podatkov, (3) izračun zračne vlage in temperature na višini 20 cm, (4) izračun napovedi omočenosti listov, (5) izračun modelne napovedi, (6) posredovanje povzetka modelne napovedi preko elektronske pošte. Program tudi avtomatično nadzira kvaliteto vremenskih podatkov in po potrebi opravi osnovne popravke. V letu 2016 smo spremljali pojavljanje znakov bolezni na polju čebule pri Šentjakobu in te podatke uporabili za validacijo in kalibracijo modela Zwipero. Model je uspešno napovedal vse pojave sporulacij. V letu 2017 bomo nadaljevali z zbiranjem podatkov o pojavu bolezni, da lahko model Zwipero bolje kalibriramo na naše klimatske razmere.

ABSTRACT

Validation and calibration of Zwipero, a downy mildew forecast model

Downy mildew is one of the most dangerous plant diseases in our environment. Although it rarely destroys the entire crop, it can extremely reduce quantity and quality of the crop. At the first appearance of spores infection can occur the same day, and visible disease symptoms appear in approximately 11 days. With favorable weather conditions (temperature, humidity, and leaf wetness) several successive generations can mature and infect larger areas relatively quickly. Timely action is therefore imperative. In accordance with the principles of integrated pest management for the timely application of plant protection products it is recommended to use model forecasts for the occurrence of pests. The model Zwipero uses actual and predicted weather information for determining the risk of infection and sporulation of the fungus *Peronospora destructor* in onions. The basic data used by the model are temperature, humidity, leaf wetness, and precipitation. It uses hourly data obtained from weather stations and a 3-day forecast. Since the latter does not include projections of leaf wetness, we have also developed a new method for predicting the latter using standard meteorological data (temperature, humidity, precipitation). The weather data is then calculated to a height of 20 cm above the ground. The program for the implementation of the model Zwipero is performed daily and is divided into six components: (1) Acquisition and editing of weather data from agro-meteorological stations (2) acquisition of a 3-day weather forecast and editing of data, (3) calculate the humidity and temperature at 20 cm, (4) calculate forecasts of leaf wetness, (5) calculation of model predictions, (6) the provision of summary model forecasts via e-mail. The program also automatically controls the quality of weather data and, if necessary, makes basic adjustments. In 2016 we monitored for signs of disease in a onion field in Šentjakob, and used these data to validate and calibrate the model. The model has successfully predicted all sporulation events. In 2017, we will continue to collect data on the occurrence of downy mildew, in order to better calibrate the model to our climatic conditions.



Virus pegavosti in uvelosti paradižnika resno ogroža pridelavo vrtnin ter gojenje okrasnih rastlin v Sloveniji

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V okviru stalnega nadzora škodljivih organizmov, ki ga vrši fitosanitarna inšpekcija in javna služba zdravstvenega varstva rastlin pod vodstvom Uprave RS za varno hrano, veterinarstvo in varstvo rastlin, izvajamo na Nacionalnem inštitutu za biologijo laboratorijsko diagnostiko karantenskih in drugih škodljivih virusov na okrasnih rastlinah in vrtninah. Zadnja leta opažamo porast okužb zlasti z virusom pegavosti in uvelosti paradižnika (TSWV), za katerega je znano, da lahko okuži več kot 800 rastlinskih vrst. S TSWV je bilo leta 2015 okuženih kar 13 od

14 analiziranih vzorcev krizantem, štiri od petih analiziranih vzorcev pelargonij in štiri od šestih analiziranih vzorcev paradižnika. TSWV smo v zadnjih petih letih dokazali tudi na drugih okrasnih rastlinah (bršljanka, dalija, vodenka, marjetica) in na papriki. Virus na okuženih rastlinah povzroča bolezenska znamenja, ki jih lahko zamenjujemo z okužbami, ki jih povzročajo drugi virusi, ali pa tudi z okužbami, ki jih povzročajo bakterije ali glive. Slednje bo podrobno predstavljeno na posvetu, vključno z načini za preprečevanje širjenja okužb.

ABSTRACT

Tomato spotted wilt virus seriously threaten the cultivation of vegetables and ornamental plants in Slovenia

Diagnostic laboratory at the National Institute of Biology is performing laboratory testing of viruses on vegetables and ornamentals, in the frame of a monitoring of quarantine and harmful pathogens carried out by the Phytosanitary Administration and Phytosanitary Inspection Service of the Republic of Slovenia. During last few years most frequently found virus was *Tomato spotted wilt virus* (TSWV), which can infect more than 800 plant species. In 2015, TSWV has been confirmed in 13 out of 14 samples of chrysanthemum plants, in four out of five samples of pelargonium plants and in four out of six samples of tomato. During last five years, TSWV has been detected also in other ornamental plants (geranium, dahlia, impatiens, daisy) and in pepper. Symptoms of TSWV infected plants are very similar to symptoms caused by other viruses, bacteria and fungi. This will be the focus of our presentation, including the possibility of preventing the spread of infections.



Prepoznavanja vira sušnega stresa pri paradižniku z uporabo hiperspektralnega slikanja

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Podnebne spremembe lahko vodijo v izrazitejša sušna obdobja ter širjenje nekaterih talnih škodljivcev, kot so rastlinsko-parazitske ogorčice iz rodu *Meloidogyne*, na območja, ki so bila v preteklosti manj prizadeta. Sodobne gospodarske smernice zahtevajo konsistentno in kakovostno rastlinsko pridelavo, zato je stresna stanja, ki vodijo v izpad pridelka, potrebno čim hitreje odkriti ter obvladovati. Analiza spektralnih odtisov predstavlja možnost daljinskega zaznavanja sprememb pri opazovanih subjektih in ima tako visok potencial za uporabo v rastlinski proizvodnji. V lončnem poskusu smo testirali možnost zgodnjega prepoznavanja sušnega stresa in določanje njegovega izvora pri paradižnikih z uporabo hiperspektralnega slikanja. Rastline smo vzgojili v rastlinjaku pri nadzorovanih temperaturnih razmerah in jih razdelili v šest skupin, glede na vodni režim (optimalna preskrba z vodo / deficitarna preskrba z vodo) ter jakost začetne inokulacije z jajčeci ogorčic *Meloidogyne incognita* (brez / 15×103 jajčec / 250×103 jajčec). Za slikanje smo uporabili hiperspektralni kameri, ki zajemata signal v območju valovnih dolžin od 409 do 988 nm (VNIR – vidna in bližnje infrardeča svetloba) in 950 do 2509 nm (SWIR – kratkovalovna infrardeča svetloba). Rastline smo slikali v štirih terminih: 12, 21, 34 in 52 dni po inokulaciji. Za normalizacijo posnetkov in izračun odstotka odboja glede na vpadno svetlobo (reflektanca) smo uporabili referenčno ploščo z 20 % sivino. Z diskriminatno analizo po metodi delnih najmanjših kvadratov smo že pri prvem slikanju dosegli ~90 % zanesljivost modela za ločevanje med rastlinami v suši in zalivanimi rastlinami. Ta zanesljivost je narastla na več kot 97 % pri tretjem in četrtem slikanju. Podoben trend smo opazili pri določanju napadenih rastlin, kjer je zanesljivost pri zalivanih rastlinah narastla od 75 % do 85 %, pri rastlinah v suši pa od 65 % do 68 %. Z uporabo hiperspektralnega slikanja je torej možno razmeroma zanesljivo zgodnje odkrivanje sušnega stresa rastlin, ter določanje prisotnosti napada z ogorčicami.

ABSTRACT

Identification of drought stress origin in tomatoes using hyperspectral imaging

Climate change can lead to more pronounced droughts as well as the spread of some soil-borne pests, such as plant-parasitic nematodes of the genus *Meloidogyne* to areas that were previously unaffected. Current economic trends require consistent and high quality crop production; therefore stresses leading to reduction of crop yield should be quickly detected and controlled. Spectral analysis can be used as a remote sensing method to detect changes in the observed subjects and as such has a high potential for use in crop production. In pot experiment we tested the possibility of using hyperspectral imaging for early detection of drought stress, and determining its origin in tomatoes. The plants were cultivated in a greenhouse with regulated temperature and divided into six groups, depending on the used watering regime (well-watered / drought) and the intensity of the initial inoculation with the nematode *Meloidogyne incognita* (without / 15×103 eggs/ 250×103 eggs). For imaging we used two hyperspectral cameras, which record the spectral signal in the wavelength range 409 to 988 nm (VNIR - visible and near-infrared light) and 950 to 2509 nm (SWIR - shortwave infrared). Plants were scanned on four occasions: 12, 21, 34, and 52 days after inoculation. For image normalization and calculating reflectance we used a calibrated 20 % grey reference plate. Using Partial least squares discriminant analysis we achieved a ~90 % reliability at the first scanning session for the distinction between plants in drought and well-watered plants. This reliability rose to more than 97 % at the third and fourth scanning sessions. A similar trend was found in the determination of the parasitized plants, where among well-watered plants the reliability increased from 75 % to 85 %, and in the group of water deprived plants from 65 % to 68 %. Hyperspectral imaging enables reliable identification of the water status of plants, and determination whether these plants are parasitized by nematodes.



Stebelne ogorčice *Ditylenchus dipsaci* v pridelavi česna

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Ditylenchus dipsaci je migratorna endoparazitska ogorčica. Napad na gostiteljskih rastlinah lahko povzročijo vsi razvojni stadiji, razen jajčeca in četrto-stopenjske ličinke v anabiozi. Največja aktivnost in največja napadalna sposobnost (agresivnost) stebelnih ogorčic je med 10 in 20 °C. V rastlinskem tkivu gostiteljskih rastlin se lahko razvije več zaporednih generacij. V razvoju omenjene škodljive vrste je pomembna četrto-stopenjska ličinka, ki je v neugodnih življenjskih razmerah sposobna preiti v anabiozo. V odmirajočem rastlinskem tkivu se ogorčice združujejo in ko se tkivo izsuši oblikujejo tako imenovano jeguljičino volno. Na okuženem zemljišču škodljivo vrsto izjemno težko izkoreninimo, zato se lahko pričakuje napade na gostiteljskih rastlinah vsa nadaljnja leta. Zaradi tega je pridelava in sajenje zdravega sadilnega materiala velikega pomena in najučinkovitejši ukrep za preprečevanje širjenja. Znotraj vrste *D. dipsaci* je znanih več bio-ras, ki se razlikujejo po različnih naborih gostiteljskih rastlin. Različne bio-rase imajo tudi skupne gostitelje, nekatere pa so sposobne tudi medsebojnega križanja, zato je določanje bio-ras še vedno nezanesljivo. V splošnem velja, da je gostiteljski krog bio-rase *Alium* omejen na čebulo, česen, druge vrste čebulnic rodu *Alium*, fižol, grah, bob, sojo in peso. V letu 2016 smo v Sloveniji zaznali večjo pojavnost napadov stebelnih ogorčic pri pridelavi česna. Na to je imelo največji vpliv obdobje hladnejšega vremena v spomladanskem času. Močnejše napade s *D. dipsaci* smo zabeležili tudi v pridelavi semenskega česna.

ABSTRACT

Stem nematodes *Ditylenchus dipsaci* in garlic production

Ditylenchus dipsaci is migratory endoparasitic nematode. All developmental stages are able to infest host plant except eggs and fourth-stage-juveniles in anabiosis. Stem nematodes are the most active and aggressive between 10 and 20 °C. Within the plant host tissue they can develop several subsequent generations. Of a great importance is the fourth juvenile stage which can switch to anabiosis in case of unfavourable life conditions. These nematodes clump together in a cryptobiotic state to form “nematode wool” when the plant tissue begins to dry. This pest species is very difficult to eradicate from the infested field and infestations can be expected in forthcoming years. The most effective measure for prevention of spread is therefore planting of propagation material free from these pests. The species of *D. dipsaci* consists of several bio-races which differ in host range. However bio-race identification is difficult and unreliable to perform because of common hosts and, to some extent, the ability of crosses between some races. In general, host range of the bio-race *Alium* is limited to onions, garlic, some other plants from the genus *Alium*, beans, pea, faba and soya bean and beet. In 2016 we have detected higher number of *D. dipsaci* outbreaks in a garlic production in Slovenia. This was influenced by a long period of cold weather conditions in the springtime. Serious outbreaks were detected in garlic propagation material production as well.



Vzgoja kakovostnega razmnoževalnega materiala česna sorte Ptujski jesenski

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Ponudba česna lokalnih sort v Sloveniji ne zadostuje povpraševanju, še posebno pereča pa je slaba oskrba s kakovostnim razmnoževalnim materialom teh sort. V okviru ciljnega raziskovalnega projekta smo zato preizkušali različne tehnike vzgoje kakovostnega razmnoževalnega materiala česna sorte Ptujski jesenski. Laboratorijsko testiranje rastlin te sorte na navzočnost OYDV (*Onion yellow dwarf virus*), LYSV (*Leek yellow stripe virus*), GarCLV (*Garlic common latent virus*), SLV (*Shallot latent virus*), GarV-A (*Garlic virus A*), GarV-B (*Garlic virus B*), GarV-C (*Garlic virus C*) in ShVX (*Shallot virus X*) je pokazalo visoko stopnjo okuženosti dveh izvorov razmnoževalnega materiala. Za poskus vzgoje brezvirusnih rastlin sorte Ptujski jesenski smo uvedli in *in vitro* razmnoževanje te sorte iz meristemov. To tehniko smo kombinirali s termoterapijo in/ali kemoterapijo, vendar je bila učinkovitost eliminacije virusov kljub temu izredno nizka. Ti rezultati kažejo, da je za nadaljnje razmnoževanje ali eliminacijo virusov zelo pomembno, da izberemo rastline okužene s čim manj virusi, kar preverimo s primernimi detekcijskimi metodami. V okviru projekta smo primerjali učinkovitost ugotavljanja navzočnosti virusov s serološkimi in delno tudi molekularnimi metodami v strokih in v rastlinah vzgojenih iz iste glavice. Ugotovili smo, da so rezultati primerljivi, čeprav je določanje virusov nekoliko bolj zanesljivo v zelenih rastlinah. Naše raziskave kažejo tudi, da je za zgodnje preverjanje uspeha eliminacije OYDV, GarCLV in LYSV v tkivni kulturi nujna uporaba občutljivih molekularnih metod. Na osnovi teh rezultatov in pridobljenih izkušenj bomo izdelali shemo vzdrževalne selekcije za lokalne sorte česna.

ABSTRACT

Production of high quality propagation material of garlic variety Ptujski jesenski

Slovenian production of local garlic varieties does not meet the demand. The supply of high-quality and healthy propagating material is especially critical. Laboratory testing for the presence of OYDV (*Onion yellow dwarf virus*), LYSV (*Leek yellow stripe virus*), GarCLV (*Garlic common latent virus*), SLV (*Shallot latent virus*), GarV-A (*Garlic virus A*), GarV-B (*Garlic virus B*), GarV-C (*Garlic virus C*) and ShVX (*Shallot virus X*) showed high infection rate of plants raised from two batches of propagation material of local variety Ptujski jesenski. Meristem tip culture and *in vitro* multiplication of the variety Ptujski jesenski were introduced and combined with thermotherapy and/or chemotherapy in the attempt to produce virus-free material. Virus elimination rate was very low. The selection of material for *in vitro* propagation or elimination of viruses is therefore critical. Reliable sampling and sensitive detection techniques need to be used for selection of plants infected with as few viruses as possible. Detection of viruses in cloves was compared to the detection of viruses in plants raised from the same bulb using serological and in some cases also molecular techniques. The results were similar, although detection in plants proved to be somewhat more reliable. Our results also show that molecular methods need to be used for reliable early detection of OYDV, GarCLV and LYSV elimination success in *in vitro* plants. Based on our experience and project results maintenance selection system for the local varieties will be prepared.



Preučevanje kontaktnega delovanja izbranih okoljsko sprejemljivih snovi na lazarje (*Arion* spp., Gastropoda, Arionidae) v laboratorijskem poskusu

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V laboratorijskem poskusu smo preučevali učinkovitost delovanja izbranih okoljsko sprejemljivih snovi na zatiranje lazarjev in raziskali potencialne možnosti uporabe teh snovi za omejevanje njihovega škodljivega delovanja na gojenih rastlinah. V poskus smo vključili naslednje snovi: lesni pepel, hidrirano apno, sol, diatomejsko zemljo in žagovino. Njihov vpliv smo preučevali posamično ali v kombinaciji. Izvedli smo dva poskusa. Prvi je potekal v petrijevkah, drugi pa v velikih steklenih posodah (insektarijih). V petrijevkah smo lazarje najprej povaljali v pripravku in opazovali, katera snov najbolje učinkuje na njihovo smrtnost. Ob stiku s snovjo so se lazarji v trenutku skrčili in začeli močno izločati sluz. Tretiranega polža smo položili v petrijevko, ki je vsebovala list solate in vlažen tampon. Najvišjo stopnjo smrtnosti preučevanih polžev smo ugotovili pri uporabi hidriranega apna in soli, kjer so lazarji v trenutku poginili. Tudi v drugem poskusu, v katerem smo v sredino posode položili svež list solate in vlažen tampon, okrog pa posuli različne preučevane snovi, se je za najučinkovitejšo oviro lazarjem izkazalo hidrirano apno oziroma kombinacija hidriranega apna z drugimi snovmi.

ABSTRACT

Testing the efficacy of selected environmentally acceptable substances against slugs (*Arion* spp., Gastropoda, Arionidae) under laboratory conditions

Environmentally acceptable substances were tested in a laboratory experiment in order to investigate their application value for controlling slugs. We included in our investigation the following substances: wood ash, lime, salt, diatomaceous earth and sawdust. Their efficacy was studied individually and in combinations. We carried out two types of experiments. The first took place in Petri dishes, other in large glass containers (insectariums). In the petri dishes the slugs were initially rolled in the preparation and observed which substance have bigger impact on their mortality. After the contact with the substance slugs started to shrink significantly and to secrete mucus.

Treated slugs were then placed in a petri dish containing a leaf of lettuce and a wet tampon. The highest rate of slug mortality was observed at the use of hydrated lime and salt, where slugs immediately died. In the second experiment, the experimental design consists of a fresh leaf of lettuce in the middle of the glass container and a wet tampon. Around the lettuce leaf we scattered various substances studied in our investigation. Our investigation showed that the most effective barrier for slugs were hydrated lime or hydrated lime in the combination with other substances.



Red palm weevil *Rhynchophorus ferrugineus* Olivier devastating pest of palms in Montenegro

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Red palm weevil *Rhynchophorus ferrugineus* Olivier is originated from in southeastern Asia. It is a notorious pest of palms in all areas where it has established. The main palm affected is the canary date palm (*Phoenix canariensis*) and date palm (*Phoenix dactylifera*). International trade of palm trees resulted in the rapid spreading of this pest from its native range westward. Its introduction into the Mediterranean area was in the 1990s and first detection in Europe in Spain in 1994. Since then it has spread to many European countries. The pest is regulated within the EU. Infested palms are hard to detect since the larvae feed on the internal tissues. They penetrate the crown and boring tunnels inside the bases of leaves and trunk. During feeding larvae, destroy the apical growth area. Infestations are usually detected after the palm tree has been seriously damaged. At high infestation levels symptoms resembling drought stress are common, although the most typical is “umbrella-like” damage which usually indicates death of infested palm. *R. ferrugineus* was detected for the first time in Montenegro in October 2012 on canary date palm. The “umbrella-like” symptom and symptoms resembling drought stress were found in hotel complex in coastal area of the city Ulcinj. Until October 2014 the pest was restricted only in this area when the first signs of spreading was noticed and pest found in area of the city Budva. Spreading was continued in the following years and in 2016 *R. ferrugineus* was registered along the whole seacoast. All infested palms in Montenegro are *Ph. canariensis*, except one *Trachycarpus fortunei* found in the city of Ulcinj in August 2016. Presence and spreading of the pest along Montenegro seacoast resulted in devastation and death of many palms and extreme changing of our traditional urban landscape. Up to November 2016 around 100 canary date palm have been eradicated. Aggregation pheromone Rhy lure 400 is used for monitoring.



Oljni molj *Prays oleae* (Bern.) - pojav škodljivca in škoda v Slovenski Istri

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Oljni molj (*Prays oleae*) je pomembnejši škodljivec oljk. V posameznih letih lahko povzroča večjo škodo in izpad pridelka. V letu 2016 je povzročil največjo škodo v zadnjih dvajsetih letih na območju Slovenske Istre. V oljčniku Nad Lamo pri Dekanih smo spremljali ulov škodljivca na feromonski vabi in primerjali izpad pridelka zaradi

škodljivca v letih 2015 in 2016. V letu 2015 je bil izpad pridelka oljk sorte 'Istrska belica' zaradi oljčnega molja 1% v letu 2016 pa kar 13%. Proučevali smo poškodovanost plodov zaradi oljčnega molja na 14 lokacijah v obdobju med 2011 in 2016 na sorti 'Istrska belica', ki je zelo občutljiva na škodljivca. Povprečna letna poškodovanost plodov na vseh lokacijah v omenjenem obdobju je bila 11,8%. Najmanjša povprečna poškodovanost je bila 5,7% leta 2011 in največja 19,8 % leta 2013. V prispevku je podan opis in načini varstva pred škodljivcem.

ABSTRACT

Olive moth *Prays oleae* (Bern.) - the occurrence of the pest and damage it cause in Slovenian Istria

Olive moth *Prays oleae* (Bern.) is an important pest of olives in Slovenian Istria. In some years, it can cause significant damage and yield loss. In 2016 it caused the greatest damage in the last twenty years. In the 2015 and 2016, we compared the observed flight of the olive moth on the pheromone traps and studied the quantity of dropped olives due to olive moth in the olive orchard Nad Lamo on cultivar 'Istrska belica'. In 2015, we found 1% yield loss, while in 2016 it was even 13%. We also studied the damage of olives at 14 locations in the period between 2011 and 2016 on a cultivar 'Istrska belica', which is very susceptible to this pest. The average annual damage of fruits at all locations in this period was 11.8%. Minimum average damage was 5.7% in 2011 and a maximum 19.8% in 2013. A description of olive moth is given and possible plant protection measures.



Vpliv napada oljčne muhe *Bactrocera oleae* (Rossi) na vsebnost in sestavo biofenolov oljčnega olja

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Samica oljčne muhe *Bactrocera oleae* odloži v plod oljke jajčece, iz katerega se izleže ličinka. Ličinka se hrani z vrtnjem mesnatega dela plodu, kar vodi v nastanek mehanskih poškodb rastlinskega tkiva. Samička z vbodom v plod oljke omogoči tudi nastanek sekundarne bakterijske in glivične okužbe, ki povzročajo gnitje plodov in občutno zmanjšanje količine in kakovosti pridelka. Izjemno vlažne in relativno hladne vremenske razmere v rastni sezoni 2014 so močno vplivale na razvoj oljčne muhe, ki je povzročila veliko gospodarsko škodo v Slovenskih oljčnikih. Z namenom, da bi ocenili vpliv poškodovanosti plodov zaradi oljčne muhe na vsebnost in sestavo biofenolov v predelanem oljčnem olju smo izvedli terensko in laboratorijsko raziskavo. Na terenu smo na različnih lokacijah Slovenske Istre opravili vzorčenje plodov sorte 'Istrska belica', pri katerih smo zabeležili različno stopnjo napadenosti plodov z oljčno muho. Vzorce plodov posamezne lokacije smo razdelili v dva podvzorca, in sicer na plodove z aktivno napadenostjo, ki smo jo definirali z vbodom samičke in na plodov z škodljivo napadenostjo, ki smo jo definirali z izhodno odprtino. Podvzorce smo predelali v olja in določili vsebnost in sestavo biofenolov. Ugotovili smo, da imajo olja, predelana iz plodov z aktivno napadenostjo največjo povprečno vsebnost biofenolov oleuropeinskega izvora (379 mg/kg), ligstrozidnega izvora (285 mg/kg) in skupnih biofenolov (770 mg/kg), medtem ko so vsebnosti obravnavanih spojin znatno manjše v vzorcih, predelanih plodov s škodljivo napadenostjo (106 mg/kg biofenolov oleuropeinskega izvora, 215 mg/kg biofenolov ligstrozidnega izvora in 363 mg/kg skupnih biofenolov).

ABSTRACT

Effect of olive fruit fly *Bactrocera oleae* (Rossi) infestation on the biophenol content and composition of olive oil

The olive fruit fly *Bactrocera oleae* damages olive by laying eggs under the skin of ripening fruits. After hatching, larvae feed on the fruit's mesocarp, causing mechanical destruction of plant tissues. Furthermore, oviposition provides entry of secondary infestation of bacteria and fungi that rot the fruit and seriously lower the quantity and quality of olive oil. In 2014, the extremely humid and relatively chill weather conditions during the growing season favoured the development of the olive fruit fly, which caused serious economic damage to Slovenian's olive orchards. In order to evaluate the effect of olive-fly-damaged fruit on the biophenol content and composition of olive oil, a field and laboratory study was carried out. Olive samples with various level of infestation of the variety 'Istrska belica' were collected from ten different locations in Slovene Istria. The fruit samples of each location were classified in two subsamples (the fruit with damage infestation determined by emergence holes and fruit with active infestation determined by olive fruit fly puncture) and olive oils were produced. In the subsamples of olive oils the biophenol content and composition were determined. Oils produced from fruits with active infestation showed the highest average amount of oleuropein derivatives, ligstroside derivatives and total biophenols (379 mg/kg, 285 mg/kg and 770 mg/kg, respectively), while the lowest average amounts (106 mg/kg, 215 mg/kg and 363 mg/kg, respectively) were determined in oils produced from fruits with damage infestation.



Nove najdbe *Xylella fastidiosa* v Evropi in ciljni raziskovalni projekt V4-1603 XylVec

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Bakterija *Xylella fastidiosa* (Wells & Raju) je rastlinski patogen, ki povzroča nevarne bolezni velikega števila rastlin. Najbolj znani sta Piercova bolezen vinske trte, ki je razširjena v nekaterih delih ZDA in šarasta bledica agrumov, ki povzroča največ škode v Južni Ameriki. Bakterija se uspešno prenaša z okuženim sadilnim materialom in žuželčimi prenašalci. V EU je bakterija uvrščena med karantenske škodljive organizme. V jeseni 2013 je bila prvič potrjena v Evropi, v italijanski pokrajini Apuliji v provinci Lecce, kjer še danes povzroča obsežno propadanje mladih in starih oljk. Kmalu se je pokazalo, da lahko različek *X. fastidiosa*, ki je razširjen v Italiji, okuži številne gostiteljske rastline in še danes odkrivajo nove. Do sedaj so bakterijo na območju EU našli tudi na ozemlju Francije, Nemčije in Španije. V prispevku bomo predstavili nove najdbe in nova spoznanja o pojavljanju *X. fastidiosa* v Evropi ter naše aktivnosti v okviru ciljnega raziskovalnega projekta V4-1603, XylVec, ki se je začel v letu 2016. Aktivnosti triletnega projekta vključujejo: (i) laboratorijsko detekcijo, (ii) proučevanje dejanskih in potencialnih vektorjev s poudarkom na območjih z visokim tveganjem, (iii) gostiteljske rastline, (iv) obveščanje in osveščanje javnosti in (v) pripravo strokovnih podlag za ravnanje v primeru izbruha bolezni povzročene s *X. fastidiosa*.

ABSTRACT

New findings of *Xylella fastidiosa* in Europe and activities within XylVec, a targeted research project (V4-1603)

The bacterium *Xylella fastidiosa* (Wells & Raju) is a plant pathogen that causes serious diseases of a large number of plant species. Best known are Pierce's disease of grapevine, which is widespread in some parts of the US, and citrus variegated chlorosis limiting citrus production in South America. The bacterium is spread through infected planting material and insect vectors. In the EU, the bacterium is classified as a quarantine pest. It was found in Europe for the first time in autumn 2013, in Italian province of Lecce in the Puglia region where it is still causing an extensive olive quick decline, affecting both young and old trees. Soon it became clear that the variant of *X. fastidiosa* present in Italy can infect many other host plants and even today, new hosts are being discovered. Until now, the bacterium has been reported also from other EU countries, France, Germany and Spain. In this contribution we present new findings and new knowledge on the occurrence of *X. fastidiosa* in Europe and our activities within a new targeted research project, XylVec (V4-1603) which began in 2016. Studies and activities of the three-year project include: (i) laboratory detection, (ii) the analysis of known and potential vectors with focus on high-risk areas, (iii) host plants, (iv) increasing public awareness, and (v) preparation of expert groundwork for dealing with a potential outbreak of disease caused by *X. fastidiosa*.



Silicon – beneficial element supporting plants in stress conditions

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The interest on role of silicon (Si) in plant cultivation has been for many years. The positive response of plants to Si application was found, mostly on improvement of plant tolerance to abiotic and biotic stress conditions such drought, extreme temperature of air, fungal infections etc. However, although total Si average concentration in soils is very high (range from 1% up to 50%), its plant availability is very limited. Thus, Si application to plants is recommended for stimulation of certain processes which results in significant plant productivity improvement. Silicon has been tested as foliar applied for numerous crops for many years in a form of OptySil – plant available formula containing 93 g of Si/L. In presented studies, the effect of OptySil on plant root development, growth and yield of selected crops are shown. Application of 45–90 g Si / ha resulted in significant increase of plant tolerance to fungal infection and ranged from 15% to 40%. In addition, it has been found that Si application to plants has a positive effect on root growth development, as shown for corn plants. The mechanism of Si activity is discussed. New results confirm previous studies and show that Si significantly increases the tolerance of plants to stress growing conditions as shown for tomato a cucumber plants. That could explain significant yield increase of plants treated with Si, which brings to farmers and growers considerable high added value to their crops.

IZVLEČEK

Silicij – koristno hranilo za podporo rastlinam v stresnih razmerah

Zanimanje za preučevanje vloge silicija (Si) pri gojenju rastlin traja že vrsto let. Pozitivni odzivi rastlin po aplikacijah Si kot gnojila so običajno izraženi kot izboljšanje tolerantnosti rastlin proti biotičnemu in abiotičnemu stresu, ki ga povzročijo suša, ekstremne temperature zraka, glivične okužbe itd. Kljub temu, da je skupna povprečna koncentracija Si v tleh zelo visoka (v razponu od 1 % do 50 %), je njegova razpoložljivost rastlinam zelo omejena. Aplikacija Si je zato priporočljiva za spodbujanje določenih fizioloških procesov, kar ima za posledico znatno izboljšanje produktivnosti rastlin. Silicij je bil veliko let testiran kot foliarno gnojilo v rastlinam

dostopni formulacijski obliki OptySil, ki vsebuje 93 g Si/L. V predstavljenih študijah so prikazani učinki pripravka OptySil na razvoj rastlinskih korenin, rast in pridelek izbranih poljščin. Uporaba 45-90 g Si / ha ima za posledico znatno povečanje tolerance rastlin proti glivičnim okužbam, obseg tolerantnosti se poveča za 15% do 40%. Prav tako je bilo ugotovljeno, da ima aplikacija Si pozitiven učinek na razvoj in rast korenin, kot je bilo demonstrirano na primeru rastlin koruze. Predstavljamo mehanizem delovanja Si. Novi rezultati potrjujejo prejšnje študije, in kažejo, da Si znatno poveča tolerantnost rastlin na stresne rastne razmere, kot je prikazano na primeru rastlin paradižnika in kumar. S tem pojasnujemo znatno povečanje pridelka rastlin, ki so bile tretirane s Si, ki prinaša za kmete in pridelovalce precej visoko dodano vrednost njihovim pridelkom.



Varstvo poljščin in krmnih rastlin



Sezonska dinamika navadne tenčičarice (*Chrysoperla carnea*) in žitnih uši (*Aphididae*) na njivi z jaro pšenico

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V letu 2013 smo na njivi z jaro pšenico na Laboratorijskem polju Biotehniške fakultete v Ljubljani postavili tri vabe s sintetičnim atraktantom z namenom privabljanja samic navadne tenčičarice, da bi na črnih blazinicah odlagale jajčeca. Vabe smo postavili v začetku aprila. Jajčeca smo šteli na vabah od zadnje dekade maja do prve dekade avgusta, na treh oddaljenostih od vab (1, 3 in 5 m) pa smo na jari pšenici šteli še krilate in nekrilate osebe listnih uši in ušje mumije. Kapsule s sintetičnim atraktantom smo menjavali v mesečnih intervalih, jajčeca navadne tenčičarice pa smo šteli v 7-10 dnevni intervalih. Ugotovili smo, da so se jajčeca navadne tenčičarice na vabah pojavljala od zadnje dekade maja (21. maj) do prve dekade avgusta (7. avgust), ko smo pšenico poželi. Največjo številčnost jajčec smo zabeležili v prvi dekadi julija (2. julija), ko smo v povprečju na vabo našli več kot 65 jajčec. Na jari pšenici smo našli malo jajčec preučevanega plenilca. Ugotavljamo, da so se nekrilate uši na jari pšenici številčno pojavljale do sredine junija, nato pa so na tej vrsti žita prevladovali krilate uši. Povprečno število ušjih mumij na rastlino se je povečevalo z oddaljenostjo od vabe, največ smo jih v povprečju (eno/rastlino) ugotovili konec junija.

ABSTRACT

Seasonal dynamics of common green lacewing (*Chrysoperla carnea*) and cereal aphids (*Aphididae*) in the field with spring wheat

In 2013, three traps with synthetic lure were placed in the field with spring wheat at the Laboratory Field of Biotechnical faculty in Ljubljana, with intention to allure common lacewing females which deposited eggs on the black scent bags. We have placed lures at the field in beginning of April. We have counted eggs on traps from the last 10-day period of May until the first 10-day period of August, while in spring wheat in 3 different distances from the traps (1, 3 and 5 m away) we have counted the winged and non-winged aphids as well as the mummies parasitised by aphid parasitoids. Capsules with synthetical attractant, the main part of the traps, were changed in monthly intervals, while the eggs on the black scent bags and the wooden bearers, on which the traps were attached, were counted in 7-10 day intervals. We have detected that the eggs of the common green lacewing occurred on the traps from last ten days of May (21st May) until first ten days of August, when wheat was harvested. The highest peak of common lace wing eggs per lure was establishes in first ten days of July (2nd July), when we have counted 65 of eggs per lure. In spring wheat, only few predator's egg were found. We can say that non-winged aphids were numerous until middle of June, afterwards winged aphids prevailed. Average number of mummies parasitised by aphid parasitoids increased with the distance from the traps, however the highest number of mummies (one mummy/plant) was recorded at the end of June.



Zmanjševanje populacije koruznega hrošča (*Diabrotica virgifera virgifera*) (Coleoptera: Chrysomelidae) z metodo zbeganja

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Koruzni hrošč (Dvv), *Diabrotica virgifera virgifera* (Coleoptera: Chrysomelidae) je pomemben škodljivec koruze, ki je prisoten tako v Severni Ameriki kot tudi v Evropi. Njegove ličinke, katere so prisotne v tleh, lahko močno poškodujejo korenine koruze (*Zea mays*) in posledično povzročijo izgubo pridelka. Velika populacija Dvv predstavlja potencialno nevarnost za zmanjševanje pridelka na mnogih gostiteljskih rastlinah, še posebno na koruzi, tako v Sloveniji kot tudi v ostalih evropskih državah. Obvladovanje omenjene škodljive vrste je pomembna tema mnogih raziskovalcev po svetu. Raziskovalci ponujajo znanje na področju interakcij med rastlino in škodljivcem (Dvv), vrednotenja naravnih sovražnikov in njegovo obvladovanje z biotehničnimi metodami. Obvezen ukrep za eradikacijo ali zmanjševanje populacije Dvv je prepoved gojenja koruze v monokulturi. V poskusu, katerega smo izvajali v letih 2015 in 2016 na njivah v Draži vasi pri Slovenskih Konjicah (na cca. 10 ha), kjer je bila populacija odraslih hroščev Dvv zelo visoka, smo testirali metodo zbejanja. Pri metodi zbejanja, kjer smo v letu 2015 uporabili feromon 8-metil- 2 dekanolpropanoat, smo zaznali manjše število oplojenih samic (spermateke so bile prazne v 58 % deležu). Ugotovili smo, da so samičke po metodi zbejanja odložile v tla manj jajčec, posledično so bile korenine koruze v naslednjem letu do 23 % manj poškodovane. V letu uporabe metode zbejanja smo opazili tudi manjšo objedenost koruznih laskov (svile). Populacija Dvv je na koruznih njivah v Sloveniji zelo velika, zato je priporočljivo neprekinjeno izvajanje kolobarja za obvladovanje njegove populacije. Hkrati je priporočljivo kombinirati okolju varno in prijazno varstvo koruze z biotičnimi agensi (metoda zbejanja, uporaba entomopatogenih ogorčic, uporaba naravnih parazitoidov), prilagojeno sistemu gojenja koruze v Sloveniji.

ABSTRACT

Reducing population of the Western Corn Rootworm (*Diabrotica virgifera virgifera*) (Coleoptera: Chrysomelidae) with mating disruption

The Western Corn Rootworm (WCR), *Diabrotica virgifera virgifera* (Coleoptera: Chrysomelidae) is an important pest of maize (*Zea mays*) present in North America and also in Europe, whose soil-inhabiting larvae can seriously damage roots of maize and lead to yield losses. The potential risk by high population of WCR and loosed yields on many host plants, especially on maize, is very high in most EU countries and also in Slovenia. WCR control is the major topic for several researchers over the world. Researchers offer expertise on the area of between plant-insect (WRC) interactions, natural enemy evaluation and biotechnological control methods. Therefore, the prohibition of corn monoculture is mandatory eradication measure for reducing population of WRC. In experiment, which was carried out on the fields of Draža vas near Slovenske Konjice (app. 10 ha), in years 2015 and 2016 - where populations of adults WCR were very high - mating disruption (MD) technique with the use of pheromone 8-metil- 2 decanolpropanoat in year 2015 was examined. In 2015 we detected reduced mating status of females (spermathecs were 58% empty). The field experiment demonstrated that after MD females layed fewer eggs in soil and we observed up to 23% less damage on the roots of maize in next year. In year of used MD less damage on maize silks were observed. Population of WCR is very high in Slovenian maize fields therefore the use of continuous rotation is highly recommended for managing WCR populations. At the same time the combination of safe and environmental friendly crop management practice with biological control agents (MD, use entomopathogenic nematodes, use of natural parasitoid species) adapted to specific maize production systems in Slovenia is highly recommended.



Zatiranje ličink koruznega hrošča *Diabrotica v. virgifera* z entomopatogenimi ogorčicami

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V letu 2016 smo na dveh lokacijah izvedli poljski poskus, kjer smo preizkušali učinkovitost različnih metod zatiranja ličink koruznega hrošča (*WCR*) (*Diabrotica v. virgifera* LeConte, [Coleoptera, Chrysomelidae]). V poskusu smo ugotavljali učinkovitost pripravka za biotično varstvo (dianem[®]), ki vsebuje entomopatogene ogorčice vrste *Heterorhabditis bacteriophora* Poinar (Rhabditida: Heterorhabditidae). Učinkovitost biotičnega varstva smo primerjali s konvencionalnim varstvom, ki je temeljilo na uporabi sintetičnih insekticidov Force 1,5 G (aktivna snov teflutirn) ali Sonido (aktivna snov tiakloprid). Poljski poskus je potekal v Bučečovcih v Prlekiji in v Šmartnem pri Cerkljah na Gorenjskem. Razlike med obravnavanji so bile zelo podobne na obeh lokacijah, čeprav je bila populacija hroščev na Gorenjskem približno 4-krat manjša kot v Prlekiji. Največ koruznih hroščev smo zabeležili v kontroli. Po padajočem številu ulovljenih hroščev so si sledili pripravki Sonido, Force in dianem[®]. Zaradi različnega pritiska populacij koruznega hrošča med lokacijama smo rezultate normirali na kontrolo in združili podatke iz obeh poskusov. Statistična analiza je pokazala, da se je le v postopku, kjer smo uporabili entomopatogene ogorčice ulovilo statistično manj koruznih hroščev kot v kontroli. Rezultati zatiranja ličink koruznega hrošča s pripravkom na osnovi vrste *H. bacteriophora* so primerljivi z objavljenimi rezultati študij iz tujine. Pri tem moramo upoštevati dejstvo, da so bile vremenske razmere ugodne za razvoj in preživetje entomopatogenih ogorčic. Poskus bomo ponavljali v prihodnjih letih, da bomo pridobili zanesljive rezultate za morebitno priporočilo biotičnega varstva zatiranja ličink koruznega hrošča.

ABSTRACT

Controlling *Diabrotica v. virgifera* larvae with entomopathogenic nematodes

In 2016 we performed a field experiment at two locations, where we tested the effectiveness of different control measures against western corn rootworm (WCR) larvae (*Diabrotica v. virgifera* LeConte, [Coleoptera, Chrysomelidae]). We tested the product (dianem[®]) based on entomopathogenic nematode *Heterorhabditis bacteriophora* Poinar (Rhabditida: Heterorhabditidae). The efficiency of inundative biological control was compared to the conventional management based on the use of synthetic insecticides Force 1.5 g (active substance tefluthrin) or Sonido (active substance thiacloprid). Field trials took place in Bučečovci (Prlekija) and Šmartno near Cerklje (Gorenjska). Differences between treatments were very similar at both locations, although the population of WCR in Gorenjska was approximately 4-x lower than in Prlekija. The highest number of beetles was caught in negative control, followed by product Sonido, Force and dianem[®], in decreasing order. Because of different densities of WCR populations between the locations we normalized the results to control values, and combined data from both trials. Statistical analysis showed that only in the treatment where entomopathogenic nematodes were used, significantly less WCR was caught than in the control. Our results are comparable to published literature. However, the weather conditions in the 2016 trial were very favourable for entomopathogenic nematodes. The experiment will be repeated in the next year(s), to obtain reliable results for potential endorsement of entomopathogenic nematodes-based biological control of WCR larvae.



Spremljanje več zaporednih množičnih rojenj poljskega majskega hrošča (*Melolontha melolontha* L.) v zaselku Zadlog skozi daljše obdobje (2007-2016)

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V zaselku Zadlog na črnovrški planoti smo s svetlobno vabo spremljali rojenje poljskega majskega hrošča v daljšem časovnem obdobju (2007 do 2016). Na tem območju so hrošči množično rojili na vsake tri leta (2007, 2010, 2013 in 2016). Po množičnem rojenju v letu 2007, ko smo na eno vabo ujeli 539 hroščev, je bil v travno rušo apliciran mikoinsekticid Melocont-Pilzgerste®, ki je močno zmanjšal populacijo ogrcev, kar se je pokazalo pri naslednjem rojenju v letu 2010, ko je bil skupni ulov hroščev le 42 % tistega v letu 2007. Tudi pri naslednjih množičnih rojenjih (2013, 2016) je skupni ulov dosegel le 49 % oziroma 37 % tistega pred aplikacijo mikoinsekticida. V prispevku so prikazani obseg in dinamika rojenja poljskega majskega hrošča ter razmerja med spoloma v posameznih letih.

ABSTRACT

The monitoring of successive mass swarming of common cockchafer (*Melolontha melolontha* L.) in the hamlet Zadlog over an extended period (2007-2016)

Swarming of common cockchafer in the hamlet Zadlog on the Črni Vrh plateau was monitored by light trap over a prolonged period (2007 to 2016). In this area, beetles massively swarmed every three years (2007, 2010, 2013 and 2016). After the massive swarming in 2007, when we caught in the trap 539 cockchafer, mycoinsecticide Melocont-Pilzgerste® was applied into the turfgrass. This measure significantly reduced the population of grubs, as shown in the following swarming in 2010, when the total number of trapped cockchafer was only 42% of that in 2007. Even the next mass swarming (2013, 2016) the total catches of cockchafer reached only 49% and 37% of that before the mycoinsecticide application. In the contribution, the abundance, sex ratio, and swarming dynamic of common cockchafer in certain years are presented.



Možnost uporabe Brownovega plina (HHO) za termično zatiranje plevelov

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Pri termičnem zatiranju plevelov z Brownovim plinom (HHO), ki smo ga preizkusili na testnih poljih iz sadovnjaka, vinograda in travnika, smo dokazali, da je uporaba Brownovega plina za zatiranje plevelov in trav mogoča. Tretiranje plevelov in trav na njivah, v sadovnjakih in vinogradih je bilo uspešno, in sicer 67-odstotno pri 4 prehodih. Najbolj uspešni rezultati pa so bili na testnem polju travnik, kjer smo izvedli 2 prehoda in 3 ponovitve v obdobju 14 dni in s 95-odstotno uspešnostjo zatrli plevele in trave. Primerjalna vrednost stroška nakupa plinske jeklenke propan-butan plina (10 kg), ki vsebuje 5250 l po ceni 19,98 EUR, in izdelava Brownovega plina (4600 l/h) s pomočjo el. energije, ki znaša 0,73 EUR/h, pokaže, da za 19,98 EUR/10 kg plina v jeklenki pridobimo 126.769,7 l Brownovega plina. Ta podatek govori v prid dejstvu, da je uporaba Brownovega plina za termično zatiranje plevelov v sadovnjakih, vinogradih in travnikih ekonomsko upravičena. Na podlagi testiranja možnosti uporabe HHO plina za termično zatiranje plevelov lahko rečemo, da plin z določenimi ponovitvami na rastno sezono lahko zatre plevele. Pri večji moči je učinkovitost plina večja, saj je naš test bil izveden pri 720 W/h, kar pa predstavlja procent energije, ki je potrebna za »traktorsko« uničevanje plevelov. Plin lahko koristno uporabimo v minimalnem kmetijstvu, saj se plin lahko izdelava na samem mestu, ga ne rabimo skladiščiti in je dosegljiv na zahtevo. Zaradi natančnega zatiranja je tudi poraba plina majhna, kar je zelo koristno pri načrtovanju stroja za avtonomno zatiranje plevelov. Naša celica za proizvodnjo BP je bila narejena kot primer delovanja celice na avtonomnem stroju, ki ga poganjajo akumulatorji. Te lahko polnimo na alternativno energijo (veter, hidroenergija, fotovoltaika ...), celico pa lahko uporabljamo tudi na traktorjih, saj lahko elektriko pridobimo s pomočjo traktorskega agregata, s tem pa pridobimo tudi plin.

ABSTRACT

The possibilities for usage of Brown's gas (HHO) for thermal control of weeds

Using thermal destruction with Brown's gas (HHO), which we tested on the test fields of orchard, vineyard and meadow, we have proved that the usage of Brown's gas for destruction of weed and grass is possible. The treatment of weeds and grasses from the fields of orchards and vineyards has been successful, namely by 67 percent at 4 points. The most successful results were on the test field of meadow, where we performed 2 points and 3 repetitions over a period of 14 days; we have repressed weeds and grasses with 95 percent successfulness. The comparative value of the cost of purchasing gas cylinder propane-butane gas (10 kg), which contains 5250 litres at cost of 19.98 EUR; and the making of Brown's gas (4600 l/h) by using the electrical energy, which costs 0,73 EUR/h shows that for 19,98 EUR/10 kg of gas in the cylinder we obtained 126,769.7 litres of Brown's gas. This data speaks in favor of the fact that the use of Brown's gas for the thermal destruction of weeds in orchards, vineyards and meadows is economically justified. On the basis of testing the possibility of using HHO gas for thermal destruction of weeds, we can say that this gas can destroy weeds with certain repetitions on the growing season. With greater power the efficiency of this gas is greater, because our test was carried out at 720 W / h, which represents the percentage of the energy that is needed for destruction of weeds with "tractors". This gas may be usefully employed in precision agriculture, because it can be produced on the spot, it does not need to be stored and is available upon request. Due to the precise destruction the consumption of the gas is also small, which is very useful when planning the machine for autonomous control of weeds.

Our cell for producing Brown's gas has been made as an example of the operation of cell in an autonomous machine, driven by battery. This batteries can be charged with alternative energy (wind, hydropower, photovoltaics...) and the cell can also be used on tractors, because the electricity can be produced by the tractor power unit and thereby the gas is also obtained.



Vpliv herbicidnih kombinacij na učinkovitost zatiranja plevelov, pridelek in agronomske lastnosti soje (*Glycine max* L.)

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V letu 2016 smo v poljskem poskusu v Jabljah (osrednja Slovenija) preučevali biotično učinkovitost herbicidnih kombinacij v posevku soje. Poskus smo zasnovali kot bločni poskus z desetimi obravnavanji v štirih ponovitvah. Herbicide smo aplicirali pred vznikom in/ali po vzniku soje. Za nanos smo uporabili nahrbtno škropilnico na stisnjen zrak, porabo škropilne brozge smo nastavili na 300 l/ha. Med vegetacijo smo izvedli dve ocenjevanji, kjer smo na podlagi neškropljene kontrole določali biotične učinkovitosti herbicidnih kombinacij na plevelno floro. Učinek herbicidov na agronomske lastnosti in pridelke soje smo določili s primerjanjem izbranih morfoloških deskriptorjev v obravnavanjih s kontrolnimi (neškropljenimi) posevki in s primerjavo z (v poskusu predpostavljenim) herbicidnim standardom (aktivni substanci (a.s.) S-metalaklor + bentazon). Pri večini preizkušanih kombinacij smo dosegli visoke (>95 %) skupne učinkovitosti na prevladujočo plevelno floro. Izjemi sta bili kombinaciji pripravkov 'Stomp Aqua' (a.s. pendimetalin) in 'Dual Gold' (a.s. S-metalaklor); skupna učinkovitost 87 %, in kombinacija pripravkov 'Harmony 75 WG' (a.s. tifensulfuron-metil) in 'Focus Ultra' (a.s. cikloksidim); skupna učinkovitost 92 %. Pri vseh herbicidnih kombinacijah, ki so vsebovale pripravek 'Plateen WG 41,5' (a.s. flufenacet in metribuzin) smo opazili močno fitotoksičnost pri rastlinah po vzniku in nad 90% uničenje

posevkov. Močno fitotoksičnost in delno propadanje rastlin smo opazili tudi pri herbicidnih kombinacijah z a.s. pendimetalin. Opaženo pripisujemo specifičnim rastnim razmeram s hladnim vremenom in obilnimi padavinami po aplikaciji herbicidov in času vznika posevka, kar je verjetno povzročilo izpiranje a.s. v koreninsko cono. Različne a.s. so imele značilne vplive tako na morfološke lastnosti (višina rastlin, višina do prvega stroka, dozorevanje) kot na pridelek. Značilno največje pridelke smo ugotovili v obravnavanjih kjer smo pred vznikom uporabili pripravek 'Dual Gold' (1 l/ha) ter po vzniku 'Basagran' (2 l/ha; a.s. bentazon) ali 'Harmony' (8 g/ha) ter pri kombinaciji 'Harmony' (8 g/ha) in 'Focus Ultra' (2 l/ha) aplicirani po vzniku.

ABSTRACT

Effect of herbicide combinations on weed control efficacy, yield and agronomic traits of soybean (*Glycine max* L.)

Biological efficacy of pre- and post-emergence herbicides and their combinations for weed control were evaluated in field trial at Jابلje (central Slovenia) in 2016. Trial design was completely randomized block with ten treatments in four replications. Applications of herbicides were done using the knapsack sprayer powered by the compressed air; spray mixture usage was set to 300 l/ha. Evaluations of herbicide efficacy for controlling weeds were done twice within the season. The effects of herbicides on agronomic traits and yields of soybean were evaluated by the comparison of selected morphological descriptors with non-sprayed control plots and by comparison with (in study postulated) standard herbicide application plots (active substances (a.s.) S-metalaklor + bentazone). High (>95%) overall efficacy on the prevailing weed flora was observed for most of the combinations tested with the exceptions at the combinations of the products 'Stomp Aqua' (a.s. pendimethalin) and 'Dual Gold' (a.s. S-metalaklor), overall efficiency of 87%; and combination of 'Harmony 75 WG' (a.s. thifensulfuron-methyl) and 'Focus-Ultra' (a.s. cycloxdim), overall efficiency of 92%. After the emergence was with all of the combinations with the products 'Plateau WG 41.5' (a.s. flufenacet and metribuzin) strong phytotoxicity to soybean observed and >90% destruction of the crop. High phytotoxicity and partial destruction of the plants were also observed for the herbicide combinations with a.s. pendimethalin. Observed is attributed to the specific growing conditions, with cold weather and intense rainfall after the herbicide application and during soybean emergence, favouring leaching of a.s. to the root zone. Effects of a.s. on the morphological characteristics (for example; on the height of plants, height to the first pod, maturing etc.) and yields of soybean were also observed. Significantly highest yields were found in treatments with the combination of pre-emergence product 'Dual Gold' (1 l/ha) and post-emergence 'Basagran' (2 l/ha as bentazone) or 'Harmony' (8 g/ha) or only post-emergence application of combination of 'Harmony' (8 g/ha) and 'Focus Ultra' (2 l/ha).



Ocena škodljivosti nekaterih še ne razširjenih vrst rodu *Cyperus* za kmetijsko pridelavo Slovenije

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Na podlagi pregleda literature in izvajanja herbicidnih poljskih poskusov je bila opravljena ocena škodljivosti nekaterih novih vrst invazivnih plevelov iz rodu *Cyperus*. V delu so obravnavane naslednje vrste: *Cyperus esculentus* L., *C. rotundus* L., *C. iria* L., *C. eragrostis* Lam. in *C. congestus* Vahl. Zelo verjetno se večina preučevanih vrst, glede na lokalne klimatske značilnosti in splošno tehniko pridelovanja kmetijskih rastlin, lahko trajno ohranjajo na ozemlju Slovenije. Kot najbolj škodljivi za kmetijsko pridelavo se kaže vrsta *C. esculentus* in *C. congestus*. Rezultati herbicidnih poskusov kažejo, da z razpoložljivimi herbicidi ne moremo zagotoviti povsem zanesljivega zatiranja. Preučevane vrste se zelo uspešno razvijajo na zemljiščih v bližini vodnih virov, kar še

dodatno zožuje nabor primernih herbicidov. Vse je potrebno uvrstiti na listo karantenskih plevelnih vrst za Republiko Slovenijo.

ABSTRACT

Noxiousness evaluation of some not yet widespread species of the genus *Cyperus* for agricultural production in Slovenia

The noxiousness status of some new invasive species from the *Cyperus* genus in Slovene agricultural production was established based on an analysis of literature sources and the performance of herbicide field trials. The following species were studied: *Cyperus esculentus* L., *C. rotundus* L., *C. iria* L., *C. eragrostis* Lam. and *C. congestus* Vahl. It is very likely, depending on the characteristics of local climate and the general techniques of cultivation in agricultural crops, that all studied species have the potential for permanent development on the territory of Slovenia. *C. esculentus* in *C. congestus* were recognised as the species with the highest level of noxious effects in agricultural production systems. Results of field trials for testing herbicide efficacy show that the herbicides available on the Slovenian market cannot guarantee completely reliable chemical control. The studied species can develop very well on land near water sources, which further narrows the choice of suitable herbicides. All studied species need to be put on the list of quarantine noxious weeds in Slovenia.



Razvoj tehnologij za preprečevanje okužb hmelja z viroidom razpokanosti skorje agrumov (CBCVd)

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Viroid razpokanosti skorje agrumov (CBCVd) povzroča agresivno obolenje na hmelju (*Humulus lupulus*) imenovano »huda viroidna zakrnelost hmelja«. CBCVd je bil do nedavnega opisan kot manj razširjen viroid na agrumih na katerih ne povzroča gospodarske škode. Hmelj tako za CBCVd predstavlja povsem novega in zelo občutljivega gostitelja. Bolezen je bila do sedaj na hmelju odkrita le v Sloveniji, kar pomeni prisotnost tega viroida na povsem novem območju izven pridelovalnih območij agrumov. Vpliv CBCVd na pridelek in proizvodnjo hmelja je zelo visok, saj rastline v primeru okužb pričnejo zaostajati v rasti že prvo leto po okužbi in odmrejo v času 3-5let. Širjenje CBCVd v hmeljiščih je izredno hitro, čemur prispeva predvsem specifičnost agrotehnike v hmeljarstvu, ki v času vegetacije povzroča idealne pogoje za mehanski prenos ter same fiziološke dovzetnosti hmelja za okužbe kot zelnate trajnice. Ker je bolezen neozdravljiva, osnovno preprečevanje širjenja temelji predvsem na izvajanju eradikativnih fitosanitarnih ukrepov, kot je uničevanje okuženih rastlin in nasadov. Pri tem je okužene rastline možno zanesljivo vizualno določevali eno leto po okužbi, problem pa predstavljajo ostale okužene rastline, ki so v stadiju inkubacijske dobe in jih vizualno ni možno odkriti. Te rastline predstavljajo prikrit infekcijski potencial, ki ga je možno omejevati le ob uničenju celotnega okuženega nasada in z izvajanjem prilagojene agrotehnike posestev na okuženem območju. Z raziskavami epidemioloških lastnosti CBCVd na hmelju smo določili kritične točke širjenja okužb in kot odgovor na to razvili postopke v tehnologiji pridelave hmelja, ki pripomorejo preprečevanju napredovanja okužb ter ohranjanju infekcijskega potenciala CBCVd. Delo se je izvajalo v okviru Ciljnega raziskovalnega programa (CRP št. V4-1405).

ABSTRACT

Technology development for preventing citrus bark cracking viroid (CBCVd) infections on hop

Citrus bark cracking viroid (CBCVd) is the causal agent of a highly aggressive disease on hop (*Humulus lupulus*) called »severe hop stunt disease«. Until recently, CBCVd was described as a less widespread viroid on citrus plants that did not cause any economic damage. Hop is therefore a new and highly susceptible host for CBCVd. The new hop disease has been currently discovered only in Slovenia, which signifies the appearance of CBCVd in a new area outside citrus production regions. CBCVd has a highly negative impact to hop production, since infected plants develop stunting symptoms in the first year after infection and die in 3-5 years. The spread of CBCVd in hop gardens is extremely fast, due to the specific agro-technical practices in hop production, which create ideal conditions for mechanical transmission, and to the physiological characteristics of hop as a green herbaceous plant. Since the disease is incurable, basic management depends mainly on eradication phyto-sanitary measures such as destroying infected plants and hop fields. In this process, infected plants can be visually detected only one year after infection, while asymptomatic infected plants in the stage of incubation cannot be observed. These infected asymptomatic plants represent hidden infection potential, which can only be eliminated by destroying the entire infected hop field, and by utilising adapted agro-techniques on infected areas. Based on epidemiology studies of CBCVd on hop, critical spreading points connected to hop cultivation practices were defined. As a response to that, new procedures in hop technology were developed, which prevent infection and the survival of CBCVd. The study was performed within the framework of a target research program (CRP no. V4-1405).



Virusi na bučnicah v Sloveniji

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V letu 2016 so bili v okviru stalnega nadzora škodljivih organizmov, ki ga vrši Uprava RS za varno hrano, veterinarstvo in varstvo rastlin, in v sklopu programa preiskav o zastopanosti newdelhijskega virusa kodravosti listov paradižnika (ToLCNDV; rod begomovirusi), ki ga koordinira Kmetijski inštitut Slovenije, pregledani nasadi bučnic v Sloveniji. Vzorci rastlin z bolezenskimi znamenji značilnimi za virusne okužbe so bili analizirani na Nacionalnem inštitutu za biologijo. Navzočnost ToLCNDV v vzorcih analiziranih z molekularnimi metodami na osnovi verižne reakcije s polimerazo ni bila potrjena, niti ne v vzorcu kumare, kjer smo z elektronsko mikroskopijo našli delce, ki so najverjetneje iz rodu begomovirusov. Identifikacija virusov opaženih v tem vzorcu kumare s sekvenciranjem nove generacije je v teku. S serološkimi analizami na vzorcih oljne buče (*Cucurbita pepo* var. *syriaca* Greb.) smo ugotovili, da je le-ta v Sloveniji pogosto okužena z virusom rumenega mozaika bučke, saj smo prisotnost tega virusa potrdili v vseh 15 analiziranih vzorcih. V sedmih vzorcih okuženih z virusom rumenega mozaika bučke smo potrdili sočasno okužbo tudi z virusom mozaika lubenice ter v dveh vzorcih dodatno še okužbo z virusom mozaika kumare. Za vse tri viruse je značilno, da se širijo mehansko s sokom okuženih rastlin in z listnimi ušmi. V prispevku se bomo osredotočili na viruse, ki ogrožajo pridelavo bučnic v Sloveniji in drugod po Evropi, vključno z možnostmi za preprečevanje širjenja okužb.

ABSTRACT

Viruses infecting cucurbits in Slovenia

In 2016, cucurbits have been inspected for harmful pathogens under the survey carried out by the Administration of the Republic of Slovenia for food safety, veterinary and plant protection, and in the frame of monitoring of *Tomato leaf curl New Delhi virus* (ToLCNDV; genus begomoviruses), coordinated by the Agriculture Institute of Slovenia. Samples with typical symptoms of virus infection have been analysed at the National Institute of

Biology. Using polymerase chain reaction, ToLCNDV has not been confirmed in any of the samples, nor in the sample of cucumber where virus particles, with the shape similar to viruses from genus begomoviruses have been observed under electron microscope. Next generation sequencing is in progress for identification of this virus. Fifteen symptomatic samples of oil pumpkins (*Cucurbita pepo* var. *syriaca* Greb.) have been analysed by serological methods. In all of those oil pumpkins *Zucchini yellow mosaic virus* has been detected. Additionally, in seven samples of oil pumpkins *Watermelon mosaic virus* has been detected; and in two of these samples we also confirmed *Cucumber mosaic virus*. All three viruses which were detected in oil pumpkins are transmissible mechanically and by aphids. In the presentation, we will focus on viruses that threaten cucurbits production in Slovenia and elsewhere in Europe, including the possibility of preventing the spread of infections.



Pregled bolezenskih znamenj bakterijskih bolezni v nasadih krompirja v luči pojava novih gospodarsko škodljivih vrst v Sloveniji

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Bakterijske bolezni, ki povzročajo znamenja mehke gnilobe in črne noge pri krompirju, predstavljajo veliko nevarnost za pridelovanje krompirja, ki pa v Sloveniji do pred kratkim niso povzročale večjih težav. Pred 15 leti je bila na uvoženem semenskem krompirju pri nas najbolj pogosta bakterijska bolezen črna noga krompirja (*Erwinia carotovora* subsp. *atroseptica*, zdaj *Pectobacterium atrosepticum*), opažali pa smo tudi znamenja mehke gnilobe (povzročitelj *Erwinia carotovora* subs. *carotovora*). Po letu 2000 smo začeli opažati vse več drugačnih znakov bakterijskih bolezni (povzročitelj *Erwinia chrysanthemi* - danes *Dickeya solani*). Ta vrsta je v Evropi v prvem desetletju novega tisočletja povzročala občutno škodo, posebno agresivne izolate pa smo v Sloveniji zasledili in laboratorijsko potrdili že v letu 2001. V zadnjih letih opažamo vse več znakov okužbe z bakterijskimi boleznimi tudi v nasadih domačega semenskega in jedilnega krompirja, kjer pa okužbe ne moremo pripisati uvoženemu semenu. Domnevamo, da so danes bakterije v tleh tudi pri nas, vendar pride do okužb predvsem takrat, ko so ustrezne vremenske razmere. Možna je tudi latentna prisotnost bakterij, tako v semenu kakor tudi v jedilnem krompirju za pranje. Ozek kolobar možnost okužb še povečuje, saj bakterije lahko preživijo v ostankih krompirjevih rastlin v tleh, v drugih rastlinah in v tleh. Posebno ugodne razmere za razvoj bolezni so velika vlaga in zastajanje vode na njivah, kar je bilo vidno v letu 2016, ko smo opazili tudi 100 % škode v skladiščih krompirja. Ob spremljanju bakterijskih bolezni v slovenskih nasadih krompirja v letih 2015 in 2016 smo oblikovali skalo za oceno znakov, ki vsebujejo različne kombinacije znakov venenja in rumenenja rastlin, zakrnele rasti, sušenja listov ter stopnje in načina propada spodnjega dela stebela in gomoljev v tleh. Z laboratorijskimi analizami smo v Sloveniji potrdili vrste *Dickeya solani*, *Pectobacterium atrosepticum*, *Pectobacterium carotovorum* ssp. *Brasiliense* in *Pectobacterium wasabiae*.

ABSTRACT

Review of the symptoms of bacterial diseases in potato crops in the light of the emergence of new economic harmful species in Slovenia

Bacterial diseases that cause wet rot and black leg symptoms on potato present a serious threat for potato production, but in Slovenia until recently they didn't cause problems. Black leg (*Erwinia carotovora* subsp. *atroseptica*, *Pectobacterium atrosepticum* now) was the most often observed bacterial disease on imported seed potato 15 years ago and the symptoms of wet rot (*Erwinia carotovora* subs. *carotovora*) were also observed. After the year 2000 odd symptoms of bacterial diseases were observed, caused by *Erwinia chrysanthemi* - *Dickeya solani*

today. This species caused significant damages in Europe in the first decade of 21st century. Very aggressive isolates were found and confirmed in laboratory in Slovenia in 2001. More and more symptoms of bacterial diseases can be found in domestic seed and ware potato fields recently, which can't be attributed to the imported seed. We assume that the bacteria became established in the soil also in Slovenia, but the infections depends a lot on suitable weather conditions. It is possible that seed and ware tubers for washing are contaminated latently. Narrow rotation enhance the possible infections, since the bacteria can survive in debris of potato and other plants and in the soil. High moisture and water retention in the soil presents perfect conditions to for the development of the disease, what was seen in the year 2016 with up to 100% damages in potato stores. A new comprehensive scale for bacterial symptoms assesment was created during monitoring of Slovenian potato fields in years 2015 and 2016. It includes a combination of disease symptoms such as wilting and yellowing of plants, shriveled growth, leaf drying, and the degree and the way of disintegration of lower part of the stem and tubers in the soil. The presence of bacterial species *Dickeya solani* *Pectobacterium atrosepticum*, *Pectobacterium carotovorum* ssp. *brasiliense* and *Pectobacterium wasabiae* was confirmed with laboratory analyses in Slovenia.



Seguris Xtra - 3 generacije aktivnih snovi za učinkovito, zanesljivo in dolgotrajno varstvo žit

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Seguris Xtra je nov kombinirani sistemski fungicid družbe Syngenta s preventivnim in kurativnim delovanjem, namenjen predvsem za varstvo pšenice in ječmena pred boleznimi lista. Sestavljajo ga tri aktivne snovi: ciprokonazol, azoksistrobin in izopirazam. Njegova največja moč je izopirazam, pripadnik nove generacije aktivnih snovi iz SDHI skupine. Izopirazam se po aplikaciji hitro premešča in veže v voščene listne plasti, kjer oblikuje zelo obstojno in dolgotrajno varstvo celotnega lista. Prav tako se veže na patogene, ki okužujejo listno tkivo, onemogoči proizvodnjo in prenos energije znotraj njih ter tako preprečuje kalitev in prodiranje spor v list oziroma nadaljnji razvoj glive v listu. Gre za edinstven način dvojne vezave: na list in na glivo (angl. Double Binding Technology). Izopirazam podpira delovanje ciprokonazola in azoksistrobina, hkrati pa zagotavlja tudi dodatno delovanje. Seguris Xtra zagotavlja odlično varstvo pšenice predvsem pred pšenično listno pegavostjo (*Mycosphaerella graminicola*) in rjami (*Puccinia* spp.), preprečuje pa tudi razvoj pšenične pepelovke (*Blumeria graminis*) in rjavenja pšeničnih plev (*Stagnospora nodorum*). V razmerah srednjega do visokega pritiska pšenične listne pegavosti priporočamo aplikacijo v stadiju BBCH 31-32. Tako zaustavimo pomikanje bolezni po rastlini navzgor in obdržimo listno maso, ki je v največji meri odgovorna za pridelek, zdravo. Sicer je Seguris Xtra v pšenici registriran od razvojne faze BBCH 31 do BBCH 61; proti rjam se lahko tretira do konca cvetenja (BBCH 69). V posevkih ječmena ga uporabljamo proti ječmenovi ramularijski pegavosti (*Ramularia collo-cygni*) v stadiju BBCH 39-49, zatira pa tudi ječmenovo mrežasto pegavost (*Pyrenophora teres*), ječmenovo pepelovko (*Blumeria graminis*) in ječmenovo rjo (*Puccinia hordei*). Registrirana uporaba v ječmenu je sicer od razvojne faze BBCH 31 do BBCH 61. Pravočasna aplikacija pripravka Seguris Xtra pridelovalcu zagotavlja, da je korak pred boleznimi in tako izpolni osnovni namen varstva, to je zavarovati vlaganja in zagotoviti ustrezno količino in kakovost pridelka.

ABSTRACT

Seguris Xtra - 3 generations of active ingredients for efficient, reliable and long-lasting protection of cereals

Seguris Xtra is a new systemic fungicide from Syngenta, with preventive and curative activity, designed primarily for the protection of wheat and barley against foliar diseases. It is combination of three active ingredients: cyproconazole, azoxystrobin and isopyrazam. It's greatest strength is isopyrazam, a member of new Benz-Pyrazole SDHI group of fungicides. After application isopyrazam moves very fast and embeds itself into the leaf wax layer

to form a durable shield for the entire leaf. Isopyrazam remains fixed in the cuticular wax, guaranteeing a long duration of control. It also binds to pathogens and blocks the development of diseases by inhibiting the fungi's energy production, which neutralises them. It is a unique way of double binding: to the leaf and to the fungus (Double Binding Technology). Isopyrazam supports the cyproconazole and azoxystrobin and provides additional activity also. Seguris Xtra provides excellent wheat protection, mainly from major foliar diseases: *Mycosphaerella graminicola* and rusts (*Puccinia* spp.). It prevents the development of *Blumeria graminis* and *Stagnospora nodorum* too. Under moderate to high pressure of *Septoria tritici* blotch is recommended application in stage BBCH 31-32. Thus stopping the disease transfer up the plant and keep main yield building leaves clean and healthy. Otherwise, in wheat, Seguris Xtra is registered from the BBCH 31 to BBCH 61 stage; against rusts until the BBCH 69. In barley is Seguris Xtra recommended targeted against *Ramularia collo-cygni* in stage BBCH 39-49, but it is also effective against net blotch (*Pyrenophora teres*), powdery mildew (*Blumeria graminis*) and rust (*Puccinia hordei*). We can use it in barley from the BBCH 31 to BBCH 61 stage.

Applying long lasting Seguris Xtra on time can help producers stay one step ahead of diseases and fulfill the basic purpose of protection: to protect investments and ensure an adequate yield quantity and quality.

Varstvo gozdnega drevja in vinske trte



Domorodni parazitoidi kostanjeve šiškarice (*Dryocosmus kuriphilus* Yasumatsu) in ostalih šiškaric v Sloveniji (2010-2016)

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Naravni sovražniki so pogosto edini učinkovit način naravnega in umetno spodbujenega omejevanja populacij škodljivih organizmov. Vendar pa so domorodni naravni sovražniki pogosto premalo učinkoviti v boju z invazivnimi tujerodnimi škodljivimi vrstami. Tako je tudi v primeru kostanjeve šiškarice (*Dryocosmus kuriphilus*) v Evropi. V letih 2010-2016 smo poleg kostanjeve šiškarice vzorčili tudi šiške ostalih os šiškaric, predvsem na hrastih in šipkih. Našli smo številne vrste domorodnih parazitoidov, ki so se pojavljale tako na kostanjevi, kot tudi na ostalih šiškaricah. Na kostanjevi šiškarici smo v sedmih letih našli in določili 35 vrst domorodnih parazitoidov in tujerodno vrsto *Torymus sinensis*, na šipkovi in hrastovih šiškaricah pa je bilo potrjenih le 33 domorodnih vrst parazitoidov.

ABSTRACT

Native parasitoids of Chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu) and other cynipids in Slovenia (2010-2016)

Natural enemies are often the only efficient method how to naturally or artificially reduce the populations of pest species. However, native natural enemies are often inefficient regarding invasive alien pests. And this is also the case of Chestnut gall wasp - CGW (*Dryocosmus kuriphilus*) in Europe. From 2010-2016 galls from CGW and other Cynipid wasps (on oaks and roses) were sampled in order to find native parasitoids and their relations among the hosts. On CGW 35 native parasitoid species were found and one alien species (*Torymus sinensis*), meanwhile on rose and oak galls there were 33 native and no alien species.



Simulacija potencialnega širjenja borovega smolastega raka (*Fusarium circinatum*) v Sloveniji

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Gliva *Fusarium circinatum* povzroča bolezen borov, ki jo po značilnih rakastih razjedah na deblu in vejah ter obilnem izcejanju smole imenujemo borov smolasti rak. Podnebne razmere za ustalitev bolezní v Sloveniji so ustrezne in njeni gostitelji so zelo razširjeni, zato obstaja veliko tveganje njenega vnosa in širjenja. Njeno širjenje in verjetnost naselitve v Sloveniji smo simulirali z modelom, ki sta ga razvila Timo Pukkala in Timo Mõykkynen v obliki računalniške aplikacije. Model je stohastičen celičen avtomat, pri katerem lahko uporabnik nastavi vrsto vhodnih parametrov (gostitelji, ekoklimatski indeks, začetne lokacije širjenja in datoteko z osnovnimi parametri). Rezultat modela je karta tveganja, ki nam poda verjetnost, da se je bolezen razširila na določeno lokacijo do določenega časa. Prostorska ločljivost modela je 1 km. Širjenje bolezní smo simulirali iz štirih lokacij (Muta, Prestranek, Koper in Tolmin) v obdobju 20. let. Simulacijo smo ponovili 10 krat. Izračunali smo ekoklimatski indeks za *F. circinatum* na območju Slovenije, ki je bil optimalen samo na 0,6 %, ustrezen na 28 % in neustrezen na 45,7 % površine Slovenije. V simulacijah se je borov smolasti rak v 20. letih razširil na 47,1 % modelskih celic, kjer se pojavljajo gostitelji. Iz Mute se bi bolezen razširila do Brnika na zahodu in do Ljutomera na vzhodu, tj.

65–85 km od izhodišča, kar v povprečju pomeni 3,3–4,3 km/leto. Najhitrejša širjenje borovega smolastega raka je bilo v prvih 5–7 letih, ko se je okužilo 20,7 % modelskih celic. Uporabnost modela se bo pokazala predvsem v primeru, ko bo škodljivi organizem vnesen v Slovenijo. Takrat bomo lahko model ponovno zagnali in simulirali verjetnost širjenja iz dejanske točke vnosa, kar nam bo lahko v pomoč pri postavitvi prioritarnih območij, kjer naj se intenzivirajo fitosanitarni pregledi in ostali ukrepi proti zaustavljanju ter izkoreninjanju tega škodljivega organizma.

ABSTRACT

The simulation of potential spread of pine pitch canker (*Fusarium circinatum*) in Slovenia

The fungus *Fusarium circinatum* causes pine pitch canker disease. Climatic conditions for the disease establishment in Slovenia are favourable and its' hosts are widespread, therefore, there is high risk of its' introduction and spread. We simulated potential spread and probability of the disease establishment in Slovenia with a model, that was developed by Timo Pukkala and Timo Mõykkynen in the form of computer application. The model is stochastic cellular automata, where a user can control number of input parameters (hosts, ecoclimatic index, introduction locations and a file with basic model settings). A result of the model is a risk map that shows probability that the pathogen has reached a certain location by certain year. The spatial resolution of the model is 1 km × 1 km. We simulated the disease spread from four locations (Muta, Prestranek, Koper and Tolmin) in the period of 20 years. The simulation was repeated 10 times. We calculated ecoclimatic index for *F. circinatum* in Slovenia, that was optimal on 0.6 %, suitable on 28 %, and unsuitable on 45.7 % of the whole area of Slovenia. The pine pitch canker spread in 47.1 % of model cells in 20 years of the simulations. The disease would spread from Muta to Brnik on the west and to Ljutomer on the east, i.e. 65–85 km from the introduction point, i.e. the average spread rate was 3.3–4.3 km/year. The fastest spread of the pine pitch canker was in the first 5–7 years of the simulations, when 20.7 % of suitable model cells were infected. An applicability of the model will be best demonstrated in a case, when the fungus will be actually introduced into Slovenia. Then we will be able to run the model again to simulate the probability of the spread from actual introduction location. This will enable to plan priority locations for phytosanitary surveys and other measures for limiting further spread and eradication of the disease accordingly.



Nove najdbe rij (Pucciniales) na drevesnih in drugih vrstah v Sloveniji

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Rje (Pucciniales) so obligatni biotrofi in predstavljajo največjo skupino glivnih patogenov rastlin, ki povzročajo ekonomske izgube tako pri gojenih kot tudi samoniklih rastlinah. Vnos tujerodnih rij v nova okolja lahko vodi do epifitocij velikih razsežnosti. Življenjski krog rij je zapleten in številne vrste potrebujejo več kot le enega gostitelja. Taksonomija in identifikacija rij je težavna in je pogosto možna le z uporabo tako morfoloških kot molekularnih podatkov. V obdobju od 2014 do 2016 smo vzorčili drevesne in druge rastline z znaki okužb z rjami. Identifikacijo vzorcev rij smo izvedli tako na podlagi morfoloških značilnosti kot tudi na osnovi filogenetske primerjave z referenčnimi nukleotidnimi zaporedji regije ITS-rDNA. V Sloveniji smo tako prvič zabeležili prisotnost nekaterih tujerodnih vrst rij iz rodov *Melampsorium* in *Phragmidium*.

ABSTRACT

New findings of rusts (Puccinales) on trees and other plants in Slovenia

Rusts (Puccinales) are obligate biotrophs, representing one of the largest groups of plant pathogenic fungi and are one of the most economically important pathogens of many native and cultivated plants. Introduction of alien rusts to new environments can lead to large-scale epiphytotics. Their life cycle is complex, requiring usually more than one host to be completed. The taxonomy and identification of rusts is notoriously difficult, and only the implementation of morphological and molecular data can reveal the correct taxonomic emplacement. From 2014 to 2016 trees and other plants with rust infections were sampled. Identifications of rusts were performed based on morphological characteristics and phylogenetical comparisons to reference ITS-rDNA sequences. First official records of alien rust species from genus *Melampsoridium* and *Phragmidium* are so reported.



Zdravje gozdov tri leta po katastrofalnem žledolomu iz leta 2014

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Posledice katastrofalnega žledoloma, ki je v letu 2014 prizadel več kot polovico slovenskih gozdov, se odražajo tudi v zdravju gozda. Žledolomu je pričakovano sledila namnožitev podlubnikov, predvsem osmerozobega smrekovega lubadarja (*Ips typographus*). Gre za največjo znano namnožitev podlubnikov v gozdovih Slovenije. S podlubniki so najbolj prizadeta v žledolomu najbolj poškodovana območja. To so gozdovi v gozdnogospodarskih območjih Postojna, Ljubljana, Tolmin in Kranj, ter gozdovi na robnih območjih v GGO Bled in Kočevje. Če je bilo zaradi posledic žledoloma treba posekati 3 milijone m³ močno poškodovanih iglavcev, jih je bilo treba v treh letih po žledolomu posekati več kot 4 milijone m³, večinoma smreke. Namnožitev podlubnikov se bo predvidoma nadaljevala tudi v letu 2017. Na poškodovanem območju nastajajo bolj ali manj velike izsekane gozdne površine, kjer bo treba gozd obnoviti. Večinoma bo obnova poškodovanih gozdov v žledolomu in namnožitvi podlubnikov potekala po naravni poti, v manjši meri s sajenjem sadik gozdnega drevja.

ABSTRACT

Slovenian Forest health three years after the catastrophic ice storm from 2014

The catastrophic ice storm, which damaged over a half of Slovenian forests in 2014, had huge implications for the future health of the forests. As expected, the ice storm was followed by an outbreak of bark beetles, especially the species *Ips typographus*. This outbreak is the largest known outbreak of bark beetles in Slovenia. The degree of damaged forest by the ice storm had a large impact on the damage by bark beetles. The most affected forests are in management units Postojna, Ljubljana, Tolmin and Kranj, as well as management units on the boundary of these area, Bled and Kočevje. Though more than 3 million heavily damaged cubic meters of conifers had had to be cut down because of the ice storm, more than 4 million cubic meters had to be cut down due to bark beetles. The outbreak is expected to continue in 2017. Small or large clear cut areas are forming in damaged forests, where the forest needs to be regenerated. The natural regeneration will be used mostly.



Stopnja zmanjšanja napada od povzročiteljev boleznin vinske trte pri uporabi titanovih in silicijevih pripravkov za krepitev rastlin

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V poljskih poskusih izvedenih v vinogradih smo analizirali vpliv dodajanja pripravkov za krepitev rastlin Tytanit® (MgO 65 g/l, SO₃ 130 g/l, Ti 8,5 g/l) in Optysil® (SiO₂ 200 g/l, Fe 24 g/l) integriranim škropilnim programom na stopnjo zmanjšanja napada od povzročiteljev boleznin (*Peronospora*, *Botrytis*, *Oidium*). Dodajanje pripravka Optysil 3 do 4 krat letno v odmerku 0,5 l/ha običajnim integriranim škropilnim programom v povprečno ugodnih razmerah za razvoj boleznin lahko zmanjša stopnjo napada pri peronospori na listju do 27 % in na grozdju do 33 %, pri oidiju trte na listju do 55 % in na grozdju do 64 % in pri sivi plesni na grozdju za 42 do 49 %. Dodajanje pripravka Tytanit 2 do 3 krat letno v odmerku 0,2 l/ha običajnim integriranim škropilnim programom v enakih razmerah za razvoj boleznin lahko zmanjša stopnjo napada pri peronospori pri listju do 33 % in pri grozdju do 39 %, pri oidiju trte na listju do 28 % in na grozdju do 33 % ter za 21 do 29 % pri sivi plesni na grozdju. Pri pogosti uporabi pripravkov Tytanit in Optysil bi bilo mogoče nekoliko zmanjšati porabo klasičnih fungicidov. Pogosta uporaba obeh pripravkov hkrati lahko poveča pridelek grozdja vsaj za 12,9-17,7 %.

ABSTRACT

The level of Grapevine Pathogen Attack Rate Reduction in the Application of Titanium and Silicon-based Plant Strengtheners

Field experiments were carried out in the vineyards to study the effect of adding Tytanit® (MgO 65 g/l, SO₃ 130 g/l, Ti 8.5 g/l) and Optysil® (SiO₂ 200 g/l, Fe 24 g/l) plant straighteners to fungicides, constituting the integrated spray program on the level of reduction of pathogen attack rate (*Peronospora*, *Botrytis*, *Oidium*). Adding a preparation of Optysil 3 to 4 times a season at a dose of 0.5 l / ha to fungicide sprays in a standard integrated spray program during a seasons with moderately favourable conditions for the development of the diseases, can reduce the downy mildew attack rate on leaves up to 27% and on bunches up to 33%, the powdery mildew rate on leaves up to 55% and on bunches up to 64 % and the grey mould rate from 42 to 49%. Adding a preparation of Tytanit 2 to 3 times a season at a dose of 0.2 l / ha, to fungicide sprays can reduce the downy mildew attack rate on leaves up to 33% and on bunches up to 39%, the powdery mildew rate on leaves up to 28 % and on bunches up to 33% and the grey mould rate from 21 to 29%. With frequent use of the preparations Tytanit and Optysil, the amount of applied conventional fungicides could be slightly reduced. Frequent combined use of both products can increase the yield of grapes for at least 12,9 to 17,7%.



Pojav sive grozdne plesni na grozdju kot posledica napada drugega rodu grozdnih sukačev

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V prispevku prikazujemo rezultate preizkušanj insekticidov za zatiranje drugega rodu grozdnih sukačev v letih 2011 in 2016 v povezavi s stopnjo okužbe s sivo grozdno plesnijo. V letu 2011 so bili preizkušani naslednji pripravki: z enim škropljenjem Reldan 22 EC, Pyrinex 25 CS, Coragen in Steward, z dvema škropljenjima Affirm. Poleg zgoraj omenjenih pripravkov so bili v letu 2016 preizkušani še Runner 240 SC, Vertimec PRO z enim škropljenjem in Lepinox plus z dvema škropljenjima. Rezultati preizkušanj so pokazali, da obstaja povezava med stopnjo okužbe s sivo grozdno plesnijo in številom napadenih grozdov. V letu 2011 je bil determinacijski koeficient med stopnjo okužbe s sivo grozdno plesnijo in številom gosenic 69,4 % v letu 2016 51,2 %:

ABSTRACT

The emergence of gray mould on grapes as a result of attack of second generation of grape moths

In the article we present results of testing different insecticides against second generation of grape moths. The trials were made in year 2011 and 2016. In year 2011 the follow insecticides were testing: Reldan 22 EC, Pyrinex 25 CS, Coragen and Steward with single application and Affirm with two applications. In year 2016 the same insecticides were used in trial and also Runner 240 SC, Vertimec PRO, with single application and Lepinox plus with two applications. The results have shown connection between the level of infection with gray mould and number of damaged grape clusters. The coefficient of determination between the level of infection with gray mould and number of damaged grapes clusters was 69.4 % in the year 2011 and 51.2 % in year 2016.



Splošna sekcija



Začasen značaj karantenske kategorije na primeru plodovih muh (Tephritidae)

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Glavna ovira pri vstopu sadja in zelenjave na tuje trge so ostanki fitofarmaceutskih sredstev, uporabljenih v pridelavi za obvladovanje škodljivih organizmov, in škodljivi organizmi sami, ki se z rastlinskim blagom lahko prenesejo na nova območja. Države zato, pravilom WTO o prosti trgovini navkljub, predpisujejo uvozne zahteve, ki jih mora sadje in zelenjava ob uvozu izpolnjevati, da ne ogroža zdravja potrošnikov oziroma zdravja rastlin v drugem primeru. Plodove muhe so med najpomembnejšimi škodljivci v pridelavi sadja in zelenjave na svetu. Opisanih je nad 4000 vrst, in mnoge so polifagne. Družina Tephritidae ima kar 500 rodov, in ti imajo vsak svoje domorodno območje. Med ekonomsko najpomembnejše rodove spadajo: *Anastrepha* (domorodne vrste pretežno v Južni in Srednji Ameriki), *Bactrocera* (Bližnji vzhod in območje Avstralazije), *Ceratit* (tropska Afrika) in *Rhagoletis* (domorodne vrste v zmerno toplem pasu Amerike, Evrope in Azije). Mnoge vrste iz teh rodov so tudi invazivne in povzročajo veliko škodo ob vnosu v nova območja, kar je vse pogostejše v mednarodni trgovini. Poročila Evropske komisije, ki temeljijo na EU obsežnih rezultatih uradnih pregledov in zadržanih neskladnih pošiljk v letih 2014-2016, kažejo, da je skoraj tretjina vseh neskladnih pošiljk napadena s škodljivimi organizmi, da so kar tri četrtine teh pošiljk iz kategorije sadja in zelenjave, in da kar tretjina zadnjih omenjenih prenaša plodove muhe. Po tej poti so se k nam verjetno vnesle npr. breskova muha *Ceratit capitata*, oljkova muha *Bactrocera oleae*, višnjeva muha *Rhagoletis cingulata* in orehova muha *Rh. completa*. Karantenski ukrepi ob uvozu in vzpostavitev npr. nenapadenih območij (ISPM 26) za te vrste niso več primerni, zato je za obvladovanje škodljivcev treba zagotoviti sistemski pristop z integriranim varstvom rastlin (ISPM 35), uporabiti ukrepe na tržnih gostiteljskih plodovih (ISPM 28), ter s spremljanjem določiti gostiteljski status plodov (sadja, paprik, buč, jajčevcev itd.) in tveganje, ki ga predstavljajo (ISPM 37).

ABSTRACT

Temporary nature of pest categorisation as a quarantine pest using the example of the Tephritidae fruit flies

The main barrier to the entry of fruits and vegetables onto foreign markets constitute the residues of pesticides used for pest control in production and the pests themselves by being carried over to new areas on goods of plant origin. Notwithstanding the WTO rules on the free trade, countries lay down the import requirements to be met prior to import of fruits and vegetables to avoid posing a consumer health risk or plant health risk, respectively. Globally, fruit flies belong to the most significant pests in the production of fruits and vegetables. Over 4000 species have been described, and many thereof are polyphagous. The Tephritidae family comprises 500 genera, and each thereof has a specific native distribution range. The economically most significant genera include: *Anastrepha* (native in the Southern and Central America), *Bactrocera* (the Middle East and Australasia), *Ceratit* (tropical range of Africa) and *Rhagoletis* (representative species in America, Europe and Asia). Many species of these genera are invasive and highly damaging to other crops after introduction into new areas, which is more and more the case in international trade. Reports by the European Commission, which are based on the EU-wide inspection results and interceptions of non-compliant consignments in the period 2014-2016, show that almost one third of all non-compliant consignments have been infested by pests, that as many as three out of four such consignments belong to the category of fruits and vegetables, and that as many as one third of the latter carry fruit flies. This same route of introduction into and establishing in our territory probably served for instance to the Mediterranean fruit fly *Ceratit capitata*, olive fruit fly *Bactrocera oleae*, cherry fruit fly *Rhagoletis cingulata*, and walnut husk fly *Rh. completa*. Quarantine measures at import and pest free areas (ISPM 26), for instance, are no longer appropriate for these species. Thus, a system approach with integrated plant protection (ISPM 35) needs to be secured for pest control, followed by measures prior the marketing of host fruits (ISPM 28), and surveillance to determine host status of fruits (fruit, melon, pepper, pumpkin, eggplant, etc.) and the risks involved (ISPM 37)



Načrtovani programi preiskav za ugotavljanje navzočnosti škodljivih organizmov rastlin

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Zgodnje odkritje škodljivih organizmov rastlin je nujno za zagotavljanje učinkovitega ukrepanja pri njihovem izkoreninjenju. Z rednim spremljanjem zdravstvenega stanja rastlin in načrtnim izvajanjem programov preiskav za ugotavljanje navzočnosti škodljivih organizmov se lahko zmanjša število ter obseg izbruhov škodljivih organizmov, ki pomenijo veliko tveganje za zdravje rastlin. Pravočasno odkrivanje škodljivih organizmov je zaradi skupnega trga pomembno tudi za celotno področje Evropske Unije. Nova Uredba (EU) 2016/2031 o ukrepih varstva pred škodljivimi organizmi rastlin in o spremembi ter razveljavitvi določenih aktov na področju zdravja rastlin (UL L 317, z dne 23.11.2016, s. 4-104) zaradi tega predpisuje obvezne programe preiskav za vse karantenske škodljive organizme. Za pomoč pri izvajanju novih pravil je bila leta 2014 sprejeta Uredba Evropskega parlamenta in Sveta št. 652/2014 o določbah za upravljanje odhodkov v zvezi s prehransko verigo, zdravjem in dobrobitjo živali ter v zvezi z zdravjem rastlin in rastlinskim razmnoževalnim materialom (UL L 189, z dne 27.6.2014, s. 1-32), ki državam članicam omogoča sofinanciranje programov preiskav navzočnosti škodljivih organizmov iz proračuna EU. Na podlagi navedene uredbe Evropska Komisija sprejme delovni program s seznamom škodljivih organizmov, za katere se na območju EU izvajajo programi preiskav. Z Letnim programom preiskav škodljivih organizmov rastlin generalni direktor Uprave za varno hrano, veterinarstvo in varstvo rastlin določi škodljive organizme, ki so vključeni v izvedbo. Pri tem se upoštevajo znanstveni in strokovni dokazi ter vse druge ustrezne informacije v zvezi z navzočnostjo zadevnih škodljivih organizmov. V program so vključeni nosilci javnih pooblastil s področja zdravstvenega varstva rastlin, ki v okviru izvajanja programov preiskav opravljajo zdravstvene preglede in vzorčenja rastlin, rastlinskih proizvodov in nadzorovanih predmetov ter izvajajo laboratorijske preiskave zaradi diagnostike škodljivih organizmov. Za vsak program preiskave navzočnosti škodljivega organizma se določi koordinatorja, ki ima povezovalno in svetovalno vlogo ter pripravi vmesna in končna poročila na podlagi enotne evidence vpisov v informacijski sistem »Evidenca o pojavih in ugotovitvah škodljivih organizmov«, kamor so vneseni podatki iz pregledov in vzorčenj ter podatki o laboratorijskih analizah. Javni del teh podatkov je objavljen na »Fitosanitarnem prostorskem portalu Slovenije: <http://fito-gis.mko.gov.si/dat/Razm.htm>. Na podlagi te evidence so opredeljeni statusi škodljivih organizmov v Sloveniji. V letu 2017 je vključenih 44 programov preiskav, od teh 39 programov sofinancira EU v višini 75 %.

ABSTRACT

Planned survey programmes of harmful organisms

Early detection of harmful organisms of plants is of key importance for effective eradication. Regular monitoring of plant health status, and planned survey programmes for detecting the presence of harmful organisms, shall reduce the number and extent of outbreaks constituting a significant risk to plant health. Early detection of harmful organisms due to the Single Market is important for the entire territory of the European Union. New Regulation (EU) 2016/2031 on protective measures against pests of plants and amending and repealing certain acts in the field of plant health (OJ L 317, 23.11.2016, p. 4-104) requires mandatory survey programmes for all the quarantine pests. Regulation (EU) No. 652/2014 of the European Parliament and of the Council of 15 May 2014 laying down provisions for the management of expenditure relating to the food chain, animal health and animal welfare, and relating to plant health and plant reproductive material (OJ L 189, 27.6.2014, p. 1-32) was adopted as aid in implementing the survey programmes. It facilitates the Union co-financing of survey programmes conducted by the Member States. To this end, the European Commission adopts the work programme comprising

the lists of harmful organisms involved in survey programmes. Within the Annual Survey Programme of Harmful Organisms, the Director General of the Administration for Food Safety, Veterinary Sector and Plant Protection (AFSVSPP) shall define the species of harmful organisms to be covered by the survey. These surveys shall take into account the recognized scientific and technical evidence and any other relevant information on the occurrence of harmful organisms. The survey programme shall involve all the institutions with public authorisations in plant health, who shall conduct the health checks and sampling of plants, plant products and regulated commodities, and laboratory testing for diagnosing harmful organisms. A coordinator shall be earmarked for each survey for the presence of a harmful organism, playing an interlinking and advisory role, and preparing the interim and final reports based on uniform records of entries made in the information system, "Records of occurrences and findings of harmful organisms". These records shall comprise all the data of surveys, sampling and laboratory analyses. Data made accessible to the general public are already published on the "Plant Health GIS Portal of Slovenia": <http://fito-gis.mko.gov.si/dat/Razm.htm>. In 2017, 44 survey programmes will be implemented and 39 thereof will be co-financed by the Union up to a level of 75 %.



Uredba Evropskega parlamenta in Sveta o ukrepih varstva pred škodljivimi organizmi rastlin

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Uredba o zdravju rastlin je del paketa »Pametnejša pravila za bolj varno hrano«, ki prinaša sodobnejši in enostavnejši pristop k varovanju zdravja rastlin, živali in ljudi ter učinkovitejša nadzorna orodja za zagotovitev spoštovanja pravil, ki naj bi usmerjala delovanje prehranske verige. Nova uredba uveljavlja preventivne ukrepe v zvezi z zgodnjim odkrivanjem pojava škodljivih organizmov na ozemlju držav članic Unije, ureditev vseh škodljivih organizmov rastlin na enem mestu, posodobitev in poenotenje določb glede premikov rastlin in rastlinskih proizvodov na notranjem trgu Unije ter ureditev izvoznih postopkov. Namen uredbe je tudi boljše varstvo pred tveganji za vnos tujerodnih škodljivih organizmov rastlin iz tretjih držav, ki so lahko prisotni na rastlinah in drugem blagu rastlinskega izvora. Vnos tujerodnih škodljivih organizmov rastlin v Unijo lahko povzroči velike negativne gospodarske učinke na kmetijsko pridelavo, gozdarstvo in okolje ter ogrozi naravne ekosisteme in biotsko raznovrstnost v Uniji. Pomemben dosežek uredbe je uveljavitev postopka predhodne ocene tveganja za nove trgovske poti iz tretjih držav, s katerimi so prepoznane visoko tvegane poti vnosa za nevarne škodljive organizme rastlin.

ABSTRACT

Regulation of the European Parliament and of the Council on protective measures against pests of plants

The new Plant Health Regulation is part of the "Smarter roles for safer food" package, updating and facilitating the approach to plant, animal and human health protection and introducing the more effective control tools guaranteeing that the rules aimed at food chain functioning are in fact respected. New regulation lays down preventive measures for early detection of emergence of plant pests in the territory of the Union Member States, regulates all plant pests in a single act, updates and unifies provisions governing the movements of plants and plant products in the Union's Single Market, and regulates the relevant export procedures. Regulation is targeting the improved protection against risk for introduction of invasive plant pests from third countries, which can be present on plants and other commodities of plant origin. Introduction of invasive plant pests into the Union could have severe economic impacts on agricultural crops, forestry and the environment and jeopardize natural ecosystems and biodiversity in the Union. An important achievement of Regulation is the introduction of preliminary assessment procedure for new trading routes from third countries in order to identify the high-risk commodities of dangerous plant pests.



Sekvenčna uporaba generičnih metod za identifikacijo bakterijskih izolatov, MALDI-TOF in določanje črtnih kod DNA, omogoča hitro in natančno identifikacijo rastlinskih patogenih bakterij

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V diagnostiki, ki zajema veliko število različnih povzročiteljev bolezni, so posebej uporabne generične metode pri katerih lahko z enakimi reagenti določamo in identificiramo večje število skupin, rodov in vrst škodljivih organizmov. Masni spektrometer MicrofleX™ (MALDI Biotyper, Bruker Daltonik) omogoča hitro izvedbo MALDI-TOF (ionizacija v matriksu z desorpcijo z laserjem in masnim analizatorjem časa preleta ionov). S to metodo zaznavamo profil ribosomalnih in drugih najpogostejših bakterijskih proteinov v 24-urnih čistih kulturah bakterij. Po določitvi profila le-tega primerjamo z že obstoječo knjižnico podatkov referenčnih sevov in na podlagi podobnosti identificiramo preiskovan bakterijski izolat. Glede na raznolikost bakterij in njihovo zastopanostjo v knjižnicah je identifikacija ustrezna na nivoju bakterijskih rodov, vrst ali sevov, na kar nas opozarja številčni rezultat. Priprava izolata in njegova analiza traja v povprečju 8 minut kar jo uvršča med najhitrejše identifikacijske metode. Počasnejša, tudi cenovno manj ugodna a bolj natančna, je generična metoda določanja črtnih kod DNA (angl. »DNA barcoding«). To je metoda, s katero na podlagi sekvenc krajših genetskih markerjev identificiramo tarčni organizem do vrste. Pri rastlinskih patogenih bakterijah iz rodu *Pseudomonas* in *Xanthomonas* se najpogosteje uporabljata za identifikacijo delni sekvenci genov *rpoD* in/ali *gyrB*. Tudi v tem primeru dobljene sekvence primerjamo z že obstoječimi javnimi bazami podatkov (npr. NCBI ali Q-bank), ki pa v primerjavi s knjižnico MALDI-TOF obsegajo večje število referenčnih sekvenc. S pomočjo določanja črtnih kod DNA nam v večini primerov uspe določiti patogen organizem tudi do nivoja nižjih taksonomskih skupin npr. patovarjev. V prispevku na primerih iz prakse prikazujemo kako nam sekvenčna uporaba MALDI-TOF in določanja črtnih kod DNA omogoča optimalen izkoristek njunih prednostih, bistveno skrajša čas identifikacije izolatov ter razširi spekter izolatov, ki jih lahko identificiramo.

ABSTRACT

Sequential use of generic methods for the identification of bacterial isolates, MALDI-TOF and DNA barcoding, allows rapid and precise identification of plant pathogenic bacteria

Generic methods allow detection and identification of organisms of different groups, genera, and species while using a generic set of reagents. This makes them especially valuable for fields such as plant pathology in which diagnostics aims to cover a myriad of different organisms. One of such methods is matrix-assisted laser desorption/ionization time of flight spectrometry (MALDI-TOF) which can be run on MicrofleX™ apparatus (MALDI Biotyper, Bruker Daltonik). With this method a profile is generated reflecting bacterial ribosomal and other most common proteins from 24 h pure bacterial cultures. After analysis the profile is compared with the profiles of reference strains in a commercial library and the bacteria identified based on the similarity of profiles. Depending on the diversity within taxonomic groups of bacteria they can isolates can be identified to genera, species or strain level. A numerical score reflects the extent of similarity observed. Isolate preparation and its analysis takes an average of 8 minutes which makes this method one of the quickest identification methods available. A slower, more costly but more precise generic method of identification is DNA barcoding. This is a method which uses a short genetic marker in an organism's DNA to identify it as belonging to a particular taxonomic group. In the case of plant pathogenic bacteria the partial sequencing of genes *rpoD* and/or *gyrB* are commonly used for identification of bacteria of genera *Pseudomonas* and *Xanthomonas*. Also in this case the identification is done by comparison of the obtained sequence with existing databases e.g. NCBI or Q-bank. In comparison with a library of MALDI-TOF is available a greater number of sequences. DNA barcoding often has a higher resolution than MALDI-TOF. In combination with a larger number of publicly available reference data DNA barcoding thus often

allows identification of isolates not only to species but also to pathovar level. With examples from diagnostics we demonstrate how a sequential use of MALDI-TOF and DNA barcoding best employs their advantages, shortens the time of identification of isolates and extend the range of isolates that can be identified.



Prva najdba ogorčice *Parasitylenchus bifurcatus*, parazita harlekinske polonice *Harmonia axyridis*, v Sloveniji

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V letih 2015 in 2016 smo nabrali okrog 200 osebkov polonic vrste *Harmonia axyridis* s šestih lokacij v Sloveniji. Polonice smo secirali in pod lupo preverili zastopanost parazitskih ogorčic. Ogorčice smo našli v dveh vzorcih polonic, nabranih na Brdu pri Lukovici in Trbojah. Stopnja okuženosti polonic je bila okrog 30 %. Morfometrična analiza je razkrila karakteristične znake ogorčice *Parasitylenchus bifurcatus*: ravno bodalo brez zadebelitev pri osnovi, bursa in razcepljeno konico repa pri črvastih samicah in ličinkah. Identiteto najdenih ogorčic smo potrdili z določitvijo nukleotidnega zaporedja odseka 18S rDNA (št. v javni bazi: LT629306 in LT629307), ki kaže visoko podobnost z zaporedji vrste *P. bifurcatus* dostopnimi v javnih bazah (več kot 99,9 odstotna enakost). Gre za prvo najdbo vrste *Parasitylenchus bifurcatus* Poinar in Steenberg, parazita harlekinske polonice *Harmonia axyridis*, v Sloveniji. Ogorčice *P. bifurcatus* zmanjšajo rodnost svojega gostitelja in so kot takšne potencialni biotični agensi za zatiranje invazivne vrste polonice *H. axyridis*, ki se je razširila in zelo namnožila tudi v Sloveniji. Pred tem pa so potrebne še dodatne študije bionomije, možnosti prenosa in vpliva te parazitske ogorčice na domorodne vrste polonic. Zahvala za finančno podporo je namenjena ARRS (P4-0072).

ABSTRACT

First report of nematodes *Parasitylenchus bifurcatus* parasitising harlequin ladybirds *Harmonia axyridis* in Slovenia

In years 2015 and 2016 around 200 specimens of ladybird species *Harmonia axyridis* were collected from 6 different locations in Slovenia. Ladybirds were dissected and checked under stereomicroscope for presence of parasitic nematodes. Nematodes were discovered in two samples of ladybirds *H. axyridis* collected at Brdo pri Lukovici and Trboje. The incidence of parasitized ladybirds was around 30%. Nematodes were analysed morphometrically and the characteristic features of *Parasitylenchus bifurcatus* nematodes were observed: straight stylet lacking basal thickenings, a bursa and a forked tail tip in the vermiform females and juvenile males. The identity of found nematodes was confirmed with 18S rDNA region sequence (acc. no. LT629306 and LT629307) which showed high similarity (>99.9 % nucleotide identity) to the *P. bifurcatus* sequences in the public domain. This is a first report of nematode species *Parasitylenchus bifurcatus* Poinar and Steenberg found parasitizing ladybirds *H. axyridis* in Slovenia. Nematode species *P. bifurcatus* compromises fecundity of its host and has therefore a potential to be used as a biological control agent to control high abundance of invasive ladybirds of *H. axyridis* species. However, future studies on biology, possible transmission and effect of this parasitic nematode for native species of ladybirds is needed. Acknowledgement: financially supported by ARRS (P4-0072).



Spremljanje in napovedovanje populacij škodljivcev - kako nam avtomatski zajem podatkov ter umetna inteligenca pomagajo pri varstvu rastlin

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Trajnostni pristop k varstvu rastlin ter razvoj novih sredstev za varstvo rastlin zahtevajo boljše in hitrejše razumevanje stanja populacij žuželk, ki povzročajo gospodarsko škodo. Pri tem imajo pomembno vlogo dejavniki, kot je prisotnost rastlinskih vrst, na katerih določene žuželke povzročajo škodo, sredstva za varstvo rastlin, vremenske razmere, migracije in podobno. V prispevku bomo prikazali, kako z obširno mrežo avtomatskih vab v Sredozemskem bazenu spreminjamo način spremljanja populacije južne plodovrtke (*Helicoverpa armigera*) ter kako si pri identifikaciji škodljivca ter napovedovanju stanja v prihodnjih dneh pomagamo z algoritmi, ki temeljijo na umetni inteligenci.

ABSTRACT

Pest monitoring and forecasting - how big data and artificial intelligence re-define crop protection decisions

Crop protection development and striving for sustainable ways of growing food require better and faster understanding of targeted pest population. Crop distribution, crop protection, weather and pest migration play significant role in achieving this goal. Presentation will show how multi-country wide (Mediterranean basin) network of automated insect traps enables near real-time data, which is then used for determination of pest population and its forecasting based on artificial intelligence based algorithms.



Posterji



Mednarodna trgovina s sadjem in zelenjavo kot pomemben vir vnosa tujerodnih vrst škodljivih organizmov

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Mednarodna konvencija o varstvu rastlin (IPPC) je edini mednarodni organ za postavljanje standardov varstva zdravja rastlin, ki ga priznava sporazum WTO-SPS. Trenutno je v okviru IPPC sprejetih 37 mednarodnih standardov za fitosanitarne ukrepe (ISPM), ki jih spoštuje vsaj 182 držav podpisnic, z namenom preprečevanja trgovinskih ovir in varovanja zdravja rastlin po vsem svetu. Vsak fitosanitarni ukrep, kot sta zavrnitev ali odrejeno tretiranje neskladnih pošiljk, mora temeljiti na ISPM, ali pa biti znanstveno utemeljen v posebnih primerih, kadar ISPM ne obstaja. Ta načela se uporabljajo v sporazumih o prosti trgovini in v uvoznih predpisih držav, vključno z uvoznimi predpisi Evropske unije (EU). V skladu z ISPM št. 20 (2004): *Smernice za fitosanitarno zakonodajno ureditev uvoza*, inšpekcijske službe nacionalnih organizacij za varstvo rastlin v državah članicah EU ustavijo in preverijo blago rastlinskega izvora na zunanjih mejah EU, da preprečijo vnos karantenskih škodljivih organizmov ali omejijo vstop reguliranih nekarantenskih škodljivih organizmov z uvoženim blagom in drugimi nadzorovanimi predmeti. Poročila Evropske komisije na podlagi obsežnih rezultatov inšpekcijskih pregledov EU ter zadržanih neskladnih pošiljk sadja in zelenjave dokazujejo, da so take pošiljke pomemben vir tujih vrst rastlinskih škodljivih organizmov. Prikazani so nekateri podatki o polifagnih škodljivcih, najpogostejše ugotovljenih v obdobju 2014-2016, kot so: listni zavijač *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae); plodove muhe iz družine Tephritidae; ščitkarji iz družine Aleyrodidae; listni minerji iz družine Agromyzidae; ter resarji iz družine Thripidae.

ABSTRACT

International trade in fruits and vegetables as a significant source of introduction of alien plant pest species

The International Plant Protection Convention (IPPC) is the only international standard-setting body for plant health recognised by the WTO-SPS Agreement. Under the IPPC, 37 International Standards for Phytosanitary Measures (ISPMs) have currently been adopted and respected by at least 182 countries, aiming at global prevention of trade barriers and plant health protection. Any phytosanitary measure, i.e. rejecting a non-compliant consignment or requiring its subsequent treatment, shall be based on ISPMs, or it shall scientifically be justified in the specific cases of absence of an ISPM. These principles apply to the free trade agreements and to import regulations of different countries, including the EU import regulations. In line with ISPM No. 20 (2004): *Guidelines for a phytosanitary import regulatory system*, the inspection services of National Plant Protection Organisations of the EU Member States shall stop and subject to checks any goods of plant origin at the EU external border inspection posts so as to prevent the introduction of quarantine pests or to limit the entry of regulated non-quarantine pests with imported commodities and other regulated articles. As reported by the European Commission, based on the EU-wide inspection results and non-compliant consignment interceptions, the consignments of fruits and vegetables proved a significant source of introduction of alien plant pest species. Some figures are shown on the polyphagous pests, most frequently found in the period 2014-2016, including the False Codling Moth *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae); the fruit flies of the Tephritidae family, the white flies of the Aleyrodidae family, the leaf miners of the Agromyzidae family; and the thrips of the Thripidae family.



Vpliv z zvijanjem listov vinske trte povezanega virusa 1 in 3 na žlahtno vinsko trto *Vitis vinifera* L. v rastlinjaku

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Bolezen zvijanja listov vinske trte povzročajo z zvijanjem listov vinske trte povezani virusi (Grapevine leafroll associated viruses, GLRaVs) in je ena najpomembnejših in najbolj razširjenih virusnih boleznih vinske trte na svetu. Prizadene lahko vse sorte in podlage, vendar bolezenska znamenja niso nujno značilna oziroma prepoznavna pri vseh sortah vinske trte. Bolezenska znamenja so navadno povezana z odzivom vinske trte na okuženost z virusi, kar zmanjšuje učinkovitost fizioloških procesov. Fiziološke parametre (neto fotosintezo, dejansko in potencialno fotokemično učinkovitost PSII, prevodnost listnih rež, transpiracijo, koncentracijo CO₂ v listu, hitrost transporta elektronov po tilakoidi in vrednost klorofila) smo vrednotili s prenosnim merilnikom fotosinteze LI-6400, PAM-fluorometrom in SPAD napravo v nadzorovanih razmerah na trtah, okuženih z GLRaV-1 in GLRaV-3. V sredini rastne sezone se je negativni učinek na spremljane fiziološke procese v listih trte izrazil močneje pri mešani okužbi (GLRaV-1 in GLRaV-3) kot pri okužbi le z GLRaV-1

ABSTRACT

Effects of grapevine leafroll associated virus 1 and 3 infection on physiological parameters of *Vitis vinifera* L. in the greenhouse

Grapevine leafroll disease is one of the most severe viral diseases of grapevine caused by Grapevine leafroll-associated viruses (GLRaVs). It can affect all varieties and rootstock. Moreover, the symptoms are not necessarily characteristically and recognizable in all varieties of the grapevine. The symptoms on infected plants are usually associated with the response of the grapevine to virus infection, which lead to a reduction of efficiency of physiological processes which can be measured by physiological parameters. Physiological parameters (net photosynthesis, photochemical efficiency of PSII, quantum and maximum quantum yield of PSII, stomatal conductance, transpiration, leaf CO₂ concentration, electron transport rate and chlorophyll fluorescence) were estimated on grapevines infected with GLRaV-1 and GLRaV-3. Leaf gas exchange rates were measured under controlled conditions using an LI-6400 measuring system and PAM-fluorometer. In the mid of the season negative effects of the virus infections on physiological processes were more severe in mixed (GLRaV-1 and GLRaV-3) than in single infection with GLRaV-1.



Kako raznolika sta z zvijanjem listov vinske trte povezan virus 1 in 3 (GLRaV-1 in GLRaV-3) v izbranih slovenskih vinogradih?

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Bolezen zvijanja listov vinske trte povzročajo z zvijanjem listov vinske trte povezani virusi (*angl.* Grapevine leafroll-associated viruses; GLRaVs) iz družine *Closteroviridae*. Virusi se nahajajo predvsem v floemu okuženih rastlin ter povzročajo zvijanje listov in nekatere druge morfološke spremembe na listih vinske trte, kar vodi k zmanjšanju fizioloških procesov v trti ter neugodno vpliva na kakovost in količino pridelka. Zaradi naštetega uvrščamo nekatere od teh virusov med najnevarnejše in gospodarsko najpomembnejše viruse vinske trte. Naravni

prenašalci teh virusov so kaparji. Z njihovo pomočjo se virusi hitro širijo in lahko okužijo celotne vinograde v le nekaj letih. Povod naše raziskave je bila prisotnost GLRaV-1 in GLRaV-3 ter kaparjev v rodnih vinogradih v Sloveniji. GLRaV-1 in -3 sta najbolj razširjena virusa na vinski trti, ki povzročata veliko gospodarsko škodo v vinogradništvu. Oba virusa sta tudi precej raznolika, kar so ugotovili na podlagi zaporedij genov in genoma. V naši raziskavi smo na podlagi zaporedja gena HSP70h prvič ovrednotili genetsko raznolikost slovenskih izolatov GLRaV-1 in GLRaV-3. S filogenetskimi analizami smo pokazali, da se slovenski izolati vsakega virusa združujejo v dve skupini, skupino I in skupino II. Ti skupini sta tudi najbolj razširjeni skupini GLRaV-1 in GLRaV-3 v večini vinorodnih okolišev po svetu.

ABSTRACT

How diverse are the Grapevine leafroll-associated virus-1 and -3 (GLRaV-1 and GLRaV-3) in Slovenian vineyards?

Grapevine leafroll disease is caused by grapevine leafroll-associated viruses (GLRaVs) of the family *Closteroviridae*. They are considered one of the most important viruses of grapevine. The most characteristic symptom of infection is downward rolling of leaves and other morphological changes which lead to a reduction of physiological parameters and yield. They are mostly located in the phloem of infected plants. The only known natural vectors of GLRaVs are scale insects. They can spread the infection through the entire vineyards within a few years. The initiation of our research was the presence of GLRaV-1, GLRaV-3 and scale insects in vineyards in Slovenia. Furthermore, these viruses are the most widespread viruses in the world, causing great damage in viticulture. Considerable genetic diversity was reported for both viruses based on complete or partial genomic sequences. In our study genetic diversity of Slovenian isolates of GLRaV-1 and GLRaV-3 was evaluated on the basis of obtained HSP70h gene sequences. Phylogenetic analyses revealed clustering of analyzed Slovenian isolates of GLRaV-1 and GLRaV-3 into two groups, group I and II. Group I and II are also the most widespread groups of GLRaV-1 and GLRaV-3 in most winegrowing regions in the world.



Results of a two year survey (2015-2016) of quarantine whitefly species from genus *Aleurocanthus* Quaintance & Baker on citrus in Croatia

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Citrus production in Croatia has a great importance in agriculture and national economy. The most important production areas are located in central and southern Dalmatia, with mandarin production in the Neretva river valley being of greatest importance. Whiteflies (Hemiptera: Aleyrodidae), in particular non-European invasive species have become increasingly important pests of citrus in the Mediterranean basin, including Croatia. The greatest phytosanitary threat to the production of citrus in Croatia and other Mediterranean countries from the insect family Aleyrodidae represent quarantine species *Aleurocanthus spiniferus* Quaintance, 1903 and *Aleurocanthus woglumi* Ashby, 1915. High risk of introduction of these quarantine species was one of the main reasons for their inclusion on the list of priorities for survey during 2015 and 2016, which was implemented as a part of the national surveillance programme of citrus harmful organisms listed in Annex IAI and IIAI of Directive 2000/29/EC. The programme was accepted by the SANCO Plant Health Evaluation and co-financed by Grant Decision SANTE PH/2015/HR/SI2.701797. The main objective of two the year survey in citrus plantations was to determine the possible presence and current status of quarantine whitefly species from genus *Aleurocanthus*

in four coastal counties (Zadar, Šibenik-Knin, Split-Dalmatia and Dubrovnik-Neretva), particularly after the first finding and successful eradication of species *A. spiniferus* in Croatia in 2012. Presence of *A. spiniferus* and *A. woglumi* was investigated in citrus orchards, gardens and public areas on totally 50 localities on the coast and on the islands. Visual inspections with sampling leaves infested by whitefly larvae were combined with trapping of adults using yellow sticky traps. The whiteflies collected in leaves samples were identified to the species level on the basis of morphological characters of puparium and pupal case, using classical identification method according to the relevant morphological keys. *Aleurocanthus* species were not recorded in Croatia in 2015 and 2016. The most common species in samples of collected leaves was *Dialeurodes citri* Ashmead, 1885, a very important pest on all Citrus species throughout the citrus growing area in Croatia. Another very commonly identified whitefly species was *Aleurothrixus floccosus* Maskell, 1896. Japanese bayberry whitefly *Parabemisia myricae* (Kuwana, 1927) was found for the first time in Croatia in 2015 in lemon plantation, in Lumbarda on the island of Korčula.



Aphids (Hemiptera: Aphidoidea) on citrus plants in Croatia

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During faunistic investigations in 2015 and 2016, citrus plants were monitored in order to determine eventual presence of quarantine aphid *Toxoptera citricidus* (Kirkaldy) (Hemiptera: Aphididae). High risk of introduction of this quarantine pest was the reason for its inclusion on the list of priorities for the official survey during 2015, which was implemented as a part of the national surveillance program of citrus harmful organisms listed in Annex IAI and IIAI of Directive 2000/29/EC. Citrus production in Croatia has a great importance in agriculture and national economy. Faunistic investigations were conducted along the coastal area, especially in the southern counties with majority of citrus production. Monitoring was carried out in intensive and extensive orchards, gardens and public greenery on species within *Citrus* spp., *Fortunella* spp. and *Poncirus* spp. genera. Visual inspections were combined with sampling of leaves infested by aphids at approximately 90 localities. Collected aphids were identified to the species level on the basis of morphological characters, using classical identification method according to the relevant morphological keys. *T. citricidus* was not recorded during the two year investigations. The most common species identified in collected samples was *Aphis gossypii* Glover. Distribution and citrus host plants of all identified aphid species in Croatia will be reported.



Inventarizacija talnih hroščev v sadovnjaku Brdo

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Zastopanost in številčnost talnih vrst hroščev, v sadovnjaku Brdo še ni bila raziskana. S tem namenom smo v letu 2016 v okviru strokovne naloge nacionalnega akcijskega program (NAP-IVR) v sadovnjaku na Brdu pri Lukovici spremljali vrstno pestrost in številčnost na tleh aktivnih vrst hroščev. Talne hrošče smo vzorčili v ekološki in integrirani pridelavi jabolk. V ekološki pridelavi, kjer v času vzorčenja nismo izvajali varstva pred škodljivci, smo izvedli dva različna režima mulčenja: v obravnavanju EKOn smo mulčili 2-krat, v obravnavanju EKOk pa 5-krat. V integrirani pridelavi, kjer pa smo poleg mulčenja zatirali tudi listne uši, predvsem krvavo uš - *Eriosoma lanigerum* in jabolčnega zavijača - *Cydia pomonella*, smo mulčili 5-krat (obravnavanje IVR). Hrošče smo vzorčili s talnimi pastmi (vinski kis z dodanim etilen glikolom) v dvotedenskih razmikih od začetka maja do konca oktobra. V talne pasti so se najpogosteje lovile vrste hroščev iz družine krešičev (Carabidae): *Harpalus rufipes*, *Pterostichus melas*, *Nebria brevicollis*, *Poecilus cupreus* in družine sijajnikov (Nitidulidae): *Stelidota geminata*, *Glischrochilus quadrisignatus* in *Epurea* sp. Potrdili smo tudi navzočnost vrst: *Anchomenus dorsalis*, *Calathus fuscipes*, *Carabus coriaceus*, *Chlaenius nitidulus*, *Diachromus germanus*, *Harpalus affinis*, *H. griseus*, *Silpha obscura* in *Amara* sp. Na podlagi podatkov smo izračunali vrstno pestrost, številčnost ter Shannon-Wienerjev diverzitetni indeks za posamezna obravnavanja. Vpliv različne obdelave tal in načina pridelave na izračunane parametre je bil majhen. Največji SWI, največjo vrstno pestrost ter največjo številčnost smo zabeležili v obravnavanju IVR, a zaradi zasnovane poskusa ne moremo govoriti o značilnih razlikah med obravnavanji.

ABSTRACT

Ground beetle (Coleoptera: Carabidae) inventarisation in Brdo orchard

Abundance and diversity of ground beetles was investigated in Brdo orchard in 2016. Inventory of beetle fauna was one of the tasks within National action plan-Integrated pest management which aimed at providing information on species diversity and abundance of ground beetles. Field sampling in research orchard in Brdo (Lukovica) was carried out in different apple production systems (organic and integrated). Additionally, we reduced the frequency of mulching between rows by half of the organic production to attain an additional treatment. Treatments were: EKOn – organic apple orchard mulched only twice between rows; EKOk – organic apple orchard mulched 5 times during growing season; IVR – integrated production, where mulching was performed 5 times and the orchard also treated against leaf aphids, mostly woolly aphids (*Eriosoma lanigerum*) and *Cydia pomonella* within the sampling period. Beetles were sampled with pitfalls (containing vinegar and ethylene glycol) in two weeks intervals from the beginning of May until the end of October. The most abundant were beetles from Carabidae family (*Harpalus rufipes*, *Pterostichus melas*, *Nebria brevicollis*, *Poecilus cupreus*) and Nitidulidae family (*Stelidota geminata*, *Glischrochilus quadrisignatus* and *Epurea* sp.). We also identified *Anchomenus dorsalis*, *Calathus fuscipes*, *Carabus coriaceus*, *Chlaenius nitidulus*, *Diachromus germanus*, *Harpalus affinis*, *H. griseus*, *Silpha obscura* in *Amara* sp.. From the results we calculated Shannon-Wiener diversity indexes for all treatments. The impact of ground management and production system on biotic diversity and beetle abundance was minor. Highest Shannon-Wiener index was recorded in IVR treatment. Unfortunately, due to experimental design, we cannot derive conclusions on statistical significance of the treatments' on the beetle diversity and abundance.



Sezonska dinamika jabolčnega zavijača (*Cydia pomonella* [L.]) in breskovega zavijača (*Grapholita molesta* [Busck]) v intenzivnem nasadu jablan v Brkinih

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Od sredine marca do začetka oktobra 2014 smo v intenzivnem sadovnjaku jablan v vasi Beka preučevali pojavljanje jabolčnega zavijača (*Cydia pomonella* [L.]) in breskovega zavijača (*Grapholita molesta* [Busck]). Njuno številčnost smo spremljali s feromonskimi vabami Csalomon (tipa RAG) madžarskega proizvajalca (Plant Protection Institute, Hungarian Academy of Sciences) in vabami Trapview slovenskega proizvajalca (EFOS d.o.o., Razdrto). Metulji breskovega zavijača so se množično lovili že v prvem terminu spremljanja, sredi marca, in dosegli vrh pojavljanja (20,6 osebkov/vabo/dan). Škodljivec se je v sadovnjaku pojavljal do 2. dekade septembra. Najštevilčnejši je bil ulov metuljev 1. rodu. Zaznavnejše število samcev 2. rodu smo zabeležili od konca aprila do začetka maja, število ulovljenih metuljev poznejših rodov pa ni več preseгло 0,4 osebkov na dan. Prve samce jabolčnega zavijača smo na ploščah našli v 1. dekadi aprila, nato pa njihov pojav beležili vse do prve polovice septembra. Škodljivec je imel dva rodova. Najštevilčnejši ulov 1. rodu smo beležili od sredine do konca junija (4,4 osebkov/vabo/dan). Metulji sicer manj številčnega 2. rodu so bili najštevilčnejši od začetka do sredine avgusta. Ulov obeh škodljivcev je bil večji na elektronskih vabah Trapview. Na pojav in številčnost metuljev so vplivali tudi temperatura, padavine in zračna vlaga.

ABSTRACT

Seasonal dynamics of codling moth (*Cydia pomonella* [L.]) and oriental fruit moth (*Grapholita molesta* [Busck]) in an intensive apple orchard in Brkini

From the middle of March to the beginning of October 2014, the occurrence of codling moth (*Cydia pomonella* [L.]) and oriental fruit moth (*Grapholita molesta* [Busck]) was investigated in an intensive apple orchard in the village Beka. The abundance of both pests was monitored by Csalomon pheromone traps (type RAG) of Hungarian producer (Plant Protection Institute, Hungarian Academy of Sciences), and electronic traps Trapview of Slovenian producer (EFOS d.o.o., Razdrto). The first and most numerous occurrence of oriental fruit moth (20.6 males/trap/day) was established already in the first monitoring period in mid-March, and the pest appeared in the orchard until the 2nd decade of September. Moths of the 1st generation were the most numerous. A notable number of males of the 2nd generation was recorded from the end of April to the beginning of May, while the number of captured males of later generations was not higher than 0.4 specimens per day. First males of codling moth were found on plates in the 1st decade of April, and their occurrence was recorded until the first half of September. The pest had 2 generations. The most numerous catch of mass 1st generation was noted from the middle to the end of June (4.4 males/trap/day). Moths of the 2nd generation were the most numerous from the beginning until the middle of August. Catches of both pests were higher on the electronic traps Trapview. The occurrence and abundance of moths were also influenced by temperature, precipitation and humidity.



Sezonska dinamika malinove hrčice *Resseliella theobaldi* (Barnes) (Diptera, Cecidomyiidae) v dveh nasadih malin v Sloveniji

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Malinova hrčica *Resseliella theobaldi* (Barnes), (Diptera, Cecidomyiidae) je eden najpomembnejših škodljivcev malin (*Rubus idaeus* L.) v Evropi. Pri nas je bila prvič ugotovljena leta 1958. Škodljivec običajno razvije do tri rodove letno. V letu 2016 smo s feromonskimi vabami švicarskega proizvajalca (Andermatt Biocontrol AG) spremljali sezonsko dinamiko malinove hrčice *R. theobaldi* v nasadih malin na Brdu pri Lukovici in Šmihelu pri Novem mestu. Glede na ulove lahko sklepamo, da je odrasla hrčica pri nas navzoča v obdobju od sredine aprila do septembra in ima tri rodove. Najštevilčnejši je bil tretji rod škodljivca, ki se je pojavil v prvi dekadi avgusta, nalet pa je trajal do sredine septembra. Na lokaciji Šmihel so bili ulovi škodljivca manj številčni, saj smo v celotnem obdobju spremljanja našli zgolj dva osebkov.

ABSTRACT

Flight dynamics of Raspberry Cane Midge *Resseliella theobaldi* (Barnes) (Diptera, Cecidomyiidae) in two raspberry plantings in Slovenia

The raspberry cane midge *Resseliella theobaldi* (Barnes) (Diptera, Cecidomyiidae) is one of the most important pests of cultivated red raspberry (*Rubus idaeus* L.) throughout Europe. In Slovenia its occurrence was first reported in 1958. It usually develops three generations per year. The flight phenology of raspberry cane midge *Resseliella theobaldi* (Diptera, Cecidomyiidae) was monitored in 2016 with Swiss-made pheromone traps (Andermatt Biocontrol AG) in raspberry plantings at locations Brdo pri Lukovici and Šmihel pri Novem mestu. Based on the monitoring results in the first location it can be concluded that raspberry cane midges occur from middle of April until September and have three generation per year. The largest trap catches were observed in the first decade of August and at the beginning of September, during the third midge generation. In Šmihel the pest was less numerous as only two specimens were found during the time of investigation.



Sensitivity of the mycelia of plant pathogenic fungi to low temperature

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Over the last decade Serbia is among top world producers and exporters of raspberry. According to the FAOSTAT official data, an average production in the period 2004/2014 was 77,988 tons on the area of about 15,000 ha. The whole production is realized on properties of individual farmers, while a negligible amount is produced by small or medium companies. Plant disease causal agents severely affect raspberry production in all growing regions. Gray mold, caused by a phytopathogenic fungus *Botrytis cinerea*, is the major fruit disease, whereas spur blight, caused by *Dydimella applanata*, is by far the most important cane disease. Both species overwinter on diseased plant debris in the soil or in infected plant parts in the form of overwintering structures or mycelium. However, it is very difficult to claim that mycelium of the phytopathogenic fungi is the one that survives low winter temperatures. Instead, survival in plant material could be an outcome of the presence of hlamidospores, microsclerotia or some other overwintering structures. The fact that fungal pathogens survive short-term freezing in plant material is successfully used for the detection of latent infections in fruits and seeds. On the other hand, how long a young mycelium can survive exposure to freezing temperature is still unknown. Therefore, the aim of this study was to determine minimum freezing duration that had lethal effect to the mycelium of *B. cinerea* and *D. applanata*. Mycelium of *B. cinerea* and *D. applanata*, isolates, grown on PDA for three or seven days respectively, was inoculated on PDA plates and exposed to the temperature of -20 °C for 1-50 days. Afterwards, survival of the mycelium was assessed by additional 7-day incubation at 20°C and regrowth observation. The results showed that all tested isolates could not survive the temperature of -20 °C longer than 44 days. The differences between species, as well as among isolates of the same species will be discussed. The article is the result of activities within the project III46008 funded by the Ministry of Education, Science, and Technological Development of the Republic of Serbia.



Main quince diseases in Montenegro

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During the last several years a survey on quince diseases in Montenegro has been done. Although quince is grown mostly in home gardens, there are a few plantations of quince throughout the country. Quince fruits are poorly used for fresh consumption, but they are usually processed into compotes, sweet, jelly, jam, juice and brandy. Collected fruit is traditionally kept in the house over the year because of its specific aroma. The most important diseases of quince in Montenegro are quince leaf and fruit spot, quince brown rot and fire blight. Quince leaf and fruit spot, caused by *Diplocarpon maculatum* (Atk.) Jorstad, is widespread on quince trees and it develops at first as purple brown then black spots on leaves which may join together, leading to premature leaf fall; similar spots appears on the fruit which can become deformed. Brown rot of quince is caused by *Monilinia fructigena* (Aderh. & Ruhland) Honey and it usually manifests as brown spots that lately take over the entire fruit with development of concentric rings made of fungal sporodochia; the fruits became mummified and overwinter on branches or fall down to the ground prematurely. Fire blight, caused by phytopatogenic bacterium *Erwinia amylovora* (Burrill) Winslow et al., is an important disease of quince in Montenegro. Among the pome fruits, quince is the most susceptible to fire blight – infection of apple and pear usually appears if they were in a vicinity of diseased old trees of quince. The pathogen has been detected on quince shoots with typical symptoms of 'shepherd's crook' on their tips with brown discoloration under the bark and blighted leaves.



Okuženost jablan in hrušk z virusi v Sloveniji

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Najbolj razširjeni virusi jablan in hrušk so virus mozaika jablane (*Apple mosaic virus*, ApMV), virus klorotične pegavosti listov jablane (*Apple chlorotic leaf spot virus*, ACLSV), virus razbrazdanja debla jablane (*Apple stem pitting virus*, ASPV) in virus jamičavosti debla jablane (*Apple stem grooving virus*, ASGV). Okužbe s temi virusi pogosto ne sprožajo vidnih znamenj okužbe, kljub temu pa lahko povzročajo pomembne izgube pridelka, še posebno v mešanih okužbah. V letih 2014, 2015 in 2016 smo na navzočnost prej omenjenih virusov s serološkimi in molekularnimi metodami testirali več kot 130 vzorcev jablan in hrušk različnih sort in starosti iz 15 lokacij po Sloveniji. Ker ti virusi nimajo znanih prenašalcev in se ne prenašajo s cvetnim prahom, so vir okužbe predvsem okužene sadike. Ob vzorčenju smo zato poleg podatkov o starosti rastlin in sorti zbrali tudi podatke o statusu sadik. Testirana stara drevesa v travniških nasadih in vrtovih so bila vsa okužena z vsaj enim virusom. Večina je bila sočasno okužena s tremi virusi. Okužbe z ApMV, ACLSV, ASGV in ASPV so torej v Sloveniji prisotne že dalj časa. Tudi v intenzivnih nasadih smo potrdili zelo visoko stopnjo okužbe pri sortah, ki so bile vzgojene iz cepičev zbranih kar v rodni nasadih in ne iz matičnih dreves. Pri obeh vzorčenih drevesih sorte Granny Smith, ki sta bili vzgojeni iz nepreverjenega materiala iz rodni nasadov, smo tako našli mešano okužbo s kar štirimi virusi. Nasprotno smo okužbo s po enim virusom potrdili le pri dveh od skupno 15 vzorčenih sort iz certifikacijske sheme. Drevesa CAC (Conformitas Agraria Communitatis) izvora so bila bistveno bolj okužena, še posebno na škrup odporne sorte. Naši rezultati kažejo, da zagotavlja uporaba certificiranega razmnoževalnega materiala skoraj popolno odsotnost virusov, medtem ko je lahko CAC material močno okužen.

ABSTRACT

Viral infections of apples and pears in Slovenia

Apple mosaic virus (ApMV), *Apple chlorotic leaf spot virus* (ACLSV), *Apple stem pitting virus*, (ASPV) and *Apple stem grooving virus* (ASGV) are the most spread viruses of apple and pear. Infections with these viruses are frequently latent, but can cause severe yield losses, especially in mixed infections. Over 130 samples from apples and pears of different varieties and age from 15 locations in Slovenia were tested for the presence of ApMV, ACLSV, ASGV and ASPV in the years 2014, 2015 and 2016 using serological and molecular methods. Since these viruses are not known to be transmitted by vectors or pollen, the main source of infection is the planting material. Data about the type of planting material was therefore collected in addition to the age and variety of sampled trees. Old trees in extensive orchards and gardens were all infected. Most of them showed mixed infections with 3 viruses. These results show that infection with ApMV, ACLSV, ASGV and ASPV have been present in Slovenia for at least 50 years. A very high infection rate with up to 4 viruses was observed also in trees originating from graftwood collected in production orchards and not from mother trees. On the contrary only two out of 15 varieties sampled from certified material were infected, each only with one virus. CAC (Conformitas Agraria Communitatis) material showed much higher infection rate, especially trees of scab resistant varieties. Our results show that using certified propagating material mostly ensures the absence of viruses, whereas CAC material can be heavily infected.



Pojav glive *Gnomoniopsis smithogilvyi*, povzročiteljice rjavenja plodov kostanja, v Sloveniji

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Rjavenje plodov kostanja je nova gospodarsko pomembna bolezen evropskega pravega kostanja in njegovih križancev. Največjo škodo povzroča v nasadih žlahtnih sort pravega kostanja. Prizadene dozorevajoče plodove, ki zaradi rjavenja endosperma izgubijo tržno vrednost. Bolezen povzroča gliva *Gnomoniopsis smithogilvyi*. Gliva je endofit v kostanjevih poganjkih, cvetovih, ježicah in listih, njeno patogeno delovanje in pojav bolezenskih znamenj pa sta povezana oz. pogojena z biotskim in abiotskim stresom ter neustreznimi rastnimi razmerami. Med najpomembnejšimi sprožilnimi dejavniki za pojav boleznii so podnebne spremembe z vremenskimi ekstremi kot sta suša in visoke temperature v poznem poletju. Bolezenska znamenja so najbolj izrazita na plodovih (pege in lise na endospermu in kalčku, tkivo izgubi čvrstost in porjavi, pod semensko lupino se razvijejo črna trosišča in velike množine trosov), pokažejo pa se tudi na poganjkih in deblu (vzdolžne razpoke in razjede v skorji, na prvi pogled nekoliko podobne kostanjevemu raku). V Evropi je rjavenje kostanjev zaradi okužbe z glivo *G. smithogilvyi* znano od leta 2005. V letu 2016 smo bolezen ugotovili tudi pri nas, v nasadih pravega kostanja in evrojaponskih križancev na območju Krškega in na Goriškem. Bolezen je prizadela do 60 odstotkov plodov, delež simptomatičnih plodov pa se je med skladiščenjem in transportom še povečal. V prispevku opisujemo izbruh boleznii v nasadih kostanja in povzemamo epidemiologijo boleznii ter razvojni cikel povzročitelja.

ABSTRACT

Occurrence of the fungus *Gnomoniopsis smithogilvyi*, the causer of brown rot of nuts of chestnut in Slovenia

Brown rot of nuts of chestnut is an emerging economically important disease of sweet chestnut and its hybrids. The damage is most severe in sweet chestnut orchards. It causes browning of endosperm of ripened nuts and thus renders them unmarketable. The causative agent of the disease is *Gnomoniopsis smithogilvyi*. Besides being a pathogen of chestnut nuts the fungus lives as an endophyte in chestnut shoots, flowers, burrs and leaves. Its pathogenic role and the emergence of symptoms are associated with biotic and abiotic stress or unsuitable growing conditions. Among the most important trigger factors for disease expression are climate changes with weather extremes such as drought and high temperatures in late summer. Disease symptoms are most evident on chestnut fruits (lesions and spots develop on endosperm and embryo, the tissue loses consistency and becomes brown, black fruiting bodies with creamy white conidial masses erupt below the seed coat) but can also develop on shoots and trunk (longitudinal cracks and cankers in the bark slightly resembling chestnut blight). Brown rot of nuts of sweet chestnut caused by *G. smithogilvyi* is known in Europe since 2005. In 2016 the disease was observed for the first time also in Slovenia, in orchards of European chestnut and its hybrids near Krško and in Goriška region. The disease affected more than 60 % of fruits. Nevertheless the proportion of symptomatic nuts increased further during storage and transportation. In our presentation we report on the outbreak of the disease in sweet chestnut orchards in Slovenia and briefly describe epidemiology of the disease and life cycle of the causative agent.



Biotično varstvo kostanjeve šiškarice (*Dryocosmus kuriphilus* Yasumatsu) s parazitoidom *Torymus sinensis* v Sloveniji in sosednjih državah

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Kostanjeva šiškarica – *Dryocosmus kuriphilus* Yasumatsu velja za najnevarnejšega škodljivca pravega kostanja v svetovnem merilu. Po hitrosti širitve in obsegu škode zaseda visoko mesto na seznamu tujerodnih vrst, ki so v zadnjih letih osvojile v Evropo. Razširjenost gostiteljskih rastlin, visok razmnoževalni potencial in odsotnost naravnih sovražnikov, so vrsti omogočili, da je v novem okolju oblikovala velike populacije ter se hitro ustalila. Pojav in ustalitev v Evropi, kot tudi pri nas, je povezan z nastankom velike gospodarske škode v kostanjevih sestojih, ki se je odražala v zmanjšanju pridelka plodov, letnega prirasta lesa in medonosnosti kostanja. Z vnosom tujerodnega parazitoida *Torymus sinensis* v letu 2005, je Italija kot prva evropska država, začela uvajati metodo klasičnega biotičnega varstva kostanjeve šiškarice. Po uspešnem vnosu v Italiji, so se zgledovale še nekatere druge države. Francija je parazitoida vnesla leta 2010, naši sosedi Hrvaška in Madžarska pa leta 2014. V Sloveniji smo prvi vnos izvedli leta 2015. Na 6 lokacijah, na različnih območjih Slovenije smo izpustili skupno 600 samic in 300 samcev *T. sinensis*. Nadaljevali smo v letu 2016, ko smo izpustili skupno 900 samic in 450 samcev na 9 lokacijah, v oskrbovanih nasadih in naravnih sestojih kostanja. V obeh letih smo po vnosu izvedli kontrolo naselitve parazitoida. Z molekularnimi in morfološkimi metodami smo na večini lokacij potrdili prisotnost vrste *T. sinensis*, z izjemo nekaterih lokacij na V Slovenije, kjer je v letu 2016, po vnosu prišlo do pozebe. Stopnja parazitizma je bila v obeh letih nepričakovano visoka, gibala se je 13,2% do 84,9 %. Prisotnost parazitoida in visok odstotek parazitiranosti šišk (>70 %) smo v letih 2015 in 2016 potrdili tudi na drugih lokacijah v Sloveniji, kjer ni bil vnesen. Do podobnih ugotovitev so prišli tudi na Hrvaškem in Madžarskem. Razširjenost parazitoida *T. sinensis* in visoka stopnja parazitizma na celotnem območju regije, je posledica dolgoletnih in intenzivnih izpustov v Italiji ter hitre naravne širitve, ki je potekala v smeri vzhod, preko Slovenije, na Hrvaško in Madžarsko.

ABSTRACT

Biological control of *Dryocosmus kuriphilus* with parasitoid *Torymus sinensis* in Slovenia and in neighbouring countries

Chestnut gall wasp (CGW) (*Dryocosmus kuriphilus* Yasumatsu) is considered as the most harmful pest of chestnut worldwide. Due to its high rate of spread and negative ecological and economic impact, it could be ranked at the top of the list of alien species, which recently invaded Europe. Host plants availability, high reproductive potential and the absence of natural enemies, especially during their establishment period, were key factors for the population growth and quick establishment in new environments. The occurrence and establishment of *D. kuriphilus* in Europe, as well as in Slovenia is related with severe economic damage in *Castanea sativa* stands, causing decrease in chestnut fruit, wood and honey production. By introducing non-native parasitoid *Torymus sinensis* in 2005, Italy was the first European county, which started the classical biological control of CGW. Following successful biocontrol in Italy, parasitoid was introduced in France in 2010 and also in Croatia and Hungary in 2014. In 2015 was first introduced in Slovenia. In total 600 males and 300 females were released on 6 locations in different parts of Slovenia. In 2016 we carried on, 900 females and 450 males were released on 9 locations in orchards and in natural chestnuts stands. In both years the settlement was verified after the release. The presence of *T. sinensis* was confirmed with molecular analyses and morphological identification on most release sites, with the exception of same locations in Eastern part of Slovenia, in which in 2016 frost occurred soon after the release. The parasitism rate was unexpectedly high in both years, ranged from 13.2% to 84.9%. In years 2015 and 2016 the presence of *T. sinensis* and high parasitism rate (above 70 %) was detected also on non-release sites in different parts of Slovenia. The similar conclusions were found at the same time in neighbouring countries. High parasitism rate and widespread of *Torymus sinensis* in the region is the result of long term and intensive releases in Italy and its rapid natural spread towards east to Slovenia, Croatia and Hungary.



Mealybugs (Hemiptera: Coccomorpha) as unusual pests on vegetables in Croatia

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Mealybugs, as well as other scale insects, are polyphagous pests that feed on and damage nut and fruit trees, greenhouse plants, forest vegetation, woody and perennial ornamentals and house plants, but are rarely found on annual vegetable and arable crops. They feed on nearly all parts on host plants, causing a variety of symptoms and decreasing quality and quantity of yield in cultivated host plants. Indirect damages are a result of virus transmission and excretion of honeydew. Fruits covered with honeydew, and subsequently with sooty mould, are of lower or non-marketability. Faunistic research on scale insects that has been in progress in Croatia since 2005, led to discovery of two mealybug species harmful to vegetable crops. Those two species are *Peliococcus turanicus* (Kiritshenko, 1931), found on field peas on the island of Cres and *Planococcus citri* (Risso, 1813), found on several occasions on greenhouse vegetables. *P. turanicus* forms dense colonies on plant's root system, causing yellowing of the leaves and total plant decline. Finding of *P. turanicus* on pea was the first record of this species for Croatia, and first finding of this species on pea altogether. *P. citri* is a common and very polyphagous pest that feeds on hosts from more than 86 plant families, so its spread from greenhouse ornamentals to vegetables is not surprising. The species forms colonies on leaves, stems and fruits of host plants, causing their desiccation and total decline. Infested plants are often covered in honeydew and sooty mould. In Croatia *P. citri* has so far been registered on following vegetable hosts: tomato, chili peppers and sweet potato. Since both pests are polyphagous, their spread to new hosts, including vegetables, is to be expected.



Spremljanje dinamike naleta kapusove hrčice *Contarinia nasturtii* (Kieffer) (Diptera, Cecidomyiidae) v cvetači s feromonskimi vabami

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V letih 2012-2014 smo v posevkih cvetače spremljali dinamiko naleta kapusove hrčice *Contarinia nasturtii* (Kieffer) (Diptera, Cecidomyiidae) na več lokacijah po Sloveniji. V letu 2012 smo škodljivca spremljali na območju Gorenjske (Kovor). V letu 2013 smo spremljanju populacije v Kovorju dodali še lokaciji Jablje (osrednja Slovenija) in Bertoki (Primorska). V letu 2014 smo hrčico spremljali na lokacijah Jablje in Šentjakob (osrednja Slovenija). Za detekcijo smo uporabljali feromonske vabe švicarskega proizvajalca Andermatt Biocontrol. Feromonske kapsule smo menjali mesečno; bele lepljive plošče smo pregledovali v 7- do 10-dnevnem intervalu. Rezultati monitoringa nakazujejo, da se kapusova hrčica pri nas pojavlja skozi celo rastno sezono in ima do tri rodove na leto. V letu 2012 smo v Kovorju največji pojav *C. nasturtii* zabeležili v prvi dekadi septembra. V 2013 smo najštevilčnejši nalet v Bertokih zaznali konec junija in v začetku julija, v Jabljah v prvi dekadi julija in v Kovorju v 2. dekadi julija. V 2014 smo najštevilčnejši nalet v na lokaciji Šentjakob zabeležili v prvi dekadi julija in v Jabljah v drugi dekadi julija. V prispevku razpravljamo o pomembnosti zanesljivega monitoringa škodljivcev v okviru programov Integriranega varstva rastlin.

ABSTRACT

Monitoring of Swede midge *Contarinia nasturtii* (Kieffer) (Diptera, Cecidomyiidae) in cauliflower using pheromone traps

In seasons 2012-2014 dynamics of Swede midge *Contarinia nasturtii* (Kieffer) (Diptera, Cecidomyiidae) in cauliflower was investigated in several locations in Slovenia. In 2012 the pest was monitored in Gorenjska (Kovor). In the year 2013 the monitoring was performed in Kovor, Jablje (central Slovenia) and Bertoki (Primorska). In 2014 investigation took place in Jablje and Šentjakob (central Slovenia). Adults were monitored with pheromone traps of Swiss producer Andermatt Biocontrol. The pheromone capsules were changed monthly, while the midges caught on sticky traps were counted every 7th to 10th day. The results of monitoring indicate that *C. nasturtii* occurs during whole growing season in Slovenia and it has up to three generations per year. Highest number of Swede midges in 2012 was recorded in the first decade of September in Kovor. In 2013 in Bertoki the highest occurrence of the pest was observed at the end of June and in the beginning of July. In the same year midges were the most numerous in first decade of July in Jablje and in the 2nd decade of July in Kovor. In 2014 the highest number of midges was recorded in Šentjakob in first decade of July and in Jablje in the 2nd decade of July. The importance of reliable pest monitoring in the frame of Integrated Pest Management programmes is discussed.



Scale insects (Hemiptera: Coccoomorpha) on Mediterranean medicinal plants

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According to the definition by World Health Organization (WHO), medicinal plants are plants whose parts contain biologically active ingredient with therapeutic activity that can be used for chemical and pharmacological synthesis. Medicinal plants include annual, biannual or perennial, herbaceous and woody plant species that can be both wild and cultivated. Croatian landscapes, particularly those of the Mediterranean region, have always been known for their abundance of wild medicinal plants such as lavender, sage, chamomile, rosemary, laurel, Cistus and other. Faunistic research on scale insects that has been in progress in Croatia since 2005, led to the discovery of 15 scale insect species from 5 different families, on various medicinal plant species. Following species have so far been recorded: *Coccus hesperidum*, *Lichtensia viburni*, *Parthenolecanium corni* and *Saissetia oleae* from the family Coccidae, *Aonidiella aurantii*, *Aspidiotus nerii*, *Hemiberlesia rapax*, *Lecanodiaspis sardoa*, *Lindingaspis rossi* and *Parlatoria oleae* from the family Diaspididae, *Lecanodiaspis sardoa* from the family Lecanodidaspididae, *Icerya purchasi* from the family Margarodidae, *Planococcus citri*, *Pseudococcus calceolariae* and *Pseudococcus viburni* from the family Pseudococcidae.



Preučevanje sočasne uporabe entomopatogenih ogorčic (Rhabditida: Steinernematidae in Heterorhabditidae) in akaricidov v laboratorijskih razmerah

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Entomopatogene ogorčice (EO) so organizmi, ki se uporabljajo v programih biotičnega varstva rastlin. Z željo po razširitvi znanja o združljivosti EO s fitofarmaceutskimi sredstvi (FFS), smo preučili združljivost infektivnih ličink (IL) EO s petimi akaricidi v laboratorijskih pogojih. Učinke posameznih akaricidov na IL smo preučili v petrijevkah pri 15, 20 in 25 °C. Čas izpostavljenosti posameznemu akaricidu je bil 1, 4 in 24 ur. V raziskavo smo vključili 4 vrste EO: *Steinernema feltiae*, *S. carpocapsae*, *S. kraussei* in *Heterorhabditis bacteriophora*. Rezultati naše laboratorijske raziskave so pokazali, da je vrsta *H. bacteriophora* najbolj tolerantna med vsemi preučevanimi vrstami in jo lahko mešamo s skoraj vsemi akaricidi. Najbolj občutljiva vrsta EO na delovanje akaricidov se je v našem poskusu izkazala *S. feltiae*, katero lahko mešamo samo z dvema pripravkoma. Aktivna snov (a.s.), ki je najbolj ustrezna za mešanje z EO, je fenpiroksimat, ki je pri 25 °C povzročila smrtnost le IL vrste *S. feltiae* (44 %). A.s. abamektin in piretrin imata zelo negativen učinek na preživetje EO. Rezultati so pokazali, da je združljivost EO s FFS vrstno specifična lastnost. Poleg tega na preživetje IL vplivata tudi čas izpostavljenosti a.s. in temperatura. Sočasni nanos EO in akaricidov bi lahko predstavljal prednost v integriranem varstvu rastlin. Kombinacije EO in akaricida bi lahko prihranile čas in denar pri hkratnem obvladovanju različnih škodljivih organizmov (žuželke, pršice).

ABSTRACT

Research on compatibility of entomopathogenic nematodes (Rhabditida: Steinernematidae and Heterorhabditidae) and acaricides under laboratory conditions

Entomopathogenic nematodes (EPNs) are organisms that can be used in biological control of plants. In order to expand our knowledge about the compatibility of the EPNs to phytopharmaceuticals, we studied the compatibility of EPNs infective juveniles (IJs) to five acaricides under laboratory conditions. The direct exposure of acaricides to EPNs was studied in Petri dishes at 15, 20, and 25 °C. EPNs were exposed to acaricides for 1, 4, and 24 hours. Four EPNs species were included in our investigation; *Steinernema feltiae*, *S. carpocapsae*, *S. kraussei*, and *H. bacteriophora*. The results of our laboratory investigation have shown that *H. bacteriophora* was the most tolerant EPN species. *H. bacteriophora* can be mixed with almost all tested acaricides. On the other hand, the most sensitive EPN species was *S. feltiae*. Our observation showed that *S. feltiae* can be mixed only with two acaricides.

Active ingredient fenpyroximate proved to be the most suitable for mixing with EPNs. Our results showed that fenpyroximate was at 25 °C lethal only to *S. feltiae* (44 % mortality). The mortality of EPNs was highest in active ingredients abamectin and pyrethrin. Our results have confirmed, that compatibility of EPNs to acaricides is a species specific characteristic. The mortality of EPNs was influenced also by the exposure time, active ingredient, and temperature. The combined use of EPNs and acaricides could represent an advantage in integrated plant management. Combinations of EPNs and acaricides could save time and money in the simultaneous control of various pests (insects, mites).



Ali lahko resarje iz rodu *Scirtothrips* in vrsto *Thrips setosus* kmalu pričakujemo v Sloveniji?

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V Sloveniji je bilo doslej ugotovljenih 120 vrst resarjev (Thysanoptera), 90 vrst iz podreda Terebrantia in 30 vrst iz podreda Tubulifera. Gospodarsko škodljivih je relativno malo vrst, med temi pripada v rastlinjakih najvidnejše mesto cvetličnemu resarju (*Frankliniella occidentalis*), ki je v njih poleg navadne pršice (*Tetranychus urticae*) in rastlinjakovega ščitkarja (*Trialetrodes vaporariorus*) prevladujoča vrsta. Na prostem je pri nas najbolj škodljiv kozmopolit in polifag tobakov resar (*Thrips tabaci*), katerega poškodbe in posledična škoda se navadno v največjem obsegu pojavljajo na zelju, čebuli in poru. Zlasti zaradi hitrega širjenja, težavnega zatiranja in velike škodljivosti cvetličnega resarja v evropskih rastlinjakih po letu 1992, ko je bil prvič ugotovljen na Nizozemskem, so predstavniki reda Thysanoptera, ki imajo podobno bionomijo kot omenjeni škodljivci, v zadnjih 25 letih v Evropi deležni precejšnje pozornosti. V okviru Programa preiskav za ugotavljanje navzočnosti škodljivih organizmov rastlin smo v Laboratoriju za fitomedicino v letu 2016 ugotavljali zastopanost resarjev iz rodu *Scirtothrips* (*S. dorsalis*, *S. aurantii* in *S. citri*), v letu 2017 pa bomo, poleg navedenih, ugotavljali tudi morebitno pojavljanje resarja *Thrips setosus*, katerega zastopanost smo sicer v okviru Programa strokovnih nalog s področja zdravstvenega varstva rastlin spremljali že v letu 2016. Resarji iz rodu *Scirtothrips* so uvrščeni na Seznam II.A.I Direktive Sveta 2000/29/ES, resar *T. setosus* pa je uvrščen na EPPO opozorilni seznam. V prispevku bodo predstavljene vse štiri vrste resarjev, navedene bodo vse njihove najdbe v Evropi, njihovi najpomembnejši gostitelji in rezultati posebnega nadzora v Sloveniji v letu 2016. V zaključku bo podano mnenje avtorjev o možnostih pojava predstavljenih vrst resarjev v Sloveniji.

ABSTRACT

Can we expect *Scirtothrips* species and *Thrips setosus* in Slovenia soon?

120 Thysanoptera species were recorded so far in Slovenia; 90 species from Terebrantia suborder and 30 species from Tubulifera suborder. Relatively small number of thrips species are known as pests of cultivated plants. In greenhouses, beside two-spotted spider mite (*Tetranychus urticae*) and greenhouse whitefly (*Trialetrodes vaporariorus*), the most important Thysanopteran pest is western flower thrips (*Frankliniella occidentalis*), while in the open the most harmful is onion thrips (*Thrips tabaci*), which injuries and consecutive damage are usually most extensive in cabbage, onion and leek plants. Because of fast spreading, difficult control, and high damage potential of western flower thrips in European glasshouses after 1992, when it was first recorded in the

Netherlands, the Thysanoptera species with similar bionomics as mentioned pest, share special attention in the last 25 years. Within the framework of the Survey Programme we assessed the occurrence of *Scirtothrips* species (*S. dorsalis*, *S. aurantii* in *S. citri*) in the Laboratory of Phytomedicine in 2016, and in 2017 we will assess, beside mentioned, the potential occurrence of *Thrips setosus*, which occurrence we studied already in 2016 within the framework of Programme of expert duties in the field of plant health. Thrips from *Scirtothrips* genus are placed in the Annex II.A.I of Council Directive 2000/29/EC, while *T. setosus* is on the EPPO Alert List. In the paper all four thrips species will be presented, and all their previous records in Europe will be mentioned. In addition the most important hosts and the results of special survey in Slovenia in 2016 for all four species will be presented. As conclusion the author's opinion about the possibilities of occurrence of three *Scirtothrips* species and *T. setosus* in Slovenia will be presented.



Uporaba mikrosatelitnih markerjev za razlikovanje med populacijami koruznega hrošča *Diabrotica v. virgifera*

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Koruzni hrošč, *Diabrotica v. virgifera* LeConte (Coleoptera, Chrysomelidae), je gospodarsko pomemben škodljivec koruze v Severni Ameriki in Evropi. V Evropi je bil prvič ugotovljen leta 1992 v okolici beograjskega letališča Surčin v Srbiji. Kmalu po tej najdbi, kjer se je hrošč uspešno prilagodil, se je začel tudi nezadržno širiti tudi v sosednje države. Do leta 2003 je bil navzoč že v več evropskih državah. Leta 1998 so koruznega hrošča prvič našli tudi v Italiji, blizu beneškega letališča v Tessari. V letu 2003 je dosegel območje Vidma (Udine), v neposredni bližini slovensko-italijanske meje. V istem letu (2003) smo prvič ulovili nekaj osebkov koruznega hrošča tudi v Sloveniji, in sicer na zahodu, v bližini Nove Gorice, ter na vzhodu države, v Prekmurju. Predpostavljali smo, da so osebkulovljeni na vzhodu države pripadali populaciji, ki se je razširila iz Srbije (vzhodna populacija), tisti, ulovljeni pri Novi Gorici, pa iz severno-Italijanske, oz. zahodne populacije. V raziskavi smo želeli z uporabo mikrosatelitnih markerjev preveriti ali sta populaciji koruznega hrošča na vzhodu in zahodu Slovenije različni. Dodatno smo preverili, če se osebkulovljeni iz vzhoda in zahoda države razlikujejo v genetskem zapisu za prvo podenoto mitohondrijske citokrom oksidaze (COI) (DNA črtno kodiranje).

ABSTRACT

The use of microsatellite markers as a tool for distinction between western corn rootworm *Diabrotica virgifera virgifera* populations

The western corn rootworm (WCR), *Diabrotica v. virgifera* LeConte (Coleoptera, Chrysomelidae), is an economically important pest of maize *Zea mays* (L.) in North America and Europe. In Europe, WCR was first detected in 1992 around Belgrade airport Surčin in Serbia. Soon after this discovery, it has successfully adapted and began to expand into neighbouring countries. Until 2003, it was already present in several European countries. In 1998, WCR was first found in Italy, at Tessari airport near Venice. In 2003, it reached Udine, near the

Slovenian-Italian border. In the same year (2003) the first beetles were caught in the west of Slovenia, near Nova Gorica, and in the east of the country, in Prekmurje. We assumed that the individuals caught in the east of the country belonged to the population originating from Serbia (eastern population), whereas the ones caught near Nova Gorica belonged to the population originating from north Italy (western population). The aim of the study was to establish if the western and the eastern WCR population in Slovenia are genetically different. To investigate this we used two molecular approaches, namely microsatellite markers, and DNA (COI) barcoding.



Preizkušanje učinkovitosti rumenih lepljivih plošč Bio Plantella - Unichem, Pherocon AM/NB - Trécé in Pals - CSalomon® za spremljanje koruznega hrošča (*Diabrotica v. virgifera*)

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Koruzni hrošč (WCR) (*Diabrotica v. virgifera* LeConte [Coleoptera, Chrysomelidae]) je gospodarsko pomemben škodljivec koruze v Severni Ameriki in Evropi. Glede na gospodarski pomen te vrste je potrebno spremljati njegovo širjenje in številčnost populacije, da lahko ustrezno in pravočasno ukrepamo. Najustreznejši način za ugotavljanje praga škodljivosti koruznega hrošča temelji na ugotavljanju števila hroščev ulovljenih na rumene lepljive plošče. Tako na osnovi ocenjevanja številčnosti hroščev v tekočem letu ugotavljamo gospodarsko škodo, ki bi jo naslednje leto povzročile ličinke z objedanjem korenin koruze. Prag gospodarske škode je izračunan za rumene lepljive plošče (Pherocon AM/NB) in znaša 40 hroščev na ploščo na teden, oziroma približno 6 odraslih osebkov na ploščo na dan. Namen poskusa je bil preizkusiti učinkovitost treh različnih tipov rumenih lepljivih plošč, ki se v praksi uporabljajo za ugotavljanje populacijske dinamike škodljivca. Poljski poskusi so v letu 2016 potekali na petih lokacijah po Sloveniji (Planina pri Uncu, Šmartno pri Slovenj Gradcu, Poljče pri Braslovčah, Skakovci in Draškovcu). Preskušali smo rumene lepljive plošče proizvajalcev Unichem, Trécé in CSalomon®. Največ hroščev se je ulovilo v drugi polovici avgusta; drugi vrh naleta smo zabeležili septembra. Na vseh petih proučevanih lokacijah se je največ koruznih hroščev ujelo na plošče PALs CSalomon®. Po padajoči številčnosti ulova so nato sledile Pherocon AM/NB – Trécé in Bio plantella – Unichem. Prag gospodarske škode, ocenjen s ploščami Pherocon AM/NB, je bil presežen v Planini Pri Uncu in sicer konec julija (27.7. 2016), kjer je prišlo tudi do poleganja koruze.

ABSTRACT

Evaluation of yellow sticky traps Bio Plantella - Unichem, Pherocon AM/NB - Trécé in Pals - CSalomon® for monitoring of *Diabrotica v. virgifera*

The western corn rootworm (WCR), *Diabrotica v. virgifera* LeConte (Coleoptera, Chrysomelidae), is an economically important pest of maize *Zea mays* (L.) in North America and Europe. Considering the economic importance of this species, it is necessary to monitor its spreading and population density, so as to be able to take adequate and timely management decisions. The most appropriate means to assess economic threshold is based on determining the number of WCR caught on yellow sticky traps. Assessing the number of WCR in the

current year enables us to determine potential economic damage caused by larvae feeding on corn roots in the course of a subsequent year. The economic threshold set for yellow sticky traps of the type Pherocon AM/NB is 40 beetles per trap per week or approximately 6 beetles per trap per day. The purpose of the experiment was to test efficiency of three different types of yellow sticky traps that are used to determine the population dynamics of the pest. In 2016, field trials took place in five locations across Slovenia (Planina near Unec, Šmartno near Slovenj Gradec, Poljče near Braslovče, Skakovci and Draškovec). We tested yellow sticky traps produced by Unichem, Trécé in Csalomon®. The WCR flight peaked in the second half of August. Additionally, also a second flight peak was observed in September. In all of the locations studied, the highest number of WCR was caught on PALS Csalomon® traps followed by Pherocon AM/NB–Trécé and Bio plantella–Unichem traps. The economic threshold determined by Pherocon AM/NB traps was exceeded on July 27th 2016 in Planina near Unec, where we also observed lodging of corn plants.



Vpliv gnojenja z organskimi gnojili, mineralnim dušikom in razlike med hibridi na poškodbe koruzne vešče – rezultati preliminarnih poskusov

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Koruzna vešča, *Ostrinia nubilalis* Hübner, je med najpomembnejšimi škodljivci pri pridelavi koruze (*Zea mays* L.) v osrednji Evropi. Poleg neposredne škode, ki jo vešča povzroča, so poškodovane rastline dovzetnejše tudi za glivne okužbe, v naših razmerah predvsem iz rodu *Fusarium* spp., redkeje *Aspergillus flavus*. Zaradi pomanjkanja ustrezne mehanizacije so možnosti neposrednega kemičnega zatiranja v Sloveniji omejene, zato prisotnost škodljivca in škode poskušamo zmanjšati z različnimi agrotehničnimi ukrepi. Drobljenje (mulčenje), zaoravanje koruznice in uničevanje vmesnih gostiteljskih rastlin so splošno priporočeni ukrepi, manj poznane pa so razlike med hibridi (mehanizmi tolerantnosti) in vpliv gnojenja. Da bi preverili smiselnost preučevanja omenjenih tematik, smo v letu 2016 izvedli več poljskih poskusov. V Jabljah (osrednja Slovenija) in Rakičanu (severovzhodna Slovenija) smo spremljali pojav in poškodbe koruzne vešče pri hibridih zrelostnih razredov FAO 200–490. Dodatno smo v trajnem gnojilnem poskusu IOSDV v Jabljah spremljali vpliv gnojenja z organskimi gnojili (hlevski gnoj, zaoravanje rastlinskih ostankov) in količine dodanega mineralnega dušika (0, 100, 200 in 300 kg N/ha) na delež poškodovanih storžev. Opazili smo, da je bil delež poškodovanih storžev značilno večji v Rakičanu. Med hibridi se nakazujejo razlike, a je za zaključke še premalo podatkov, potrebni so večletni in natančnejši poskusi. Delež poškodb v Rakičanu je značilno padal z naraščanjem zrelostnega razreda, medtem ko v Jabljah ta odnos ni bil značilen. Med pridelki in deležem poškodb ni bilo značilnih korelacij. Pri načinih gnojenja smo opazili razlike. Značilen vpliv na delež poškodovanih storžev zaradi vešče je imelo gnojenje z mineralnim N, medtem ko gnojenje z organskimi gnojili ni imelo vpliva. Interakcije med obema dejavnikoma prav tako niso bile značilne. Med gnojenjem z N in poškodbami storžev zaradi vešče smo opazili močno linearno povezanost; z večanjem odmerka N se je delež poškodovanih storžev povečeval (v povprečju za 0,12 odstotkov na kg dodanega N). Kljub povečanju poškodb so z večanjem odmerka N značilno naraščali tudi pridelki. Preliminarni poskusi nakazujejo na razlike v poškodbah storžev med hibridi (obstoj morebitnih razlik v mehanizmih tolerantnosti/odpornosti) in močan vpliv gnojenja z N na delež poškodovanih storžev zaradi vešče.

ABSTRACT

Effect of fertilisation with organic fertilisers, mineral nitrogen and differences between hybrids on the European corn borer damages – the results of preliminary trials

European corn borer, *Ostrinia nubilalis* Hübner, is among the most important pests of maize (*Zea mays* L.) in central Europe. In addition to the direct damage caused by the corn borer, are damaged plants also more susceptible to fungal infections (in our conditions mainly *Fusarium* spp., rarely *Aspergillus flavus*). Due to the lack of appropriate machinery is direct chemical control limited in Slovenia. Therefore are only different agro-technical measures available to reduce the borer occurrence and damages. Mulching, incorporation of maize straw and destroying host plants are generally recommended measures. Less information's are available on hybrids tolerance/resistance or on the effects of fertilisation. Several field trials were established in Jablje (central Slovenia) and Rakičan (north-eastern Slovenia) in 2016 for preliminary study of above mentioned topics. Differences in maize hybrids damages were studied in maturity classes FAO 200-490. Impact of organic fertilisers (manure, crop residues incorporation) and mineral nitrogen (0, 100, 200 and 300 kg N/ha) was studied in long term IOSDV trial at Jablje. Results show that there was significantly higher percentage of damaged cobs in Rakičan. Some differences among hybrids were observed; however for any conclusions more data (years) and more detailed study is required. Percentage of damaged cobs declined with increasing maturity class in Rakičan, while at Jablje this relationship was not significant. No significant correlations were observed between the yields and percentage of damaged cobs. In IOSDV trial were differences between the fertilisations treatments observed. Mineral N had significant impact on the percentage of damaged cobs, while organic fertilizers showed no effect. Interactions between the two factors were also non-significant. Strong linear relationship was observed between the mineral N and damaged cobs. Increasing rates of N increased the percentage of damaged cobs (an average of 0.12 percent per kg of added N/ha). However, increased rate of N also significantly increased yields, regardless of the increase of damaged cobs. Results of preliminary trials suggest on possible differences in cob damages between the hybrids (differences in hybrids resistance mechanisms) and on high impact of N fertilisation on the damage of European corn borer. Nevertheless, further detailed trials should be implemented to validate these early findings.



Spremljanje zastopanosti štirih vrst skladiščnih škodljivcev iz redu metuljev s feromonskimi vabami

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Različne vrste moljev iz reda Lepidoptera so pogosti škodljivci uskladiščenih pridelkov žit in drugega živeža. V Sloveniji med najbolj zastopane spadajo vrste koruzni molj (*Sitotroga cerealella* [Oliver], Gelechiidae), žitni molj (*Nemapogon granella* L., Tineidae), krhljev molj (*Plodia interpunctella* [Hübner], Pyralidae) in močna večša (*Ephestia kuehniella* Zeller, Pyralidae). Njihovo zastopanost smo v letu 2015 in 2016 spremljali s pomočjo feromonskih vab, v skladišču žit Infrastrukturnega centra Jablje Kmetijskega inštituta Slovenije v Mengšu. Najštevilčnejši so bili ulovi koruznega molja, pri katerem smo zabeležili pojav dveh rodu. Največje ulove krhljevega molja in močne večše smo v letu 2015 zabeležili v prvi dekadi julija, v letu 2016 pa mesec dni kasneje. Populacija žitnega molja je bila v obeh letih najmanj številčna.

ABSTRACT

Monitoring of four lepidopteran stored grain pests with a pheromone – baited traps

Grain lepidopteran pests often attack stored grains and food commodities. Angoumois grain moth (*Sitotroga cerealella* [Oliver], Gelechiidae), European grain moth (*Nemapogon granella* L., Tineidae) Indianmeal moth (*Plodia interpunctella* [Hübner], Pyralidae) and Mediterranean flour moth (*Ephestia kuehniella* Zeller, Pyralidae) are commonly present in Slovenia. In 2015 and 2016 pheromone traps were used to monitor their occurrence in grain warehouse of the Infrastructural center Jablje of the Agricultural Institute of Slovenia in Mengeš.

Indian mealmoth was the most numerous, developing two generations per year. Captures of Indianmeal moth and Mediterranean flour moth were most numerous in first decade of July in 2015 and a month later in 2016. European grain moth was the least common in both years of investigation.



Influence of spinosad and spinetoram on *Sitophilus granarius* (L.) and *Sitophilus oryzae* (L.) offspring production and wheat grain damage rates

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Weevils *Sitophilus granarius* and *Sitophilus oryzae* are the most important primary pests of stored wheat. Aiming towards improving the existing control methods, the present study focused on examining of spinosad and spinetoram efficacy after 21 days of *S. granarius* and *S. oryzae* adults exposure in treated wheat grain and their influence on weevils offspring production and wheat grain damage rates. Investigation was conducted under laboratory conditions at 25±1°C and 70±5% r.h. Both insecticides were applied to untreated wheat grain with 12.3±0.1% of m.c. at the rates of 0.5, 1.0 and 2.0 mg a.i./kg for both weevil species. Then, 25 adults were added to each plastic dish containing 50 g of treated wheat, in six replicates, for each insecticide/species tested. Mortality of weevils was determined after 21 days, and the effect on progeny production was determined seven weeks after parental exposure. When the offspring were counted, damage caused by the weevils were also assessed on 100 randomly selected kernels. Spinosad and spinetoram demonstrated the highest mortality (96-100%) of *S. granarius* and *S. oryzae* parents after 21 days of contact with 1-2 mg/kg and 2 mg/kg, respectively. The highest *S. granarius* offspring reduction (>90%) was found in wheat treated with 2 mg/kg spinosad and 1-2 mg/kg spinetoram, while *S. oryzae* offspring reduction was the greatest in wheat treated with 2 mg/kg spinetoram. In these experimental conditions, the percentage of grains damaged by *S. oryzae* was ≥50% in wheat treated with 0.5-1 mg/kg spinosad and 0.5 mg/kg spinetoram, while grain damage below 5% was found only in wheat treated with 2 mg/kg spinetoram. The results show that spinetoram was more effective than spinosad. Also, *S. granarius* was more susceptibility to both insecticides than *S. oryzae*. Under these experimental conditions, spinosad and spinetoram can be successfully used to control both weevil species at the rate of 2 mg/kg.

IZVLEČEK

Vpliv spinosada in spinetorama na potomstvo črnega žitnega žužka (*Sitophilus granarius* [L.]) in riževega žužka (*Sitophilus oryzae* [L.]) ter na delež poškodb na zrnju pšenice

Rilčkarja *Sitophilus granarius* in *Sitophilus oryzae* uvrščamo med najpomembnejše primarne škodljivce skladiščene pšenice. S ciljem obogatitve znanja o obstoječih načinih varstva uskladiščenih žit smo se v pričujoči raziskavi osredotočili za preučevanje učinkovitosti spinosada in spinetorama po 21. dnevnem tretiranju odraslih osebkov vrst *S. granarius* in *S. oryzae*. Zanimal nas je tudi vpliv obeh pripravkov na številčnost potomcev in poškodovanost zrnja pšenice. Poskus je potekal v laboratoriju pri temperaturi 25±1°C in relativni zračni vlagi 70±5%. Oba insekticida sta bila tretirana na žito, ki je vsebovalo 12.3±0.1% vlage pri koncentracijah 0.5, 1.0 in 2.0 mg a.s./kg. Omenjene koncentracije so bile uporabljene za obe preučevani vrsti. V plastično posodo, ki je vsebovala 50 g tretiranega zrnja, smo dali 25 odraslih osebkov izbranega škodljivca. Za vsako obravnavanje in vrsto žuželke je bil poskus ponovljen šestkrat. Smrtnost odraslih žužkov smo spremljali 21. dan po tretiranju. Po sedmih tednih smo ugotavljali vpliv obeh insekticidov na razvoj potomcev pri obeh preučevanih vrstah žuželk. Ob štetju potomcev

smo ocenili tudi delež poškodb na žitu, pri čemer se je neodvisno vzelo vzorec, ki je vseboval 100 pšeničnih zrn. Spinosad in spinetoram sta povzročila najvišjo smrtnost (96-100%) odraslih osebkov vrst *Sitophilus granarius* in *Sitophilus oryzae* po 21. dneh pri koncentracijah 1-2 mg/kg. Največje zmanjšanje potomstva (>90%) je bilo pri vrsti *S. granarius* doseženo ob uporabi 2 mg/kg spinosada ter 1-2 mg/kg spinetorama, medtem ko se je potomstvo pri vrsti *S. oryzae* najbolj zmanjšalo ob uporabi spinetorama v koncentraciji 2 mg/kg. Več kot 50 % delež poškodb na žitu smo pri vrsti *S. granarius* opazili pri uporabi 0.5-1 mg/kg spinosada in 0.5 mg/kg spinetorama. Manj kot 5 % delež poškodb na žitu je bil dosežen le ob uporabi 2 mg/kg spinetorama. Rezultati naše raziskave so pokazali, da je spinetoram bolj učinkovit za zatiranje skladiščnih škodljivcev kot spinosad. Vrsta *S. granarius* je bila bolj občutljiva na oba preučevana pripravka kot vrsta *S. oryzae*. V razmerah našega poskusa sta bila oba pripravka učinkovita pri zatiranju črnega žitnega žužka in riževega žužka pri koncentraciji 2 mg/kg.



Korenje po Evropi je pogosto okuženo z bakterijo 'Candidatus Liberibacter solanacearum', ki se prenaša s semenom in žuželčimi prenašalci - kako je pri nas?

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Bakterija 'Candidatus Liberibacter solanacearum' (Liefing *et al.*, 2009) je po Gramu negativna bakterija omejena na floem gostiteljskih rastlin in hemolimfo žuželčnih prenašalcev, različnih bolšic. Največjo nevarnost predstavlja bakterija za krompir (*Solanum tuberosum* L.) pri katerem okužba povzroča značilno progavost notranjosti gomoljev (angl. »zebra chip«) zaradi katere so gomolji neuporabni za namene pri katerih je pomemben tudi njihov videz (npr. za čips, ocvrt krompirček). Poleg krompirja bakterija okužuje paradižnik (*Solanum lycopersicon*), papriko (*Capsicum annum*), jajčevce (*Solanum melongena*) ter druge rastline iz družine razhudnikovk in rastline iz družine kobulnic (Apiaceae). Bakterija je razširjena v Severni in Srednji Ameriki, kjer jo prenaša bolšica *Bactericera cockerelli*, ki v Evropi ni navzoča. V Evropi bakterije na krompirju še niso našli. V Evropi o njenem pojavljanju poročajo v pridelavi korenja (*Daucus carota*), zelene (*Apium graveolens*) in pastinaka (*Pastinaca sativa*), tako z juga Evrope, iz Španije in Francije (Munyanza *et al.*, 2010; Alfaro-Fernández *et al.*, 2012; Loiseau *et al.*, 2014), Nemčije (Munyanza *et al.*, 2015), kot tudi iz skandinavskih držav (Munyanza *et al.*, 2011 in 2012). Bolezenska znamenja na nadzemnih delih okuženih rastlin so podobna znamenjem kakršna povzročajo fitoplazme. Pojavlja se zakrnela rast, rozetavost, rumenenje in vijolična obarvanost listov, izraščanje stranskih poganjkov in motena tvorba plodov. Koreni okuženih kobulnic so manjši in tvorijo več stranskih korenin. Bakterija se na daljše razdalje prenaša z okuženim semenom (Bertolini *et al.*, 2015) in med rastlinami z okuženimi bolšicami. V Sloveniji bakterije 'Ca. Liberibacter solanacearum' v prvem letu programa preiskav z laboratorijsko analizo petih vzorcev rastlin korenja nismo ugotovili. V prispevku bomo povzeli informacije pomembne za izvajanje vizualnih pregledov, vzorčenje in laboratorijsko diagnostiko 'Ca. Liberibacter solanacearum' ter njen pomen za Slovenijo.

ABSTRACT

Carrots in Europe are frequently infected with seed and vector transmitted bacteria 'Candidatus Liberibacter solanacearum' - what is the situation in Slovenia?

Bacterium 'Candidatus Liberibacter solanacearum' (Liefing *et al.*, 2009) is a Gram negative bacterium limited to the phloem of host plants and hemolymph of its insect vectors. It causes zebra chip of potato (*Solanum tuberosum* L.) making the tubers unusable for production of fries and chips. It also infects tomato (*Solanum lycopersicon*), pepper (*Capsicum annum*), eggplant (*Solanum melongena*), and other plants of Solanaceae and Apiaceae families. 'Ca. Liberibacter solanacearum' is widespread in North and Central America where it is efficiently transmitted by potato psyllid, *Bactericera cockerelli*. This psyllid is not known to occur in Europe. Also, the bacterium has

not been reported on potatoes in Europe but has been reported to occur in carrots (*Daucus carota*), celery (*Apium graveolens*) and parsnip (*Pastinaca sativa*) from the south and north of Europe including Spain, France, Germany and Scandinavian countries (Munyaneza *et al.*, 2010; Alfaro-Fernández *et al.*, 2012; Loiseau *et al.*, 2014; Munyaneza *et al.*, 2015). Symptoms on above ground plant parts are similar to those caused by phytoplasma and include stunting, chlorosis and purpling of foliage, rosetting, axillary branches or aerial tubers, and disruption of fruit set, and the production of numerous, small, misshapen and poor quality fruits. Infected roots of plants of Apiaceae family are smaller and show proliferation of secondary roots. In carrots, bacterium can be spread long distance with infected seeds (Bertolini *et al.*, 2015) and between infected plants with infected psyllids. In the first year of survey in Slovenia five samples of carrots were analysed for the presence of 'Ca. Liberibacter solanacearum' and were negative. Here, we summarize the information relevant to the survey including visual inspections, sampling and diagnostics of 'Ca. Liberibacter solanacearum', as well as its relevance to Slovenia.



Program preiskav preverjanja zastopanosti bakterije *Pantoea stewartii* v rastlinah in semenu koruze (*Zea mays* L.)

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Z letom 2017 v Sloveniji začnemo s programom preiskav v okviru katerega bomo preverjali prisotnost bakterije *Pantoea stewartii*, povzročiteljice bakterijske uvelosti koruze. Ni znano, da bi se bakterija pojavljala v Evropi in je uvrščena v priložo II.A.I Direktive Sveta 2000/29/ES ter na seznam A2 pri Evropski organizaciji za varstvo rastlin (EPPO). Bolezen je navzoča in razširjena v ZDA in nekaterih drugih državah, kjer jo učinkovito prenaša ameriška vrsta bolhačev, koruzni bolhač (*Chaetocnema pulicaria*; *Coleoptera*, *Crysmelidae*: *Alticine*) v katerem bakterija uspešno prezimi. Poglavitna gostiteljska rastlina je koruza (*Zea mays* L.). Najbolj občutljiva je sladka koruza (*Zea mays* convar. *saccharata* var. *rugosa*). Občasno se lahko okužijo tudi druge rastline: plevel sivozeleni muhvič (*Setaria pallide-fusca*), nekatere trave, ki se gojijo za krmo: teosinta (*Zea mexicana*) in *Tripsacum dactyloides* ter srečni bambus (*Dracaena sanderiana*). Pri okuženih rastlinah se razvije bodisi uvelost sadik bodisi ožig listov. Populacija koruznega bolhača ima bistven vpliv na pojav bolezni zato jih na okuženih območjih spremljajo z namestitvijo rumenih lepljivih plošč. Na dolge razdalje se bolezen širi predvsem z okuženim semenom pri katerem so bakterije lahko prisotne na površini ali v notranjosti semena. Z vidika tveganja vnosa na območje Slovenije je najbolj rizičen vnos semena iz območij, kjer je bolezen navzoča, še posebej če gre za seme sladke koruze. V prispevku so predstavljene informacije, ki pomembno vplivajo na izvedbo programa preiskave. Poleg informacij o biologiji, simptomatiki, poteh prenosa in možnosti širjenja, je predstavljen način, kako se na podlagi znanih geografskih podatkov (raba zemljišča) uporabi ustrezno metodiko načrtovanih zdravstvenih pregledov rastlin, vzorčenj in testiranj v skladu z uveljavljenimi diagnostičnimi metodami.

ABSTRACT

Survey on the presence of bacterium *Pantoea stewartii* in plants and seeds of maize (*Zea mays* L.)

In 2017, the national plant health authorities are starting with a national survey on *Pantoea stewartii*, the causative agent of Stewart's disease in maize (*Zea mays* L.). *P. stewartii* is not known to occur in Europe and is listed as a quarantine organism (Annex II.A. of Council Directive 2000/29/EC and A2 list of the European Plant Protection Organization (EPPO)). The disease is present and widespread in the US and some other American countries. In the USA, *Chaetocnema pulicaria* is the only known efficient vector and an overwintering site of the bacterium.

Yellow sticky traps can be used to follow their populations which are significant for the disease development. The main host plant is maize (*Zea mays* L.), among which the most sensitive is sweet corn (*Zea mays* convar. *saccharata* var. *rugosa*). *P. stewartii* occasionally infects other plants: pale pigeongrass (*Setaria pallida-fusca*), some grasses grown for forage e.g. teosinte (*Zea mexicana*) and *Tripsacum dactyloides*, and lucky bamboo (*Dracaena sanderiana*). Infected plants develop either seedling wilt or leaf blight. While *Pantoea stewartii* is indigenous to America it has been introduced to other parts of the world with maize seeds in which it is present both on the outside and on the inside. The highest risk of introduction to Slovenia is therefore associated with seeds originating from areas where the disease is known to occur, especially with seeds of sweet corn. In this article we summarize the information relevant to the survey including the biology of the disease, symptomatology, possible pathways of introduction, visual inspections, sampling and testing in accordance with established diagnostic protocols, and the aid of geographic data for appropriate planning of visual inspections.



Glivične bolezni soje v Sloveniji

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Pridelovanje soje se je v Sloveniji začelo uveljavljati v zadnjem desetletju. Površina njiv s sojo je v Sloveniji narasla s 50 ha v letu 2008 na 2500 ha v letu 2016. O boleznih in škodljivcih, ki bi se v naših rastnih razmerah lahko širili in ogrožali pridelovanje soje, doslej ni bilo podatkov. Glivične bolezni v svetovnem merilu zmanjšajo pridelek za okrog 10 %. Pričakovati je, da se bodo z večanjem obsega pridelave stopnjevale tudi težave povezane z boleznimi. Da bi ugotovili navzočnost za sojo patogenih gliv v Sloveniji in njihovo razširjenost, smo v letih 2015 in 2016 pregledali 26 posevkov v različnih območjih Slovenije. Glive smo identificirali na osnovi morfoloških značilnosti in z molekularno metodo. Na polovici pregledanih njiv ali pogosteje smo potrdili navzočnost gliv iz kompleksa *Diaporthe/Phomopsis*, rjave listne pegavosti soje (*Septoria glycines*) in gliv iz rodu *Colletotrichum*. Vse omenjene glive se prenašajo tako s semenom kot preko tal z ostanki okuženih rastlin. Rjava listna pegavost soje v letu 2015 ni bila razširjena, v letu 2016 pa je bila najdena na 83 % njiv. Bolezenska znamenja so bila na nekaj njivah močno izražena in v območjih s pogostimi padavinami v prihodnosti ni izključena potreba po ukrepih za zatiranje bolezni. Sojina plesen (*Peronospora manshurica*) je bila razširjena v obeh letih (na 46 % njiv) vendar bolezenska znamenja niso bila močno izražena. Gliva *Macrophomina phaseolina* se je pojavila na 15 % njiv. Poleti se pri visoki temperaturi hitro širi in povzroča sušenje rastlin, podobno predčasnemu odmiranju zaradi suše. V tleh preživi v obliki mikrosklerocijev in ima zelo širok krog gostiteljev, zato lahko ogrozi tudi pridelovanje drugih poljščin, ki sledijo v kolobarju. Podobno imajo številne gostitelje tudi različne vrste iz rodu *Fusarium* in bela gniloba (*Sclerotinia sclerotiorum*), ki smo jih našli na petini pregledanih njiv s sojo.

ABSTRACT

Soybean diseases caused by fungi in Slovenia

Commercial soybean production has started in Slovenia in last decade and area under soybean has increased from 50 ha in 2008 to 2500 in 2016. There are no data about pests and diseases which could pose risk to soybean under growing conditions in Slovenia. The global yield losses caused by fungal pathogens are estimated to about 10%. It is expected that with growing soybean on larger scale, plant diseases will become increasingly important also in Slovenia. In order to find out which pathogenic fungi are present on soybean plants and what is the incidence, 26 soybean fields were surveyed in different regions in 2015 and 2016. Fungi were identified using

their morphological characters and with molecular methods. Fungi from *Diaporthe/Phomopsis* complex, *Septoria glycines* and *Colletotrichum* species were found in half of the fields or more often. They can be spread by infected seeds or by infected plant residue in soil. Brown leaf spot caused by *Septoria glycines* was not detected in 2015 but it appeared in 83% of the fields in 2016. The symptoms were severe in some fields and there is a possibility that control measures will be needed in future in growing regions with more precipitations. Downy mildew (*Peronospora manshurica*) was widespread in both years (in 46% of fields) but symptoms were inconspicuous. *Macrophomina phaseolina* appeared in 15% of the fields. It spreads fast at high temperatures and causes premature death of plants in summer which resembles draught stress. It can survive in soil in form of microsclerotia. As its host range is very broad it can affect other crops in rotation. Broad host range is also typical for *Fusarium* species and white rot (*Sclerotinia sclerotiorum*) which were isolated from soybean plants in approximately one fifth of the fields.



Varstvo soje (*Glycine max* (L.) Merr.) pred plevlji, povzročitelji bolezni in škodljivci – izkušnje in pričakovanja

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Leto 2016 je bilo razglašeno za leto zrnatih stročnic, med katerimi je soja (*Glycine max* (L.) Merr.) glavna oljnica in svetovna beljakovinska stročnica za prehrano ljudi in domačih živali. Pogled na številna polja soje v Sloveniji v letu 2016 ni bil več tako redek in presenetljiv kot v preteklosti. Soja je v slovenskem prostoru z 2400 ha vse bolj »domača« poljščina, ob kateri spoznavamo njene morfološke značilnosti, biološke posebnosti in agrotehnične lastnosti. Za biotsko in kemično varstvo soje pred plevlji smo s pomočjo posevkov na njivah in v poljskih poskusih sodelavci na projektu CRP Soja (2014-2017) pridobili prve izkušnje in dokaze glede količine semena za setev, medvrstne razdalje in njihovih medsebojnih vplivov na velikost pridelka različnih sort. Povzročitelji bolezni in škodljivci za zdaj niso bili opaženi, njihov pojav pa je vendarle pričakovan pri povečevanju zemljišč s sojo, še posebej, če se bo soja prepogosto vračala na isto njivo in s tem ustvarjala razmere za njihovo razmnoževanje, prenos in širjenje. V prispevku bomo predstavili gospodarsko pomembno škodo, ki jo lahko povzročijo glive (plesni, rje, listna pegavost, bela gniloba in druge), bakterije in virusi ter ukrepe za njihovo zmanjševanje. Od škodljivcev bomo morali biti tudi pri soji bolj pozorni na strune, ogrce, bramorje, sovke in koruznega hrošča (za zdaj pri nas povzroča škodo le na koruzi), ki so pogosto čezmerno prisotni v posevkih žit, krompirja, oljne ogrščice in sončnic. Pisici prispevka opozarjamo, da je temelj trajnosti katere koli pridelave (konvencionalne, ekološke) kolobar. Ta pri soji ustreza biološko pravilnemu presledku štirih do petih let. Izbira poljščin v kolobarju je v glavnem odvisna od usmeritve kmetije, zato je za poljedelsko-živinorejske kmetije ustrezen kolobar: koruza za zrnje, soja, ozimna pšenica, koruza za silažo in ozimni ječmen. Velik pomen za varstvo pred plevlji, boleznimi in škodljivci ima sklenjen kolobar, zato po pšenici oziroma ječmenu posejemo dosevek, ki naj ne bo metuljnica.

ABSTRACT

Protection of soybean (*Glycine max* (L.) Merr.) from weeds, pathogens and pests – experiences and expectations

The year 2016 was declared as Year of grain legumes. Among them, soybean (*Glycine max* (L.) Merr.) is the world major oil and protein crop used for nutrition of human and animals. View of many soybean fields in Slovenia in 2016 was no longer so rare and surprising than it was in the past. Soybean, which was grown on 2400 ha in the Slovenia in 2016, is becoming "domesticated" crop for our area and we are learning about its morphological characteristics, biological features and agrotechnical properties. Using results from field trials and experience from agricultural practice, collaborators of project CRP-Soybean (2014-2017) gained initial

information and evidence relating to sowing rate, row spacing and the influence of their interactions on the yield of different soybean varieties, as well as knowledge about biological and chemical protection of soybean from weeds. Pathogens and pests of soybean have not been observed to date. However, their emergence is expected due to the increase in the soybean fields and its incidence would be accelerated if the soybean will be sown at the same field too often, thereby creating the conditions for their reproduction, transmission and dissemination. In this paper we will present economic loss that can be caused by fungi (mold, rust, leaf blight, white rot and the other), bacteria and viruses as well as measures to reduce them. According to the soybean pests, in the future we need to be focused on the click beetles, blackheads, spavin, budworm and corn rootworm (for now corn rootworm only attacks maize), which are often excessively present in cereals, potato, oilseed rape and sunflower. The authors of this paper would like to emphasize that the foundation of the sustainability of any kind of farming (conventional, organic) is crop rotation. Biological proper interval for soybean is four to five-year crop rotation. Selection of the crops for the crop rotation mainly depends on the orientation of the farm. Therefore, an appropriate crop rotation for the mix crop-livestock farms should be: maize for grain, soybean, winter wheat, maize for silage and winter barley. Comprehensive crop rotation has a great importance for the protection against weeds, pathogens and pests, therefore a catch crop is sown after wheat and barley and it should not be a legume.



Genotipizacija različnih slovenskih populacij sive breskove uši (*Myzus persicae*) za iskanje potencialne odpornosti na insekticide

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Prave listne uši so gospodarsko pomembna skupina rastlinskih škodljivcev, ki naseljujejo skoraj vse gojene rastline. Krompir lahko naseljuje več vrst listnih uši, med katerimi pa so le določene vrste znane kot prenašalke rastlinskih virusov. Siva breskova uš, *Myzus persicae* Sulzer (Hemiptera: Aphididae) je znana prenašalka gospodarsko najpomembnejših virusov krompirja: virus zvijanja listov krompirja (PLRV), virus M krompirja (PVM), virus S krompirja (PVS) in virus Y krompirja (PVY). V nasadih semenskega krompirja se insekticide uporablja primarno za zatiranje koloradskega hrošča. Ti insekticidi pa posredno vplivajo tudi na zmanjšanje populacij listnih uši. Zaradi njihove pogoste rabe se lahko razvije odpornost žuželk na insekticide. V Slovenskih krompiriščih so se v preteklih letih najpogosteje uporabljali insekticidi z aktivno snovjo acetamiprid, pirimikarb, flonikamid, teflutrin in tiakloprid. Po podatkih tuje literature je znano, da je siva breskova uš ponekod že razvila odpornost na nekatere aktivne snovi, ki pa je bila omejena na specifične genotipe. Naš namen je bil s presejalnim genetskim testom ovrednotiti genotipsko sestavo različnih slovenskih populacij sive breskove uši in ugotoviti morebitno prisotnost genotipov, potencialno odpornih na pirimikarb. Ulove virusonosnih vrst listnih uši smo spremljali z rumenimi lovnimi posodami (Merické) na območjih pridelave semenskega krompirja od leta 2004 do 2015 po Sloveniji. Iz populacij sivih breskovih uši smo na nivoju posamezne uši izolirali genomsko DNA in z uporabo specifičnih PCR markerjev (mikrosateliti) določili njen genotip. Potrdili smo prisotnost genotipa, ki je potencialno odporen na pirimikarb, saj so v njem že dokazali mutacijo za odpornost. Uporaba omenjenih molekularnih markerjev ponuja priložnost za nadaljnje vrednotenje prisotnosti genotipov listnih uši, ki so potencialno odporni na insekticide.

ABSTRACT

The search for potentially insecticide resistant genotypes in different Slovenian populations of the green peach aphid (*Myzus persicae*)

Aphids are economically important group of plant pests that inhabit almost all crops. Potatoes can be inhabited by several aphid species. Certain aphid species are known to be vectors of plant viruses. The green peach aphid, *Myzus persicae* Sulzer (Hemiptera: Aphididae), is known to transmit the most important potato viruses: potato leafroll virus (PLRV), potato virus M (PVM), potato virus S (PVS) and potato virus Y (PVY). In seed potatoes, the insecticides are used primarily for control of Colorado potato beetle and these insecticides also indirectly reduce aphid populations. However, their frequent use can lead to resistance development. In Slovenia, acetamiprid, pirimicarb, flonikamid, teflutrin and tiaklopid are the most commonly used insecticides on potato crops. The green peach aphid already developed resistance to certain active substances in some parts of the world; however this was limited to specific genotypes. The aphid virus vectors were monitored and collected in seed potato production by yellow 'Merické' traps from 2004 to 2015. The aim of our research was to evaluate the genotypic composition of green peach aphid populations in Slovenia and confirm possible presence of genotypes potentially resistant to pirimicarb. Genomic DNA was isolated from individuals of several green peach aphid populations. Specific microsatellite markers were used to determine their genotypes. The presence of genotype resistant to pirimicarb was confirmed in a Slovenian aphid population. We discuss the use of molecular markers as a powerful tool for detection of insecticide resistant aphid populations in the context of integrated pest management.



Prvi poskus preučevanja navadnega graha (*Pisum sativum* L.) kot privabilnega posevka za zmanjševanje škodljivosti strun (*Agriotes* spp., Coleoptera, Elateridae) na krompirju (*Solanum tuberosum* L.)

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Strune (*Agriotes* spp.) prištevamo med gospodarsko najpomembnejše škodljivce krompirja (*Solanum tuberosum* L.). Med alternativnimi načini varstva krompirja pred strunami so tudi privabilni posevki, katerih namen je privabljanje škodljivcev na rastline, ki so zanje dovzetnejše od rastlin, ki jih pridelujemo za živež ali krmo. S tem se zmanjša gospodarski pomen škodljivcev na slednjih. Namen naše raziskave je bil ugotoviti, ali lahko navadni grah (*Pisum sativum* L.) služi kot privabilni posevek za zmanjševanje škodljivosti strun na krompirju. Zato smo v letu 2015 na Laboratorijskem polju Biotehniške fakultete v Ljubljani izvedli bločni poskus v treh obravnavanja (1. kontrola - brez privabilnega posevka, 2. navadni grah, škropljen s sistemskim insekticidom tiametoksamom, 3. neškropljeni navadni grah). V prispevku bodo predstavljeni rezultati povprečnega pridelka krompirja, in sicer v različnih vrstah na njivi (glede na oddaljenost od roba njive) in po velikostnih frakcijah, ter povprečno število poškodb na posamezen gomolj po vrstah, blokih, obravnavanjih in frakcijah. Z raziskavo nismo uspeli potrditi domneve o privabilni sposobnosti graha za strune ter razlikah v obsegu poškodb med posameznimi obravnavanji. Prav tako nismo mogli potrditi domneve o tem, da naj bi se s povečevanjem razdalje med privabilnim in glavnim posevkom manjšal obseg poškodb na gomoljih. Da bi lahko potrdili učinkovitost graha za privabljanje strun, bodo potrebne še nadaljnje raziskave.

ABSTRACT

First attempt of efficacy testing of pea (*Pisum sativum* L.) as trap crop for diminishing the damage caused by wireworms (*Agriotes* spp., Coleoptera, Elateridae) in potato (*Solanum tuberosum* L.) crops

Wireworms (*Agriotes* spp.) are one of the most important pests of potato (*Solanum tuberosum* L.). One of the alternative ways of controlling wireworms are trap crops, that attract pests on plants that are more susceptible for their attacks, so that populations of those organisms are much smaller on the main crops. The purpose of our field trial was to determine if pea (*Pisum sativum* L.) is suitable as a trap crop for reduction of injuries caused by wireworms on potato tubers. Therefore in 2015, we performed a field trial with three different treatments (control – without trap crop, pea treated with thiametoxam, and untreated pea) in each of the 3 blocks at the Experimental Field of Biotechnical faculty in Ljubljana. In the contribution we will present an average yield of potato tubers on each row and each fraction and the average number of holes/tuber of each row, block, treatment and fraction. The results of our trial did not give us enough information about adequacy of pea as a trap crop for reduction of injuries caused by wireworms on potato tubers. Much more experiments will be needed to determine if wireworms are attracted by easily accessible sugar, released by the roots of pea.



Preučevanje fungicidnega delovanja propolisa na povzročitelja črne listne pegavosti krompirja (*Alternaria solani*) in krompirjeve plesni (*Phytophthora infestans*) v poljskih razmerah

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V letih 2015 in 2016 smo v poljskih poskusih na Laboratorijskem polju Biotehniške fakultete v Ljubljani preučevali fungicidno delovanje propolisa na črno listno pegavost krompirja (*Alternaria solani*) in krompirjevo plesen (*Phytophthora infestans*). Poskus je potekal v treh blokkih, znotraj katerih smo naključno razporedili 4 obravnavanja, in sicer propolis v višji koncentraciji (10 ml/1 l vode), propolis v nižji koncentraciji (5 ml/ 1 l vode), pozitivna (sintetični fungicidi) in negativna kontrola (neškropljeno). V obeh letih smo krompir s propolisom poškrpili šestkrat v rastni dobi. Ocenjevanje indeksa okužbe s črno listno pegavostjo in krompirjevo plesnijo smo izvedli z modificirano 6-stopenjsko lestvico EPP0. V letu 2015 smo ocenjevanje stopnje okužbe z glivo *Alternaria solani* izvedli v štirih terminih, v letu 2016 pa ocenjevanje stopnje okužbe z obema glivama izvedli v šestih terminih. V obeh letih poskusa se je na krompirju pojavila črna listna pegavost krompirja, a indeks okužbe tudi na neškropljenih rastlinah v obdobju intenzivne rast ni presegel 3,5 (približno 15 % okužene listen površine). Ugotavljamo, da je propolis v prvem letu poskusa pokazal nekoliko slabše fungicidno delovanje od sintetičnih fungicidov, v drugem letu poskusa pa je bila njegova učinkovitost primerljiva s sintetičnimi fungicidi. V letu 2016 je bilo v obeh obravnavanjih, kjer smo uporabili propolis, indeks okužbe s krompirjevo plesnijo signifikantno manjši kot v negativni kontroli in primerljiv s pozitivno kontrolo. Rezultati raziskave kažejo obetavne rezultate delovanja propolisa na povzročiteljici črne listne pegavosti krompirja in krompirjeve plesni, vendar pa bo potrebno njegovo učinkovitost preveriti še v razmerah močnejše okužbe, saj sta se obe glivične bolezni v letih naše raziskave pojavljali v relativno majhnem obsegu.

ABSTRACT

Field testing of fungicidal efficacy of propolis on early blight of potato (*Alternaria solani*) and late blight of potato (*Phytophthora infestans*)

During 2015 and 2016, field experiment was performed to evaluate fungicidal efficacy of propolis on early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) on potato at the Laboratory field of Biotechnical faculty in Ljubljana. Field trial was performed in three blocks, which were divided into 4 treatments (propolis in higher dose – 10 ml/1 l of water, propolis in lower dose – 5 ml/1 l of water, positive (synthetic fungicides) and negative control (non-treated plants)). Spraying with propolis was performed for six times per growing season. Severity

index of infection caused by early and late blight was evaluated according to 6-grade EPP0 evaluation scale. In 2015, severity index of early blight infection was evaluated four times, meanwhile severity indices of early and late blight infection were evaluated six times in 2016. Early blight was detected in both experimental years, but even on non-treated plants severity index did not exceed 3.5 index level (app. 15 % of infected leaf area) during intensive plant growth. We have established lower efficacy of propolis in the first experimental year, meanwhile its efficacy was comparable to synthetic fungicides in second experimental year. In 2016 severity index of late blight was lower on plants treated with propolis (both concentrations) in comparison to negative control, and could be compared to positive control. Results of our research have demonstrated promising fungicidal activity of propolis on pathogens that cause early and late blight on potato, although additional tests should be performed in conditions with severe infection with both pathogens. Occurrence of both fungal pathogens was relatively low in both experimental years.



Nova molekularna orodja na osnovi PCR za identifikacijo ogorčic iz skupine *Meloidogyne ethiopica* in tropskih ogorčic koreninskih šišek

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Tropska skupina ogorčic koreninskih šišek (RKN) vključno z vrstami *Meloidogyne incognita*, *M. arenaria*, *M. javanica* in *M. ethiopica* so izredno polifagni, široko razširjeni rastlinski škodljivci, ki močno zmanjšajo pridelek. Vrsto *Meloidogyne ethiopica* so našli v več evropskih državah (Slovenija, Italija, Grčija in Turčija). Nedaven opis vrste *M. luci*, ki je morfološko zelo podobna *M. ethiopica*, uvršča vse do sedaj opisane najdbe *M. ethiopica* v Evropi kot *M. luci*. Loči ju profil izoencimov esteraze. Na osnovi filogenetske analize regije mtDNA so vrste *M. ethiopica*, *M. luci* in *M. inornata* zelo sorodne. Zaradi hibridnega nastanka teh vrst pa so njihove sorodstvene relacije nedorečene. Tudi naši rezultati strukture *map1* genske družine potrjujejo bližnjo sorodnost teh treh vrst, zato smo jih uvrstili v skupino *M. ethiopica* (Gerič Stare in sod., neobjavljeno). Za identifikacijo ogorčic koreninskih šišek je najprimernejša uporaba kombinacije morfometričnih, biokemičnih in molekularnih pristopov. Zaradi morfološke podobnosti vrst in variabilnosti populacij je ločevanje vrst znotraj skupine *M. ethiopica* zelo težko. Molekularni pristopi so lahko v veliko pomoč, saj jih lahko uporabimo na vseh razvojnih stopnjah in tudi na neživem materialu. Razvili smo dva para začetnih oligonukleotidov; prvi, specifičen za skupino *M. ethiopica*, ki pomnožuje 241 bp dolg fragment, drugi, specifičen za tropsko skupino RKN pa 621 bp. Novi metodi smo validirali na več vrstah in populacijah različnega geografskega izvora; *M. ethiopica*, *M. luci*, *M. inornata*, *M. arenaria*, *M. incognita*, *M. javanica*, *M. hapla*, *M. hispanica*, *M. chitwoodi* in *M. fallax*. Zahvala: finančni podpora s strani ARRS (P4-0072, BI-TR/15-17-008) in TUBİTAK (214 O 667).

ABSTRACT

Novel PCR based identification tools for the *Meloidogyne ethiopica* group and the tropical group of root-knot nematodes

Tropical group of root-knot nematodes (RKN) including *Meloidogyne incognita*, *M. arenaria*, *M. javanica* and *M. ethiopica* are highly polyphagous, remarkably widespread and damaging pests of agricultural crops. *Meloidogyne*

ethiopica has been reported from several European countries (Slovenia, Italy, Greece, and Turkey). However, a recent description of morphologically very similar species *M. luci* classifies all European populations of *M. ethiopica* reported up to date as *M. luci* with esterase isozyme pattern as the most distinguishing character between the two otherwise very similar species. Based on phylogenetic analysis of mtDNA markers species *M. ethiopica*, *M. luci* and *M. inornata* are very closely related. Because of hybrid origin of these species the relationship between these species or lines is not well understood. Additionally, our results on structure of *map1* gene family support close relationship of these three species and therefore we have classified them together as *M. ethiopica* group (Gerič Stare et al, unpublished). RKN identification is ideally based on combination of morphometrical, biochemical and molecular methods. Because of morphometrical similarity and intra-specific variation it is very difficult to distinguish species within *M. ethiopica* group. Molecular approaches can be very valuable, as they work with all life stages or unviable material. We have developed two primer sets, first specific for *M. ethiopica* group yielding 241 bp amplicon and the second specific for the whole tropical RKN group resulting in 621 bp long amplicon. Both novel identification methods were validated on RKN species and populations of diverse geographical origin: *M. ethiopica*, *M. luci*, *M. inornata*, *M. arenaria*, *M. incognita*, *M. javanica*, *M. hapla*, *M. hispanica*, *M. chitwoodi* and *M. fallax*. Acknowledgements: financial support from ARRS (P4-0072, BI-TR/15-17-008) and TUBITAK (214 O 667).



Vrednotenje *in vitro* aktivnosti treh sevov bakterije *Bacillus firmus* proti ogorčicam koreninskih šišč *Meloidogyne incognita*

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Ogorčice koreninskih šišč iz rodu *Meloidogyne* so najpomembnejša skupina rastlinsko-parazitskih ogorčic, saj njihova namnožitve na polju privede do zmanjšanja oz. izpada pridelka ter s tem povezane gospodarske škode. Dodaten problem povzroča širok krog gostiteljskih rastlin, ki jih te ogorčice lahko napadajo. Mnogi v preteklosti uporabljeni nematocidi se zaradi toksičnosti za ljudi in okolje ne uporabljajo več, tako da je za obvladovanje ogorčic koreninskih šišč potrebno razviti nove strategije varstva rastlin. Trenutno delo na tem področju je usmerjeno v razvoj aplikacije bioloških agensov, ki delujejo kot antagonisti rastlinskim patogenom in škodljivcem. V sklopu našega dela smo testirali *in vitro* aktivnost treh različnih sevov bakterije *Bacillus firmus* proti ogorčicam *Meloidogyne incognita*. Sev bakterije *B. firmus* I-1582 smo izolirali iz komercialnega pripravka VOTIVO®, dva dodatna seva bakterij iste vrste pa iz vrtno zemlje na gredi, kjer je rasel grah, v Mariboru. Vrsto bakterij *B. firmus* smo potrdili s pomočjo analize rDNA zaporedja. V *in vitro* poskusih smo jajčeca ogorčic *M. incognita* izpostavili bakterijam v tekočem gojišču LB, filtratu bakterijske kulture ter spranim bakterijskim celicam v pufru. Beležili smo število izleženih ličink in motilnost ličink ter rezultate primerjali s kontrolami, pri katerih je izleganje potekalo v sterilni vodi, pufru in svežem gojišču LB. Vsako obravnavanje v poskusu ter celoten poskus smo ponovili štirikrat. Pri vseh testnih obravnavanjih smo zabeležili zmanjšanje števila izleženih ličink in motilnih ličink. Izleganje je bilo do 97,9% nižje v primerjavi s kontrolo v obravnavanju, kjer smo jajčecem ogorčic dodali bakterijsko kulturo v gojišču LB. Dodatek filtrata z ekstracelularnimi metaboliti bakterij je zmanjšal izleganje do 78,9%, dodatek spranih bakterijskih celic pa do 77,9% ličink. Vsa testna obravnavanja negativno vplivajo na motilnost ličink, opazili pa smo razlike v delovanju različnih sevov bakterije *B. firmus*, katere bomo dodatno ovrednotili z lončnimi poskusi ter poskusi na mikro-parcelah.

ABSTRACT

Evaluation of *in vitro* activity of three *Bacillus firmus* strains against the root-knot nematode *Meloidogyne incognita*

Root-knot nematodes (RKN) belonging to the genus *Meloidogyne* are considered the most important group of plant-parasitic nematodes due to the associated yield loss and economic burden upon field infestation, as well as because of their broad range of host plants. Environmental concerns and toxicity to humans have been instrumental in the phase-out of many nematicides used in the past. Therefore development of alternative control strategies for RKN is currently needed. Recent focus is in the application of biological control agents that act as antagonists to plant pathogens and pests. In our study we tested *in vitro* activity of three different *Bacillus firmus* strains against *Meloidogyne incognita*. *Bacillus firmus* strain I-1582 was isolated from the commercial VOTIVO® formulation, while two additional *B. firmus* strains were isolated from garden soil on a plot where peas have been cultivated in Maribor, Slovenia. Identity of bacterial strains was confirmed by sequence analysis of rDNA. In the *in vitro* experiment we exposed *M. incognita* eggs to bacterial culture in LB medium, culture filtrate and washed bacterial cells in buffer. The number of hatched eggs and motility of juveniles was recorded and compared to control treatments in sterile water, buffer and sterile fresh LB medium. All treatments as well as whole experiment were replicated four times. All test treatments inhibited nematode hatching and motility. Hatching was inhibited up to 97.9% compared to control when unprocessed bacterial culture was added to the nematode eggs. Bacterial extracellular metabolites in culture filtrate and the direct contact of washed bacterial cells with nematode eggs significantly inhibited hatching up to 78.9% and 77.9% respectively. Test treatments negatively affected juvenile motility but some differences were observed in activity of different *B. firmus* strains tested, which will be analysed in further in pot- and micro-plot experiments.



Pojavljanje škodljivih organizmov na travni ruši nogometnih igrišč v Sloveniji

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Nogomet je v Sloveniji zelo priljubljen ekipni šport, zato se nogometna igrišča pojavljajo po vsej državi. Razlike v urejenosti nogometnih igrišč so očitne, saj imajo klubi oz. lastniki igrišč za vzdrževanje travne ruše in spremljajočih objektov na voljo zelo različna denarna sredstva. Glavna hipoteza naše raziskave, v kateri smo leta 2015 na 20 nogometnih igriščih v Sloveniji preučevali zbitost in pokrovnost tal, sestavo travne ruše, pojavljanje bolezni, škodljivcev in plevelov ter ugotavljali načine vzdrževanja ruše in zatiranja škodljivih organizmov, je bila, da je travna ruša nogometnih igrišč, ki tekmujejo v višjih rangih tekmovanja bolj vzdrževana in lepša od travne ruše nogometnih igrišč, na katerih igrajo nižje rangirani klubi. V raziskavo smo vključili 4 nogometna igrišča slovenskih prvoligašev (Domžale, Ljubljana - Stožice, Maribor - Ljudski vrt, Zavrč), 4 nogometna igrišča drugoligašev (Dob, Ptuj, Radomlje, Šenčur), 6 igrišč tretjeligašev (Ivančna gorica, Lesce, Ljubljana – ŽAK, Ruše, Kočevje, Komenda) in 6 nogometnih igrišč klubov iz nižjih rangov tekmovanj (Bled, Dobrova, Dobrovoce, Mirna, Stojnci, Vrhnika). Igrišča smo združili v skupine glede na rang tekmovanja. V prispevku bodo prikazani rezultati razširjenost plevelov in gliv, katerih razširjenost smo na vseh lokacijah ocenjevali dvakrat (spomladi in poleti) v rastni dobi. Zastopano plevelov smo določali z ocenjevanjem sestave travne ruše na 5 mestih na vsakem igrišču. Rastline smo identificirali in razvrstili na 3 skupine – trave, metuljnice in zeli (zadnji dve predstavljata v travni ruši plevela). Zastopano plevelov je bila tako v spomladanskem kot poletnem terminu največja na igriščih klubov tretje lige, najmanjša pa na igriščih klubov prve lige. Pokrovnost tal je bila v povprečju nižja pri prvem (spomladanskem) ocenjevanju, kjer je znašala od 86,8 % (drugoligaši) do 97,3 % (prvoligaši), medtem, ko je pri

poletnem ocenjevanju (z izjemo enega igrišča) vselej preseгла 95 % pokrovnost. Povprečni odstotek trav v ruši je pri prvem ocenjevanju znašal od 94,78 % (tretjeligaši) do 100 % (prvoligaši), pri drugem ocenjevanju pa od 89,3 % (tretjeligaši) do 100 % (prvoligaši). Pri prvem ocenjevanju je največji delež metuljnic (*Trifolium repens*) v ruši znašal 15,4 %, pri drugem pa kar 53,0 % (obakrat v Komendi). Na istem igrišču smo pri obeh ocenjevanjih ugotovili tudi največji delež zeli (4,4 oz. 3,0 %), med katerimi je bil prevladujoči plevel *Plantago major*. Na celotnem igrišču smo ocenjevali tudi obseg okužbe s talnimi glivami in ugotovili, da so se te pojavljale izključno v poletnem terminu. Na preučevanih nogometnih igriščih nimajo večjih težav s škodljivci, ponekod jim povzročajo težave iztrebki deževnikov na talnem površju. Ugotovili smo, da imajo nekateri upravljavci nogometnih igrišč premalo znanja o načinih vzdrževanja travne ruše in da predvsem mineralna gnojila uporabljajo preveč na pamet, medtem ko na polovici igrišč iz naše raziskave fitofarmaceutskih sredstev skoraj ne uporabljajo. Na podlagi rezultatov zaključujemo, da je zdravstveno stanje igrišč višje rangiranih klubov boljše.

ABSTRACT

The occurrence of harmful organisms in turfgrass of soccer fields in Slovenia

Soccer is a very popular team sport in Slovenia and soccer fields are therefore spread all across the country. The differences in their appearance are noticeable, as budgets for maintenance and management vary greatly. Our main hypothesis was that turfgrass in the soccer fields owned or used by clubs competing in Slovenian First League is better maintained and managed and more attractive than turfgrass in soccer fields owned by clubs competing in lower ranking competitions. In the study, which was performed in 2015, we evaluated the state (soil compaction, sward cover, composition of turfgrass plants [grasses, legumes and herbs], common diseases, pests, and weeds) of different soccer fields in different regions of Slovenia. During our study we visited 20 soccer fields in total (4 owned or used by the clubs from the Slovenian First League, 4 by the clubs from the Slovenian Second League, 6 from the clubs from the Slovenian Third League (all leagues are organized by Football Association of Slovenia), and 6 by the clubs from the lower ranks of competition), each one twice – in spring and in summer. In this presentation we limited ourselves only on results connected with turfgrass weeds and fungi. Infestation with weeds was evaluated by the study of turfgrass composition. This was done by placing a 1 m² wooden frame on 5 random spots while diagonally crossing the field. We also used this method for determining the sward cover. It allowed us to estimate what the percentage of grasses, legumes and other herbs was. Main weed species in soccer turf belong to the last two groups. Presence of weeds in both spring and summertime evaluation was greatest on 3rd league soccer fields while smallest on 1st league fields. Average sward cover was lower in springtime evaluation, amounting from 86.8% (2nd league fields) to 97.3% (1st league). In summertime it was (with the exception of one field) always greater than 95%. Average springtime percentage of grasses in the turf ranged from 94.78% (3rd league fields) to 100% (1st league fields). Greatest share of legumes (mostly *Trifolium repens*) in springtime amounted to 15.4% in 3rd league fields while it increased greatly in summertime when it reached up to 53% (both results are from the field in Komenda). On the same field we also documented the highest percentage of herbs (4.4 and 3.0%) with *Plantago major* being the main species. While inspecting each field we also searched for signs of fungal infections, but we only found signs of them during the summertime evaluation. According to turfgrass managers, pests are not a problem in visited fields, but worm piles are sometimes considered a nuisance. We are concluding that some of the managers lack knowledge on the topic of turfgrass maintenance, especially when it comes to fertilizing or pest and disease control (half of the managers use hardly any phytopharmaceutical substances). Based on our results we conclude that soccer fields owned or used by clubs competing in higher ranks of competition are better maintained or managed and more attractive.



Vsebnost mikotoksina deoksinivalenol in kakovost zrnja pri različnih sortah ozimne pšenice

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Poljski poskus smo izvedli v letu 2016 na Laboratorijskem polju Biotehniške fakultete v Ljubljani. V poskusu so bile sledeče sorte ozimne pšenice: Arezzo, Bastide, Cimabue, Farmeur, Illico, Moisson, Olimpija, Valbona, Vulcanus in Vulkan. Za zatiranje fuzarioz klasa (*Fusarium* spp.) smo uporabili fungicid Prostaro® (a.s. protiokonazol in tebukonazol). Škropljenje smo izvedli s traktorsko nošeno škropilnico, ki je imela nameščene injektorske šobe z dvojnimi simetričnim curkom AVI TWIN 110 03. Ostalo kemično varstvo rastlin in agrotehnična dela na poskusu smo izvedli v skladu z dobro kmetijsko prakso. Žetev je bila izvedena z žitnim kombajnom Deutz Fahr Ectron. Po žetvi smo za vsako sorto vzeli vzorec zrnja za analizo kakovosti zrnja in vsebnosti mikotoksina deoksinivalenol (DON). Prikazani so podatki o vsebnosti mikotoksina DON in kakovostnih parametrih pridelanega zrnja.

ABSTRACT

Mycotoxin deoxynivalenol level and grain quality at different winter wheat cultivars

In 2016 field trial was done at the Laboratory Field of Biotechnical Faculty in Ljubljana. Different winter wheat cultivars were used, namely Arezzo, Bastide, Cimabue, Farmeur, Illico, Moisson, Olimpija, Valbona, Vulcanus and Vulkan. Fungicide Prostaro® (a.i. prothioconazole and tebuconazole) was applied for the fusarium head blight control. Tractor mounted field sprayer equipped with injector nozzles with 2 symmetrical spray jets AVI TWIN 110 03 was used for spraying. Other chemical control and agrotechnical work on the trial were done according to good agricultural practice. Harvest was done using self propelled harvester Deutz Fahr Ectron. After the harvest grain samples were taken for the mycotoxin deoxynivalenol (DON) level and for quality parameters. Results linked with DON level and quality parameters of grain will be presented in the article.



Vpliv uporabe različnih šob na kakovost nanosa fungicida na ozimno pšenico (*Triticum aestivum* L.)

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Ko nanašamo fungicid na klas ozimne pšenice, je zelo pomembna dobra pokritost sprednje in zadnje strani klasa. S tem namenom smo izvedli poskus, v katerem smo pri nanosu fungicida na klas uporabili novo izvedbo odbojnih šob Turbo FloodJet. Poskus je bil izveden v letu 2014 na Laboratorijskem polju Biotehniške fakultete v Ljubljani. V poskusu smo proučevali dva dejavnika, in sicer položaj šobe na škropilni letvi s tremi ravnimi (položaj šobe na škropilni letvi s curkom usmerjenim naprej, s curkom usmerjenim nazaj in z izmeničnim curkom glede na smer škropljenja) ter dve vrsti šobe (standardno špranjasto šobo ST in injektorsko špranjasto šobo z dvojnimi asimetričnim curkom SPEED). Nanos fungicida na ozimno pšenico smo opravili v začetku cvetenja z nošeno traktorsko škropilnico delovne širine 12 m. Hitrost škropljenja je bila 6,0 km/h, tlak škropljenja pa je znašal 4,0 bara. Najenakomernjšo pokritost sprednje in zadnje strani klasa ozimne pšenice smo dobili z izmeničnim položajem odbojne šobe Turbo FloodJet na škropilni letvi. Enako je veljalo tudi za število odtisov kapljic na cm² listne površine. Zelo dobra pokritost sprednje strani klasa je bila dosežena tudi pri curku, usmerjenem naprej v smeri vožnje, medtem ko je bila zadnja stran klasa pri tem curku zelo slabo pokrita. Standardna šoba ST je dala najslabšo pokritost na klasu.

ABSTRACT

The effect of different nozzles on spray deposition quality of fungicide on winter wheat (*Triticum aestivum* L.)

When applying fungicide on the winter wheat ears, it is important to achieve good coverage of both front and rear side of the ears. For that reason, we have planned a trial in which we used new version of deflector nozzle type, namely Turbo FloodJet. The experiment was conducted at the Experimental field of Biotechnical Faculty in Ljubljana in 2014 and it consisted of two studied factors; nozzle position on spraying boom with three levels (the first one with a forward spray jet, the second one with a backward spray jet and the third one with an alternate spray jet) and nozzle type with two shapes (standard flat fan nozzle ST and the asymmetric double-flat fan air-injection nozzle SPEED). The spraying was performed with tractor-mounted sprayer with a 12 m working width at the beginning of winter wheat flowering with 6.0 km/h of spraying speed and 4.0 bars of pressure during spraying. With alternate positioning of the Turbo FloodJet deflector nozzle on the spraying boom, we have achieved the most equal distribution on the front and rear sides of the winter wheat ear and the most homogenous droplet impression number per cm². With the nozzle with a forward spray jet, we have achieved high coverage on the front side of the wheat ear; it was, however, very low on the rear side. The lowest coverage of the wheat ear was achieved while using the standard ST nozzle.



Tehnične možnosti za manjšo izpostavljenost FFS pri pripravi škropilne brozge

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Uporabnik fitofarmacevtskih sredstev (FFS) mara biti pri svojem delu čim manj izpostavljen škropivom. Nepravilna uporaba FFS lahko škoduje samemu uporabniku FFS, drugim ljudem in okolju. Tveganje, da bo uporabnik FFS izpostavljen pesticidom, je zlasti veliko med samo pripravo škropiva – škropilne brozge. Taka tveganja je potrebno zmanjšati kolikor je to mogoče. Ena izmed rešitev teh problemov so tudi različne konstrukcijske izboljšave (dopolnitve) strojev za nanašanje FFS. Možna je uporaba polnilnih posod, še boljše možnost pa je uporaba CTS sistemov. CTS pomeni »Closed Transfer System« ali po domače zaprt sistem odvzema koncentriranega – nerazredčenega škropiva iz originalne embalaže. Nekaj CTS sistemov je že na tržišču ali pa se še razvijajo. Obstajajo sistemi, ki so kompatibilni s standardnimi embalažami FFS, so pa tudi sistemi, kjer morajo biti FFS dobavljeni v specialnih embalažah, ki omogočajo delovanje CTS sistema.

ABSTRACT

Technical options to reduce exposure to pesticides in the preparation of the spray

The user of plant protection products (PPP) must be as little exposed to the spray as possible during the work. Improper use of PPP can harm the user of PPP, other people and the environment. The risk of operator contamination is particularly high during the preparation of the spray. Such risks should be reduced to be as little as possible. The possible solution of that problem is various engineering controls on the application equipment. It is possible to use a low level induction bowl; the better option is to use the "Closed Transfer System" - CTS system. CTS means closed transfer of the concentrated active substance from the container to the application equipment. Some CTS systems are already on the market or they are being developed. There are systems, that are compatible with standard packaging of PPP and there are also systems where PPP must be shipped in special containers that enable CTS system.



Potrebna moč za pogon pršilnika z radialnim ventilatorjem

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Poraba goriva pri nanašanju FFS v trajnih nasadih je odvisna od številnih parametrov in tudi od same izvedbe pršilnika. Pri pršilnikih je potrebna moč za pogon odvisna tudi od izvedbe ventilatorja. V Sloveniji prevladujejo pršilniki z aksialnimi ventilatorji, delež pršilnikov z radialnimi ventilatorji pa počasi raste. Z meritvami navora in števila vrtljajev na priključni gredi traktorja smo izračunali moč za pogon pršilnika z radialnim ventilatorjem. V prvi prestavi ventilatorja je bila izmerjena zagonska moč 43,3 kW, v drugi prestavi pa je bila ta zagonska moč večja za 8,8 %. Povprečna potrebna moč je v prvi prestavi znašala 24,5 kW, v drugi prestavi pa 31,8 kW. Potrebna moč za pogon pršilnika se linearno veča tudi z naraščanjem tlaka škropljenja. Potrebna moč za pogon pršilnika vpliva na porabo goriva za škropljenje, ta pa na ogljični odtis pridelka.

ABSTRACT

The required power for driving the mistblower with radial fan

Fuel consumption during the application of pesticides in plantations depends on many parameters and also from the performance of the mistblower. The power, required to drive the mistblower also depends on the construction of the fan. In Slovenia the most common are mistblowers with axial fans, although the share of mistblowers with radial fans is slowly growing. By measuring the torque and number of revolutions on the PTO shaft of the tractor, we calculated the power to drive the mistblower with a radial fan. In first gear of the fan we measured 43.3 kW of starting power, in second gear the starting power increased by 8.8%. The average power consumption is in the first gear 24.5 kW, in second gear 31.8 kW. The power, required to drive the mistblower increases linearly with increasing pressure of spraying. The power required to drive the mistblower influences the fuel consumption for spraying and this has an impact to the carbon footprint of the yield.



Spremljanje dinamike ulova plodove vinske mušice (*Drosophila suzukii* [Matsumura]) v nasadu ameriških borovnic (*Vaccinium corymbosum* L.) s sistemom daljinskega zaznavanja Trapview

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Plodova vinska mušica je pomemben škodljivec jagodičja, koščičarjev in nekaterih drugih sadnih vrst. Za odločanje o ustreznem terminu zatiranja škodljivca, spremljamo dinamiko ulova s pastmi. Za ta namen smo v letu 2016 prvič uporabili sistem za daljinsko zaznavanje škodljivcev Trapview, model pasti Fly. Za izboljšanje selektivnosti smo past nekoliko prilagodili. Past je bila postavljena v nasadu ameriških borovnic sorte 'Early Blue' v Borovnici. S spremljanjem smo začeli 10. junija, ko so bile ameriške borovnice pred zorenjem (BBCH 79). V posodo za vabo, ki je del pasti Fly, smo natočili vinski kis. Lepljivo ploščo, katera je pritrjena na vrhu posode za vabo, smo menjali v dvotedenskem intervalu, oziroma po potrebi. Za potrebe napovedovanja zatiranja škodljivca

smo določevali le samce *D. suzukii*, pri končnem štetju ulovljenih mušic pa smo določevali tudi samice. Kljub temu, da s fotografij, katere past samodejno posreduje uporabniku, ni možno določiti samic, nam je past bistveno olajšala spremljanje populacije *D. suzukii*. Prvi ulov smo zabeležili 27. junija. Številčnost ulova se je zelo povečala v sredini septembra in ostala zelo visoka vse do konca novembra.

ABSTRACT

Monitoring catch dynamics of spotted wing drosophila (*Drosophila suzukii* [Matsumura]) population in highbush blueberry (*Vaccinium corymbosum* L.) orchard using remote sensing technology Trapview

To help producers of soft fruits manage damages caused by *D. suzukii*, we trap monitor the pest and issue pest warnings and management recommendations. In 2016 remote sensing technology Trapview, model Fly, was used for the first time. To enhance the selectivity of the trap some modifications were done. We set the trap in a highbush blueberry orchard cv. 'Early Blue' on June 10th, at which time blueberries were about to start ripening, phenophase (BBCH 79). Wine vinegar was used as bait. We changed the sticky plate that is attached to the top of bait vessel on a two week interval or according to needs. During the season we only determined male *D. suzukii* for the needs of pest control, but at the end of season also females were determined and counted. Even though, photos that are transmitted to the user cannot be used to determine females, trap significantly eased the monitoring of the pest. First catch was on June 27th. Catch greatly increased in the middle of September and stayed very high until the end of November.



15 let prognostičnih obvestil v varstvu rastlin

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Obveščanje pridelovalcev rastlin o pojavu in širjenju škodljivih organizmov, okoljskih dejavnikov ter pravočasnem in ustreznem varstvu rastlin v realnem času, ima pomembno vlogo pri izvajanju integriranega varstva rastlin. Informacijsko-komunikacijske tehnologije (IKT) imajo vedno večjo vlogo tudi v kmetijstvu saj omogočajo kmetijskim pridelovalcem dostop do podatkov kjerkoli in kadarkoli to potrebujejo. Prognostična obvestila, ki jih v okviru javne službe zdravstvenega varstva rastlin izdajajo prognostični centri, imajo svoje začetke že v letu 2002. Takrat je bilo iz Slovenskega informacijskega sistema za varstvo rastlin FITO-INFO po elektronski pošti izdano prvo obvestilo pridelovalcem. V 15-ih letih obstoja prognostičnih obvestil je šel njihov razvoj skozi različne informacijske faze in vedno nove izzive, ki jih postavljajo pravila interneta, varnosti in zahteve uporabnikov. V letu 2014 so prognostična obvestila dobila uporabniku bolj prijazno in uporabno obliko, saj se uporabniki lahko po novem naročijo na prejemanje obvestil tudi za posamezno skupino rastlin. Modul za naročanje in pregled prognostičnih obvestil je dostopen na Agrometeorološkem portalu Slovenije (AGROMET) na naslovu: <http://agromet.mkgp.gov.si/pp/>.

ABSTRACT

15 years of forecast information in plant protection

Providing information to the plant producers about the occurrence and spreading of harmful organisms, environmental factors and timely and adequate plant protection in real time, plays an important role in implementation integrated pest management. Information and communications technology (ICT) have an increasing role also in agriculture as it enables agricultural producers access to the data wherever and whenever they need them. Forecast information which are issued by the 5 regional centers operating in the frame of forecasting and warning service, have their beginnings in 2002. In that year first forecast information was issued from the Slovenian information system for plant protection FITO-INFO through Automatic messaging service to the producers. In the 15 years of existence of automatic forecast information, their development went through different information stages and increasing challenges which are posed by the rules of internet, security and users requirements. In 2014, forecast information became more user friendly and usable, because users can now easily subscribe to receive notifications for each group of plants. Module for subscription and overview of forecast information is now accessible on the Slovenian Agrometeorological portal (AGROMET): <http://agromet.mkgp.gov.si/pp/>.



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