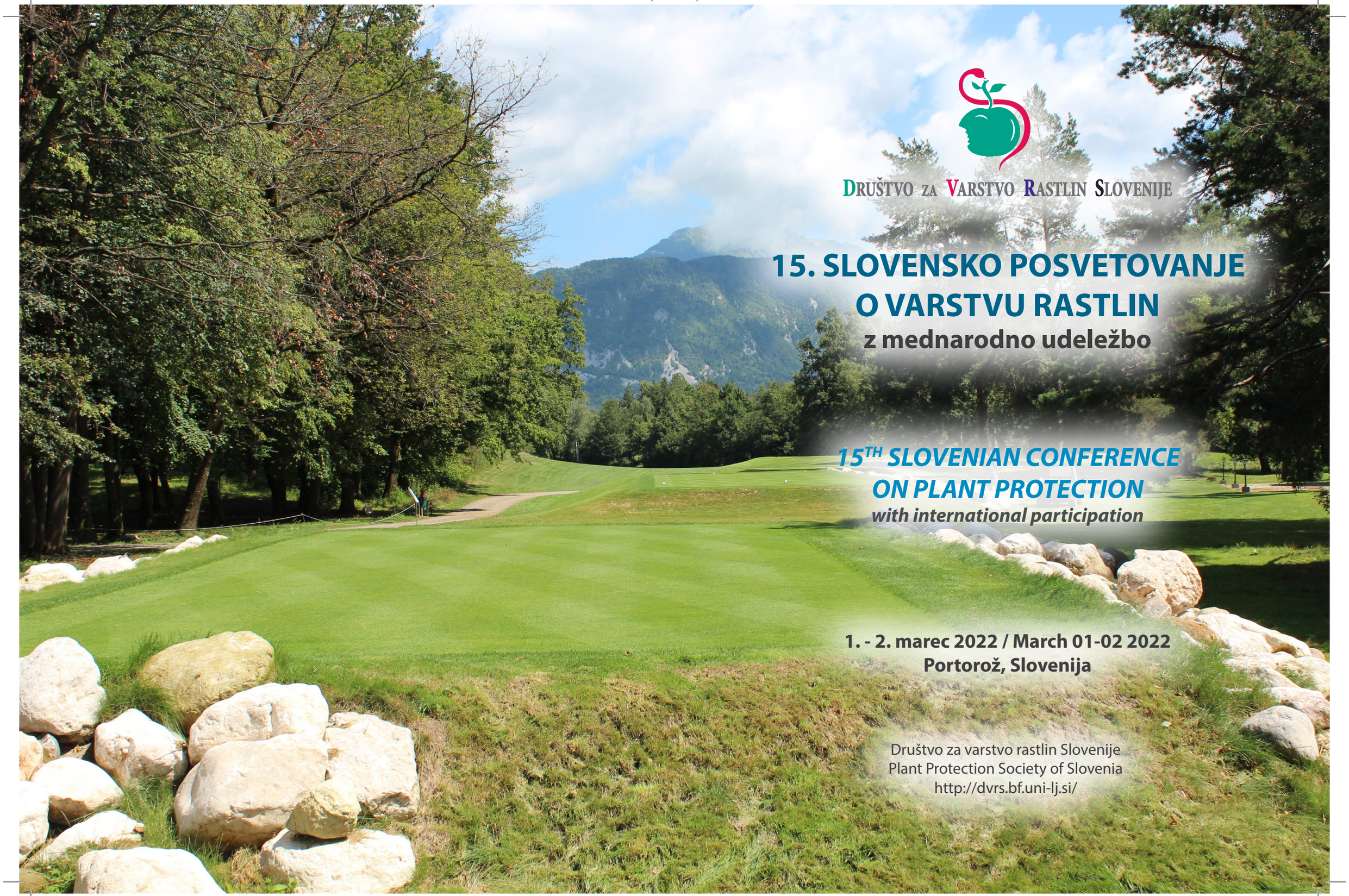

DRUŠTVO ZA VARSTVO RASTLIN SLOVENIJE

15. SLOVENSKO POSVETOVANJE O VARSTVU RASTLIN

z mednarodno udeležbo

15TH SLOVENIAN CONFERENCE ON PLANT PROTECTION

with international participation

1. - 2. marec 2022 / March 01-02 2022
Portorož, Slovenija

Društvo za varstvo rastlin Slovenije
Plant Protection Society of Slovenia
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KAZALO

Uvodni referati

Insects for food and feed: if you can't beat them, eat them!

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The utilization of insects for food and feed is definitely not a new idea, but it has recently developed remarkably at the industrial level, especially in the European Union (EU). In 2017, EU gave the "green light" for the use of seven insect species in aquaculture, while in 2021, this authorization was expanded for poultry and swine production. At the same time, two species, the yellow mealworm, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) and the migratory locust, *Locusta migratoria* (L.) (Orthoptera: Acrididae), have been approved for human consumption. All these latest developments greatly contributed in strengthening the EU insect production sector, while the production of insect meals is estimated to exceed 1200 thousand tonnes in 2025. The vast majority of research has been focused on *T. molitor* and the black soldier fly, *Hermetia illucens* (L.) (Diptera: Statiomyidae), since most of the insect meal-producing companies in EU are based on these two species. Apart from the utilization of insects for food and feed, however, insects can be used for other purposes as well, such as the production of fertilizers, which are based on insect frass. More recent data show the need for additional data towards important priorities in the insect production sector, such as the development of specific insect strains with desirable characteristics, consumer acceptance, quality control of the final product and potential risks for animals or humans.

IZVLEČEK

Žuželke za hrano in krmo: če jih ne moremo premagati, jih pojejmo!

Uporaba žuželk za hrano in krmo vsekakor ni nova ideja, vendar se je v zadnjem času izjemno razvila na industrijski ravni, zlasti v Evropski uniji (EU). Leta 2017 je EU dala "zeleno luč" za uporabo sedmih vrst žuželk v ribogojstvu, leta 2021 pa je bilo to dovoljenje razširjeno za rejo perutnine in prašičev. Hkrati sta bili za prehrano ljudi odobreni dve vrsti, veliki mokar *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) in kobilica selka *Locusta migratoria* (L.) (Orthoptera: Acrididae). Vsi ti zadnji dogodki so močno prispevali k krepitvi sektorja proizvodnje žuželk v EU, medtem ko naj bi proizvodnja moke iz žuželk leta 2025 presegla 1200 tisoč ton. Velika večina raziskav je bila osredotočena na vrsti *T. molitor* in *Hermetia illucens* (L.) (Diptera: Statiomyidae), saj večina podjetij za proizvodnjo moke žuželk v EU temelji na teh dveh vrstah. Poleg izkoriščanja žuželk za hrano in krmo pa se lahko žuželke uporabljajo tudi za druge namene, kot je proizvodnja gnojil. Novejši podatki kažejo na potrebo po dodatnih podatkih za pomembne prednostne naloge v sektorju proizvodnje žuželk, kot so razvoj specifičnih sevov žuželk z zaželenimi lastnostmi, sprejemljivost pri potrošnikih, kontrola kakovosti končnega izdelka in možna tveganja za živali ali ljudi.

Advances in Digital Decision Support Systems for Integrated Pest Management

Mark RAMSDEN, RSK ADAS Ltd, Cambridge, UK

Decision support systems (DSS) are important resources for advancing integrated management of agricultural pests. DSS help growers and their advisors to improve strategic, tactical or operational decisions, based on the best information on potential risks to a crop. Most systems, especially tactical and operational systems, are intrinsically linked to crop monitoring as observation data is usually required to run the model, and outputs often require more targeted monitoring to define the final decision output. Monitoring is already a core part of IPM, however it is time consuming and can be expensive. DSS enable users to target monitoring in crops, or parts of crops, that are most vulnerable to pests, and where effective management of infestations would result in economic gains. Such DSS provide users with the confidence to know whether targeted crop monitoring is required, and information on how this should be carried out. This two-step decision process allows for application of any IPM techniques for reducing pest risks, whether they are preventative or curative. Development of advance DSS for IPM usually take the form of novel systems for specific pests, and so their application can be limited by region and/or access to resources (e.g. climate data). IPM Decisions (H2020 No. 817617) is developing an online IPM Decisions DSS Platform that will act as an advanced one-stop-shop for IPM DSS, facilitating wider access to current and future systems at a multi-national scale.

IZVLEČEK

Napredek pri digitalnih sistemih za podporo odločanju za integrirano varstvo rastlin

Sistemi za podporo odločanju (SPO) so pomemben vir za napredek integriranega varstva rastlin. SPO pomaga pridelovalcem in njihovim svetovalcem izboljšati strateške, taktične ali operativne odločitve, ki temeljijo na najboljših informacijah o možnih tveganjih za pridelek. Večina sistemov, zlasti taktičnih in operativnih sistemov, je neločljivo povezana s spremljanjem pridelka, saj so za zagon modela navadno potrebni podatki opazovanja, rezultati pa pogosto zahtevajo bolj ciljno usmerjeno spremljanje za opredelitev končnega rezultata odločitve. Spremljanje je že ključni del IVR, vendar je dolgotrajno in je lahko drago. SPO omogoča uporabnikom, da se usmerijo na spremljanje pridelkov ali delov pridelkov, ki so najbolj ranljivi in kjer bi učinkovito varstvo imelo gospodarsko korist. Takšen SPO uporabnikom zagotavlja zaupanje, da vedo, ali je potrebno ciljno spremljanje pridelka in informacije o tem, kako naj se to izvede. Ta dvostopenjski postopek odločanja omogoča uporabo vseh tehnik IVR, ne glede na to, ali so preventivne ali kurativne. Razvoj naprednega SPO za IVR navadno poteka v obliki novih sistemov za specifične škodljivce, zato je njihova uporaba lahko omejena glede na regijo in/ali dostop do virov (npr. podnebnih podatkov). V sklopu projekta IPM Decisions (H2020 št. 817617) raziskovalci razvijajo spletno platformo, ki omogoča širši dostop do sedanjih in prihodnjih sistemov v večnacionalnem merilu.

Induction of resistance by priming elicitors and soil microorganisms

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The presentation will make a brief introduction to the different types of defenses that exist in plants as well as a review of the pyramid of the disease highlighting the role of soil microorganisms as elicitors of defenses in plants, with special interest in the elicitation through the application of mycorrhizal and bacterial inoculants. It will also address the effect of soil microorganisms on the plant-insect interactions of the canopy and at the microscopic level those of bacteria, fungi, and oomycetes. The main topic will be the elicitation of plant self-defenses through the application of priming activators, their biological meaning, their mode of action, the types of elicitors identified (commercial or not) as well as field tests of applications of this type of solutions and their integration with traditional crop protection products.

IZVLEČEK

Induciranje odpornosti rastlin z »priming« elicitorji in talnimi mikroorganizmi

Predstavitev bo zajemala kratek povzetek različnih obrambnih mehanizmov rastlin ter pregled bolezenskega trikotnika, s poudarjeno vlogo talnih mikroorganizmov kot elicitorjev obrambnih reakcij pri rastlinah in posebnim poudarkom na elicitaciji po aplikaciji mikoriznih in bakterijskih inokulantov. Obravnavan bo vpliv talnih mikroorganizmov na interakcije rastlina-žuželka, na mikroskopski ravni pa na interakcije bakterije, glive in oomicete. Osrednja tema bo elicitacija samoobrambe rastlin z aplikacijo »priming« aktivatorjev, njihov biološki pomen, način delovanja, vrste elicitorjev (komercialni ali ne) in tudi testiranje uporabe tovrstnih rešitev na terenu ter njihova integracija s tradicionalnimi pripravki za varstvo rastlin.

Varstvo poljščin in krmnih rastlin

Spremembe v plevelni semenski banki v obdobju prehoda iz konvencionalne obdelave tal v sistem konzervirajoče obdelave tal in sistem brez obdelave tal

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Talna plevelna semenska banka predstavlja naravno skladišče plevelnih semen, v agronomskem smislu pa poglavitni vir zapleveljenosti z enoletnimi plevelnimi vrstami. Različne kmetijske prakse, med katere spadajo tudi različni sistemi obdelave tal, imajo pomembno vlogo pri dinamiki plevelne populacije, saj vplivajo na reprodukcijo, propadanje in premeščanje plevelnih semen vertikalno po talnem profilu. Za boljše razumevanje sprememb populacijske dinamike plevela v zgodnjem obdobju prehoda iz konvencionalne v sistem konzervirajoče in sistem brez obdelave tal, smo v letih 2020 in 2021 izvedli analizo talne semenske banke. Glavni cilj raziskave je bil ugotoviti količinsko stanje plevelnih semen v tleh in vrstno sestavo plevelne populacije v zgodnjem obdobju prehoda na manj intenzivne sisteme obdelave tal. Vzorčenja tal smo izvedli na površinah Kmetijskega inštituta Slovenije v Jabljah v trajnem poskusu s tremi različnimi sistemi obdelave tal (konvencionalna, konzervirajoča in neobdelana tla) in v dveh terminih pred setvijo glavnih kultur (spomladi in jeseni). Vzorci tal so bili odvzeti v štirih ponovitvah znotraj posameznega sistema obdelave in na treh globinah: 0-5 cm, 5-10 cm in 10-20 cm. Rezultati kalilnega poskusa so pokazali statistične razlike v terminu vzorčenja in sistemu obdelave tal. Skupno je največ plevelnih semen vzklilo na konvencionalno obdelanih tleh, medtem ko je bil vznik na neobdelanih tleh dvakrat manjši. V spomladanskem terminu vzorčenja, smo pričakovano največ plevelov našteli v konvencionalnem sistemu, v globljih dveh plasteh tal (5-10 in 10-20 cm). Nasprotno je bilo v sistemu brez obdelave tal največ plevelov v zgornjem sloju tal (0-5 cm). V jesenskem terminu je bil največji vznik ugotovljen v sistemu konzervirajoče obdelave tal, medtem ko je bil na neobdelanih tleh dvakrat manjši. Pri spomladanskem vzorčenju je v obeh letih prevladovala mnogosemenska metlika (*Chenopodium polyspermum* L.). V letu 2020 je največji delež vzniklih plevelov pri jesenskem vzorčenju predstavljala mrtva kopriva (*Lamium purpureum* L.), medtem ko je bilo v letu 2021 največ mnogosemenske metlike. Naši rezultati nakazujejo, da je bil že v zgodnjem obdobju prehoda na manj intenzivne sisteme obdelave tal zaznan pozitiven vpliv na zmanjšanje količin in razporeditve kalivih semen v zgornjem sloju tal, medtem ko bistvenih sprememb v sestavi plevelne populacije nismo ugotovili.

ABSTRACT

Changes in the weed seed bank in the early transition period from conventional to conservation and no-tillage system

Soil weed seed bank represents a natural reservoir of weed seeds and in agronomic terms the main source of future weed infestation with annual weed species. Agricultural practices, including different tillage systems, play an important role in the weed population dynamics, affecting the reproduction, decay and the vertical distribution of weed seeds. To better understand the weed population dynamics in the early transition period from conventional tillage to conservation and no-tillage systems, a soil seed bank analysis was performed in 2020 and 2021 in the experimental field of the Agricultural institute of Slovenia in Jablje.

The main objective of the study was to determine the quantitative status of weed seeds and the weed species composition in the early transition period to less intensive tillage systems. Soil sampling was carried out in two periods before crop sowing (spring and autumn). Soil samples were taken within the newly established long-term tillage experiment including three different tillage systems (conventional, conservation and no-tillage) at three depths: 0-5 cm, 5-10 cm, and 10-20 cm. The results of germination experiment showed statistically significant differences for both sampling period and the tillage system. In total, the most weed seeds germinated under conventional tillage system, while germination under no-tillage system was decreased by half. In the spring sampling period, the most germinated weed seeds were found in the conventional tillage system in the deeper two soil layers (5-10 and 10-20 cm). In contrast, under no-tillage system most weeds were determined in the topsoil layer (0-5 cm). In the autumn sampling period, the highest weed emergence was observed under conservation tillage system, while the germination was decreased by half under no-tillage system. In the spring sampling period manyseeded goosefoot (*Chenopodium polyspermum* L.) predominated in both years. In 2020 autumn sampling period purple deadnettle (*Lamium purpureum* L.) was the prevailing weed species, while in 2021 manyseeded goosefoot was found in highest density. Our results suggest that the quantitative reduction of weed seed bank and the differences in their distribution along the soil layer can be observed already in the early transition to less intensive tillage systems, while no significant changes in the composition of weed population was observed.

Vpliv priprave setvišča za setev in načina uporabe herbicidov na obseg erozije v posevkih koruze na strmini

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V letu 2021 smo v okviru projekta TOPPS izvedli 2 poskusa za prikaz obsega površinskega odtoka zemljine na njivi koruze v strmini v odvisnosti od načina priprave setvišča in načina uporabe herbicidov. Obseg erozije izražen v kg zemljine na ha na eno rastno dobo smo ugotovili z uporabo tehnike vkopanih zbirnih posod. Pri njivi 1 z naklonom strmine 11° smo testirali tri sisteme gojenja koruze; 1a klasično oranje, fina priprava setvišča, setev vzdolžno na strmino in uporaba talnega herbicida takoj po setvi, 1b klasično oranje, groba priprava setvišča, setev vzdolžno na strmino in uporaba listnega herbicida 2 tedna po setvi, 1c klasično oranje, minimum-till priprava setvišča, setev vzdolžno na strmino in uporaba listnega herbicida 4 tedna po setvi. Pri njivi 2 z naklonom strmine 8° smo testirali štiri sisteme gojenja koruze; 2a = 1a, 2b klasično oranje, minimum-till priprava setvišča, setev vzdolžno na strmino in uporaba talnega herbicida takoj po setvi, 3b klasično oranje, groba priprava setvišča, setev prečno na strmino in uporaba talnega herbicida takoj po setvi, 2d klasično oranje, fina priprava setvišča, setev vzdolžno na strmino in uporaba listnega herbicida 3 tedne po setvi. V poskusu 1 je znašal obseg letne erozije pri 1a 38,06 t/ha, pri 1b 26,33 t/ha in pri 1c 8,23 t/ha in v poskusu 2 ja erozija pri 2a znašala 35,73 t/ha, pri 2b 2,16 t/ha, pri 2c 3,16 in pri 2 d 28,75 t/ha. S spremenjenim načinom priprave setvišča (minimum-till), spremenjeno smerjo setve in uporabo listnega

namesto talnega herbicidov je obseg erozije na njivah s koruzo na strmini možno zmanjšati za več kot 30 %.

ABSTRACT

Influence of seedbed for sowing and choice of herbicide application method on the extend of erosion in maize crops grown on slope

In 2021, we performed 2 field experiments in the frame of TOPPS project to demonstrate the extent of surface runoff in a maize field grown on a slope, depending on the method of seedbed preparation and the method of herbicide use. The extent of erosion expressed in kg of soil per ha per growing season was determined using the technique of buried collection vessels. In field 1 with a slope of 11º, we tested three maize cultivation systems; 1a classical plowing, fine preparation of seedbed, sowing longitudinally on the slope and application of soil herbicide immediately after sowing, 1b classical plowing, rough preparation of seedbed, sowing longitudinally on the slope and application of leaf herbicide 2 weeks after sowing, 1c classical plowing, minimum-till preparation of seedbed, sowing longitudinally on the slope and application of foliar herbicide 4 weeks after sowing. In field 2 with a slope of 8º, we tested four maize cultivation systems; 2a=1a, 2b conventional plowing, minimum-till seedbed preparation, longitudinal sowing and application of soil herbicide immediately after sowing, 3b conventional plowing, rough preparation of seedbed, sowing cross-slope and application of soil herbicide immediately after sowing, 2d conventional plowing, fine preparation of the seedbed, sowing longitudinally on the slope and application of foliar herbicide 3 weeks after sowing. In experiment 1, the extent of annual erosion at 1a was 38.06, at 1b 26.33 and at 1c 8.23 t/ha, and in experiment 2 the erosion at 2a amounted 35.73, at 2b 2.16, at 2c 3.16 and at 2d 28.75 t/ha. With the adopted method of seedbed preparation (minimum-till), direction of seeding and application of foliar herbicide instead of soil herbicide, the extent of erosion in fields with corn on the slope can be reduced by more than 30%.

Vpliv različne obdelave tal na učinkovitost herbicidov in pridelek koruze

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Kvalitetna obdelava tal je pomemben tehnološki ukrep za doseganje visokih in kakovostnih pridelkov koruze. V zadnjih letih se ob oranju vse bolj pogosto izvajajo tudi drugi načini obdelave, ob tem pa se pojavljajo vprašanja kako je v teh primerih učinkovito delovanje herbicidov. Prav zato smo v letu 2020 izvedli poskus zatiranja plevelov v kombinaciji z različnimi načini obdelave tal. Cilj je bil ugotoviti, kako obdelava tal vpliva na pridelek in učinkovitost delovanja herbicidov. Preizkušana sta bila herbicida Adengo (a.s. izoksaflutol in tienkarbazon-metil) in Aliseo plus (a.s. dikamba, nikosulfuron in rimsulfuron), ter štirje različni načini obdelave tal: oranje do 24 cm, plitvo podrahljavanje do 20 cm , globoko podrahljavanje do 50 cm, minimalna obdelava do 10 cm. V poskusu so bili prisotni sledeči glavni pleveli: srhkodlakavi ščir (*Amaranthus retroflexus* L.), bela metlika (*Chenopodium album* L.) navadna kostreba (*Echinochloa crus-galli* (L.) P.BEAUV.), mnogosemenska metlika (*Chenopodium polyspermum* L.), njivski slak

(*Convolvulus arvensis* LINNAEUS) in škrlatnordeča mrtva kopriva (*Lamium purpureum* L.). Med različnimi postopki obdelave tal v povezavi s herbicidi ni bilo statistično značilnih razlik v količini pridelka; najvišji pridelek (13204 kg/ha) je bil pri postopku 'plitko podrahljavanje do 20 cm in Adengo'. V neškropljenih kontrolah je bil pridelek pri postopku oranje do 24 cm (9431,53 kg/ha) statistično značilno večji kot pri postopku minimalna obdelava (4123,07 kg/ha). Statistično značilne razlike v učinkovitosti delovanja herbicidov v odvisnosti od vrste obdelave tal so bile ugotovljene samo pri plevelu srhkodlakavi ščir in njivski slak.

ABSTRACT

Effect of different soil tillages on efficiency of herbicides and maize yield

Quality tillage is an important technological measure to achieve high and quality maize yields. In recent years, beside plowing, other tillage methods have become more common. This raises questions about the effectiveness of herbicides in different tillage methods. That is why in 2020 we conducted an attempt to control weeds in combination with various methods of tillage. The aim was to determine how tillage affects the yield of maize and performance of herbicides. The herbicides Adengo (a.s. isoxaflutole and thiencarbazone-methyl) and Aliseo plus (a.s. dicamba, nicosulfuron and rimsulfuron) were tested, as well as four different tillage methods (plowing up to 24 cm, shallow loosening up to 20 cm, deep loosening up to 50 cm, minimum tillage up to 10 cm). The following main weeds were present in the experiment: *Amaranthus retroflexus* L., *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. BEAUV., *Chenopodium polyspermum* L., *Convolvulus arvensis* LINNAEUS and *Lamium purpureum* L. There were no statistically significant differences in yield between the different tillage methods in connection with herbicides; the highest yield (13204 kg/ha) by shallow loosening up to 20 cm and Adengo. In the non-sprayed controls, the yield in the plowing method up to 24 cm (9431.53 kg/ha) was statistically significantly higher than in the minimum tillage procedure (4123.07 kg/ha). Statistically significant differences in the effectiveness of herbicides depending on the type of tillage were found only in the case of *Amaranthus retroflexus* L. and *Convolvulus arvensis* LINNAEUS.

Integrated weed management (IWM platform) – four years of trials, experiences and results

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In recent years, we have often received complaints from farmers about the ineffectiveness of some herbicides from the group of acetolactate synthase (ALS) inhibitors on certain weed species (eg APESV, SORHA, AMBEL). During 2017, in experiments in maize, at the location of Dubrovcak Lijevi, we noticed the lack of effectiveness of certain herbicides from the group of acetolactate synthase (ALS) inhibitors on the weed species wild sorghum (SORHA). After the performed analyzes (PCR technology and bioassays), the resistance of wild sorghum (SORHA) to ALS - herbicides in maize in the Republic of

Croatia has been irrefutably proven. As the fight against the growing number of resistant weed species worldwide and in Europe is becoming one of the leading problems in agricultural production and as due to increasingly strict registration criteria of a.i. and the potential risk of losing a significant number of herbicides and thus mechanisms of action, Bayer has decided to set up an IWM platform in Croatia aimed at raising producer awareness of weed resistance, the importance of good agricultural practice and responsible behavior in the application of herbicides. One such practice and responsible behavior in the application of herbicides includes the Integrated Weed Management (IWM) which enables sustainable weed control in our fields using various methods (chemical, physical and biological) that complement each other. Based on this principle, we designed our IWM platform that combines good agro-technical measures (crop rotation, tillage, stubble cleaning) with good practice of chemical crop protection (using various modes of action in crop rotation).

Izkušnje z zatiranjem bolezni v ozimnem ječmenu v letu 2021

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Zatiranje bolezni s fungicidi je še naprej pomemben tehnološki ukrep za doseganje visokih in kakovostnih pridelkov ječmena. V zadnjih letih je nabor fungicidov vse manjši. Nekatere učinkovite aktivne snovi so izgubile registracijo ali jo bodo v bližnji prihodnosti. Med snovmi, ki niso več v uporabi je tudi klorotalonil, kontaktni fungicid s t.i. »multi-site« delovanjem. V kombiniranih pripravkih je imel poleg dobre učinkovitosti tudi pomembno vlogo pri preprečevanju razvoja odpornosti povzročiteljev proti fungicidom. V poskusih smo želeli preveriti primernost dodajanja nekaterih drugih kontaktnih fungicidov za zatiranje bolezni v ječmenu. V letu 2021 smo na lokacijah Jablje (osrednja Slovenija) in Kušernik (SV Slovenija) preizkušali učinkovitost kombiniranih fungicidov Revycare (a.s. mefentriflukonazol + piraklostrobin), Elatus era (benzovindiflupir + protiokonazol) in Siltra Xpro (biksafen + protiokonazol) samostojno in z dodajanjem kontaktnih fungicidov na osnovi žvepla ali folpeta. Na obeh lokacijah je dodajanje kontaktnih fungicidov v primerjavi s čistimi pripravki vplivalo pozitivno na zatiranje ječmenove ramularijske pegavosti (*Ramularia collo-cygni* Sutton & Waller), najpomembnejše bolezni v ječmenu to leto. V Jabljah so bile najboljše učinkovitosti dosežene pri postopkih z dodajanjem folpeta. Povečanje učinkovitosti je bilo najbolj izrazito pri pripravku Revycare. Tudi na lokaciji Kušernik so bile dosežene boljše učinkovitosti in višji pridelki pri kombinacijah z dodatkom folpeta ali žvepla.

ABSTRACT

Experiences with disease control in winter barley in 2021

The protection with fungicides continues to be an important technological measure in winter barley to achieve high and quality yields. In recent years the pool of fungicides has been smaller. Some effective active substances have lost registration or will in the near future. Among the substances no longer in use is chlorothalonil, a contact fungicide with so-called "multi-site" action, which in addition to good efficacy also played an important role in preventing the fungicide resistance development. We wanted to check the efficacy of other contact components adding to suppress the diseases and also fungicide resistance development in winter barley. In 2021, the efficacy of the fungicides Revycare (mefentriflukonazol + piraklostrobin), Elatus era (benzovindiflupir + protiokonazol) and Siltra Xpro (biksafen + protiokonazol) with the addition of sulphur or folpet based contact fungicides, compared to pure fungicides, was tested at the locations Jablje (central Slovenia) and Kušernik (NE Slovenia). The addition of contact fungicides had at both locations a positive effect on the suppression of Ramularia leaf spot (*Ramularia collo-cygni* Sutton & Waller) compared to pure fungicides. In Jablje, the best efficacy and the highest yields were achieved in combinations, where folpet was added to the selected fungicides. The increase in efficacy was most pronounced with Revycare. Similar results were achieved at Kušernik with better efficiency and higher yields at combinations with folpet or sulphur.

Odpornost glive *Zymoseptoria tritici*, povzročiteljice pšenične listne pegavosti, proti fungicidom iz skupine azolov

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Listna pegavost pšenice, ki jo povzroča gliva *Zymoseptoria tritici*, je bolezen, ki v Sloveniji najbolj zmanjšuje pridelek pšenice in za njeno zatiranje porabimo največ fungicidov**.** Med najbolj pogosto uporabljenimi aktivnimi snovmi so fungicidi iz skupine azolov, ki delujejo kot inhibitorji demetilaze (DMI). Za azole na splošno velja, da je tveganje za pojav odpornosti srednje visoko. Stopnja odpornosti izolatov *Z. tritici* v Sloveniji doslej še ni bila preučevana. V letu 2020 smo iz 13 pšeničnih polj v različnih regijah Slovenije zbrali preko 100 izolatov *Z. tritici*, za katere smo ugotavljali odziv na različne koncentracije epoksikonazola in protiokonazola v *in vitro* testu na mikrotitrskih ploščah. Vrednosti EC_{50}, ki so merilo za ugotavljanje stopnje zmanjšane občutljivosti oziroma odpornosti, smo primerjali z občutljivim referenčnim izolatom na testirani aktivni snovi. Za večino lokacij smo ugotovili širok razpon med vrednostmi EC_{50}, kar kaže na veliko variabilnost glede občutljivosti izolatov znotraj populacije na posamezni lokaciji. Na vsaki lokaciji se tako pojavljajo izolati, ki izstopajo po visokih vrednostih EC_{50} za epoksikonazol, ki so vsaj stokrat višje od EC_{50} občutljivega seva. Izstopale so nekatere lokacije, kjer je bil delež takšnih izolatov višji od 50 %. Večina izolatov testiranih za občutljivost na protiokonazol je imela vrednosti EC_{50}, ki ne presegajo 10-kratne vrednosti EC_{50} občutljivega seva za protiokonazol in delež izolatov s faktorjem rezistence nad 100 je bil nižji v primerjavi z epoksikonazolom. Zmanjšanje občutljivosti *Z. tritici* na azola je bilo bolj izraženo na poljih, ki so bila škropljena večkrat. Ugotovili smo, da je pojav odpornosti glive *Z. tritici* v Sloveniji realna težava, saj ugotovljena stopnja odpornosti v posevku predstavlja grožnjo za nadaljnje naraščanje odpornosti lokalnih populacij glive proti protiokonazolu predvsem zaradi omejene izbire aktivnih snovi iz skupine DMI.

ABSTRACT

Resistance of the fungus *Zymoseptoria tritici*, the causative agent of Septoria tritici blotch (STB), to azole fungicides

Septoria tritici blotch (STB) caused by *Zymoseptoria tritici* is the disease that seriously affects the wheat production in Slovenia and the majority of fungicides on wheat is used to control it. Among commonly used active substances are fungicides from the azole group, which act as demethylase inhibitors (DMI). Azoles are considered to possess medium-high risk level for the development of the resistance. The resistance against azoles of isolates of *Z. tritici* in Slovenian agricultural environment has not been assessed so far. In 2020, we have collected over 100 isolates of *Z. tritici* from 13 wheat fields in different regions of Slovenia, for which we determined the response to different concentrations of epoxiconazole and prothioconazole in microtiter *in vitro* test. Their EC_{50} value, which is the criterium for the determination of decreased sensitivity or resistance, was compared to a reference isolate sensitive to the active substances. For most locations, we noticed a wide range of EC_{50} values, which indicates a large variability in the sensitivity of isolates within the population. In each location isolates standing out for their high EC_{50} values for epoxiconazole, *i.e.* at least 100-times higher than the EC_{50} of the sensitive strain, were detected. In several locations share of those isolates was even higher than 50%. Most isolates tested for their sensitivity to prothioconazole had EC_{50} values below 10-times the EC_{50} values of the sensitive strain and the proportion of isolates with a resistance factor above 100 was lower compared to epoxiconazole. The decrease in sensitivity of *Z. tritici* to azoles was pronounced on the fields that were fungicide-treated several times. We report that the occurrence of the resistance of the fungus *Z. tritici* in Slovenia is a serious problem, resulting in the substantial threat for further increase of the resistance within the local populations of the fungus against prothioconazole especially in the light of reduced repertoire of available active substances within DMI group.

Testiranje virulentnosti različnih vrst z žuželkami povezanih gliv na ličinkah velikega mokarja (Coleoptera: Tenebrionidae) ter njihove potencialne stimulacije rasti koruze

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Entomopatogene glive se zaradi svoje insekticidne učinkovitosti uporabljajo kot sredstva za zatiranje škodljivcev v ekološkem kmetijstvu, zaradi sposobnosti kolonizacije rastlinskega tkiva pa lahko rastlinam omogočijo tudi stimulacijo rasti ter zaščito pred herbivorijo in drugimi stresorji. Ta prispevek raziskuje 71 glivnih izolatov, ki pripadajo dvema rodovoma entomopatogenih gliv, *Metarhizium* in *Beauveria*, ter biostimulativnemu rodu *Trichoderma*, z namenom preverjanja njihove virulentnosti na ličinkah mokarja (*Tenebrio molitor*) in spodbujanja rasti koruze (*Zea mays*). Ličinke mokarjev in semena koruze smo potopili v suspenzijo konidijev s koncentracijo 1 x 10^8 konidijev ml^{-1}. Število mrtvih ličink smo spremljali 14 dni, učinkovitost izolatov na hitrost in uspešnost vznika rastlin smo spremljali vsakodnevno, dolžino korenin, dolžino nadzemnega dela in suho maso rastlin pa smo izmerili 21. dan poskusa. Pri analizi virulence smo upoštevali tudi izvor, gostitelja in metodo izolacije glive in ugotovili, da obstaja možnost višje virulence pri glivah, ki so izolirane bodisi iz mikotičnih odraslih žuželk, travniških habitatov in

gostiteljev iz redu Lepidoptera. Našli smo sedem izolatov, ki so pri mokarjih povzročili več kot 75 % smrtnost po 14 dneh poskusa, najvišjo smrtnost (100 %) pa sta povzročila izolata *Metarhizium brunneum* (1154) in *Beauveria bassiana* (2121). Prav tako smo našli sedem izolatov, ki so povečali dolžino nadzemnega dela, korenin ali suho maso koruze, in sicer sta izolata *Trichoderma atroviride* (2882) in *Trichoderma gamsii* (2883) značilno povečala dolžino nadzemnega dela koruze, trije izolati *Metarhizium robertsii* (2691, 2693 in 2688) so povečali dolžino korenin, dva izolata *M. robertsii* (2146 in 2794) pa sta povečala suho maso rastlin. Glede na oba kriterija je bil najuspešnejši izolat *M. robertsii* (2693), saj je povzročil smrt 73 % ličink mokarjev in tudi znatno povečal dolžino korenin koruze za 24.4 %. Opisani pristop omogoča selekcijo rastlinam koristnih glivnih izolatov, ki lahko zatirajo škodljivce in hkrati povečajo rast rastlin.

ABSTRACT

Testing virulence of different species of insect associated fungi against yellow mealworm (Coleoptera: tenebrionidae) and their potential growth simulation to maize

Due to their insecticidal activity, entomopathogenic fungi can be used as pesticides in organic farming. However through their ability to colonize plant tissues, they can also stimulate growth and protect plants from herbivores and other stressors. In this study we investigated 71 fungal isolates belonging to two genera of entomopathogenic fungi, *Metarhizium* and *Beauveria*, and one biostimulative genus *Trichoderma* to infect larvae of yellow mealworm (*Tenebrio molitor*) and stimulate maize (*Zea mays*) growth after seed treatment. Both larvae and maize seeds were immersed in a conidial suspension with a concentration of 1 x 10^8 conidia ml^{-1}. Larval mortality was observed for 14 days. The efficacy of isolates on seed emergence speed and success was monitored daily, while root length, shoot length and plant dry weight were measured after 21 days of growth. Fungal origin, host and isolation method were considered in the virulence analysis and showed a possible association of high virulence with wild adult mycosed insects, meadow habitats, and Lepidopteran hosts. We found seven isolates that caused more than 75 % mortality against *T. molitor* after 14 days post inoculation, with the highest mortality (100%) caused by isolates *Metarhizium brunneum* (1154) and *Beauveria bassiana* (2121). We also found seven isolates that increased shoot length, root length or maize dry weight, namely isolates *Trichoderma atroviride* (2882) and *Trichoderma gamsii* (2883) significantly increased shoot length, three *Metarhizium robertsii* isolates (2691, 2693 and 2688) increased root length and two *M. robertsii* isolates (2146 and 2794) increased plant dry weight. According to both criteria, the most successful isolate was *M. robertsii* (2693), as it caused the death of 73 % of mealworm larvae and also significantly increased maize root length by 24.4 %. The described approach allows the selection of plant-beneficial fungal isolates that can control pests and at the same time increase plant growth.

Diatomaceous earths in stored-product protection: assets and liabilities

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Diatomaceous earths (DEs) are considered promising alternatives over the use of traditional pesticides that are currently in use for stored product protection. DEs are based on the fossilized remains of phytoplanktons and act on insects' cuticle mechanically, through desiccation. Apart from the control of insects, DEs can be also effective for the control of fungi in stored products, and are regarded as functional aflatoxin binders. Earlier studies have shown that the Western Balkan area is rich of natural deposits that can be used for this purpose. In this context, there are several DE formulations that have been registered for surface treatments in storage and processing facilities or as admixture with grains. Numerous publications have clearly illustrated that the efficacy of DEs is highly moderated by a series of biotic and abiotic conditions, and, as such, any DE-based strategy should be regarded under this prism. Despite their high efficacy, the application of DEs against insects and pathogens has certain drawbacks, mostly on the physico-chemical properties of the commodity that are to be applied. In the current work, we will summarize the pros and cons of DE use at the industrial level, and the potentials of these substances in an IPM-based strategy.
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IZVLEČEK

Diatomejska zemlja v varstvu skladiščenih pridelkov: prednosti in slabosti

Uporaba diatomejska zemlje (DZ) v varstvu skladiščenega pridelka spada med pomembne alternativne načine zatiranja skladiščnih škodljivcev napram klasičnim insekticidom. DZ temeljijo na fosilnih ostankih fitoplanktona in delujejo na kutikulo žuželk mehansko, z izsuševanjem. Poleg zatiranja žuželk so DZ lahko učinkovite tudi za zatiranje gliv v skladiščenih proizvodih in veljajo za funkcionalna veziva aflatoksinov. Prejšnje študije so pokazale, da je območje Zahodnega Balkana bogato z naravnimi nahajališči DZ, ki jih je mogoče uporabiti v ta namen. V tem kontekstu obstaja več formulacij DZ, ki so bile registrirane za površinsko obdelavo v skladiščih in predelovalnih objektih ali kot primesi zrn. Številne publikacije so jasno ponazorile, da je učinkovitost DZ močno zmanjšana z vrsto biotskih in abiotskih dejavnikov, zato je treba vsako strategijo, ki temelji na DZ, obravnavati iz vidika omenjenih dejavnikov. Uporaba diatomejske zemlje proti žuželkam in povzročiteljem bolezni ima kljub visoki učinkovitosti določene pomanjkljivosti, predvsem glede fizikalno-kemijskih lastnosti skladiščenega pridelka, ki ga je treba uporabiti. V trenutnem delu bomo povzeli prednosti in slabosti uporabe DE na industrijski ravni ter potenciale teh snovi v strategiji, ki temelji na metodah IVR.

Preučevanje učinkovitosti inertnih prašiv za zatiranje koloradskega hrošča (*Leptinotarsa decemlineata* [Say], Coleoptera, Chrysomelidae) na krompirju

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Na Laboratorijskem polju Biotehniške fakultete v Ljubljani smo leta 2021 v poljskem poskusu preučevali delovanje treh inertnih prašiv slovenskega izvora za zatiranje koloradskega hrošča (*Leptinotarsa decemlineata*). V poskus smo vključili pet različnih obravnavanj, in sicer diatomejsko zemljo, lesni pepel, zeolit, negativno kontrolo in pozitivno kontrolo. Negativno kontrolo so predstavljale netretirane rastline, v pozitivni kontroli pa smo uporabili registrirane insekticide s kontaktnim delovanjem. Fungicidi so bili naneseni na krompir v vseh obravnavanjih. Inertna prašiva smo na rastline nanesli v štirih različnih terminih. Z nanosom internim prašiv smo začeli, ko so se na rastlinah začele pojavljati mlajše ličinke (L1 in L2). Inertna prašiva smo nanašali z nahrbtnim prašilnikom v koncentraciji 40 g/m^2. V osmih terminih smo na krompirju ugotavljali številčnost različnih razvojnih stadijev koloradskega hrošča (odrasli osebki, mlajše ličinke [L1-L2], starejše ličinke [L3-L4] in jajčna legla), v štirih terminih pa smo na krompirju ocenili tudi odstotek defoliacije. Po spravilu smo v obravnavanjih stehtali pridelek krompirja, pri čemer smo gomolje razdelili v tri frakcije. V prispevku bodo predstavljeni rezultati delovanja različnih inertnih prašiv na številčnost koloradskega hrošča in odstotek defoliacije ter vpliv preučevanih pripravkov na pridelek gomoljev.

ABSTRACT

Testing the efficacy of inert dusts against Colorado potato beetle (*Leptinotarsa decemlineata* [Say], Coleoptera, Chrysomelidae) on potato

In the Laboratory Field of the Biotechnical Faculty in Ljubljana, we have studied the efficacy of three inert dusts of Slovenian origin for the control of the Colorado potato beetle (*Leptinotarsa decemlineata*) in a field experiment in 2021. Five different treatments were included in the experiment, namely diatomaceous earth, wood ash, zeolite, negative control, and positive control. The negative control was represented by untreated plants, and in the positive control we used registered insecticides with contact mode of action. Fungicides were applied to potato in all treatments. Inert powders were applied to the plants in four different time intervals. We started with the application of inert dusts, when young larvae (L1 and L2) started to appear on the plants. Inert powders were applied with a backpack powder at a concentration of 40 g/m^2. The abundance of different developmental stages of the Colorado potato beetle (adults, young larvae [L1-L2], old larvae [L3-L4] and egg clusters) was evaluated eight times. We have evaluated the percentage of defoliation four times. After harvesting, we have weighed the potato yield from the treatments, respectively dividing the tubers into three fractions. In the paper we will present the results of efficacy of different inert dusts on the abundance of Colorado potato beetle, on the percentage of defoliation and the impact of inert dusts on potato yield.

Larvicidal efficacy, antifeedant activity and repellency of *Lactifluus piperatus* against *Plodia interpunctella* Hübner (Lepidoptera: Pyralidae)

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Many mushrooms, such as *Cantharellus* and *Lepista* spp., are almost resistant to insect attacks. However, only a few studies about the possibilities of using mushrooms in the protection of stored cereals from storage insect pests have been performed. *Lactifluus piperatus* is a non-toxic, edible mushroom, but rarely consumable due to its very strong, spicy taste. Until now, insecticidal potential, antifeedant activity and repellency have not been tested. Powdered *L. piperatus* was applied at 0.025, 0.05, 0.1 and 0.5 g per 100 g of maize (hybrid NS 640), with ten 2^{nd}-3^{rd} instar *P. interpunctella* larvae. There were four replicates for each concentration of the powder, as well as for untreated control. The number of dead larvae was registered after 2, 4 and 7 days after the exposure, and each living larva was weighed. The moderate larvicidal effect was registered – at a concentration of 0.5 g, 40% of larvae died after 7 days. The antifeedant activity was strongest at two highest doses (0.1 and 0.5 g), where larvae significantly less advanced in weight, compared to the control group ($p<0.05$). Satisfactory repellency (76%) of the powder was confirmed with the Y tube olfactometer. Results obtained by the area preference method showed even higher repellency: 5% extract water solution repelled 90% of larvae. Similar results were observed with the 1 and 2% extract water solutions (80 and 83% of repellency, respectively). These results direct towards the possibility of using *L. piperatus* powder as a natural repellent in the protection of stored maize from the *P. interpunctella* attacks. Further studies are recommended to overcome the existing problems in practical application in storages. Also, isolation of the active compounds of the mushroom would be necessary, as well as the assessing their effect on the quality of the treated maize.

IZVLEČEK

Larvicidna učinkovitost, antifidantna aktivnost in repelentnost *Lactifluus piperatus* na *Plodia interpunctella* Hübner (Lepidoptera: Pyralidae)

Številne gobe, kot sta *Cantharellus* in *Lepista* spp., so skoraj odporne na napade žuželk. Izvedenih pa je le nekaj raziskav o možnostih uporabe gob pri varstvu skladiščenih žit pred škodljivci skladiščnih žuželk. *Lactifluus piperatus* je nestrupena, užitna goba, vendar je zaradi zelo močnega okusa redko užitna. Insekticidni potencial, antifidantna aktivnost in repelentnost do zdaj niso bili testirani. *L. piperatus* v prahu smo dali v odmerkih 0,025, 0,05, 0,1 in 0,5 g na 100 g koruze (hibrid NS 640), z desetimi ličinkami *P. interpunctella*, II-III stopnje. Za vsako koncentracijo praška so bile štiri ponovitve, kot tudi za kontrolo. Število mrtvih ličink smo registrirali po 2, 4 in 7 dneh po izpostavljenosti, in stehtali vsako živo ličinko. Zabeležen je bil zmeren larvicidni učinek – pri koncentraciji 0,5 g je po 7 dneh poginilo 40 % ličink. Antifidantna aktivnost je bila najmočnejša pri dveh najvišjih odmerkih (0,1 in 0,5 g), kjer so ličinke statistično značilno manj napredovale v masi v primerjavi s kontrolno skupino ($p<0,05$). Zadovoljivo repelentnost (76 %) praška smo potrdili z olfaktometrom z Y cevjo. Rezultati, dobljeni po metodi filtrirnega papirja, so pokazali še večjo repelentnost: 5 % raztopina vodnega ekstrakta je odgnala 90 % ličink. Podobne rezultate so opazili pri 1-odstotni in 2-odstotni vodni raztopini ekstrakta (80 oziroma 83-odstotni repelentni učinek). Ti rezultati kažejo na možnost uporabe prahu *L. piperatus* kot naravnega repelenta pri zaščiti skladiščene koruze pred napadi *P. interpunctella*. Priporočljive so nadaljnje študije za premagovanje obstoječih težav pri praktični uporabi v skladiščih. Prav tako bi bila potrebna izolacija aktivnih spojin gobe in ocena njihovega vpliva na kakovost obdelane koruze.

Preizkušanje alternativnih možnosti obvladovanja koloradskega hrošča (*Leptinotarsa decemlineata*) z uporabo bioinsekticidov

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Metode integriranega varstva rastlin vključujejo uporabo različnih načinov nekemičnega zatiranja škodljivcev. Koloradski hrošč (*Leptinotarsa decemlineata*) je najpomembnejši škodljivec krompirja, ki ga lahko zatiramo z uporabo insekticidov izdelanih na podlagi rastlinskih izvlečkov, entomopatogenih mikroorganizmov in drugih snovi, ki predstavljajo manjše tveganje za zdravje ljudi in živali ter okolje. V letih 2020 in 2021 smo v poljskem poskusu izvedenem v okviru EU projekta Ecobreed preizkušali učinkovitost štirih različnih bioinsekticidov ter njihovih kombinacij na ličinke koloradskega hrošča: azadirahtin (Neemazal), spinosad (Laser Plus), suspenzija konidijev entomopatogene glive *Beauveria bassiana* (Bals.-Criv.) Vuill. (KIS izolat 2300 in 2121), endotoksini in spore bakterije *Bacillus thuringiensis* subsp. *tenebrionis* (Novodor). Preučevali smo tudi sodobnejši biokemijski pristop obvladovanja koloradskega hrošča z RNA interferenco (RNAi). Učinkovitost pripravkov smo ugotavljali na podlagi razlik v številu ličnik ter deležu poškodb na listih rastlin zaradi objedanja ličink. Največja učinkovitost na zmanjšanje števila ličnik v primerjavi s kontrolo je bila v obeh letih dosežena v obravnavanjih kjer je bil vključen spinosad (spinosad priporočena doza, spinosad 0,2 priporočene doze in spinosad + *B. bassiana*). V letu 2020 je bilo število ličink statistično značilno manjše tudi v obravnavanju azadirahtin + *B. bassiana*, medtem ko v letu 2021 uporaba ostalih bioinsekticiodov ni izkazovala učinkovitosti za zatiranje ličink. Razlika v manjši poškodovanosti listov je bila v obeh letih statistično značilna, z izjemo *B. bassiana* in RNAi. Pri slednjem je bila razlika v letu 2020 statistično značilna, v letu 2021 pa ne. Kljub razlikam v poškodovanosti listov in deležu poginulih ličink, razlik v pridelku gomoljev med obravnavanji ni bilo.

ABSTRACT

Testing of alternative approaches of Colorado potato beetle (*Leptinotarsa decemlineata*) management with the use of bioinsecticides

Integrated pest management strategies include the use of various methods of non-chemical pest control. Colorado potato beetle (*Leptinotarsa decemlineata*) is the most important insect pest of potato and can be controlled by using insecticides based on plant extracts, entomopathogenic microorganisms and other substances that pose a lower risk for human and animal health, and the environment. Within the EU project Ecobreed field experiments were carried out in 2020 and 2021 to test four bioinsecticides and their combinations against Colorado potato beetle larvae: azadirachtin (Neemazal), spinosad (Laser Plus), conidial suspension of entomopathogenic fungi *Beauveria bassiana* (Bals.-Criv.) Vuill. (KIS isolates 2300 and 2121) and endotoxin and spores from *Bacillus thuringiensis* subsp. *tenebrionis* (Novodor). An innovative approach based on RNAi mechanism was also assessed. The effectiveness of different treatments was determined

as a reduction in the number of larvae and damaged leaf area after biopesticide application. In both years, treatments with spinosad (spinosad full dose, spinosad 0.2 dose, and spinosad + *B. bassiana*) exhibited the greatest efficacy in reducing the number of larvae. In 2020, the number of larvae was significantly lower in the treatment of azadirachtin + *B. bassiana*, while in 2021 the use of other bioinsecticides did not result in significant CPB larvae control. With the exception of *B. bassiana*, the difference in leaf damage reduction was significant in all treatments. In RNAi treatment the difference was statistically significant in 2020 but not in 2021. Despite the differences in rate of defoliated area and larvae reduction, no significant differences in tuber yield were observed between treated and untreated potato plants.

Odkrivanje gomoljev krompirja napadenega z ogorčicami koreninskih šišk *Meloidogyne luci* s hiperspektralnim slikanjem in metodami PCR v realnem času

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Ogorčice koreninskih šišk (*Meloidogyne* spp.) veljajo za najbolj agresivno, škodljivo in gospodarsko najbolj pomembno skupino rastlinsko-parazitskih ogorčic, ki predstavljajo pomemben omejevalni dejavnik pri pridelavi krompirja. Ogorčica *Meloidogyne luci*, vključena na opozorilni seznam EPPO, je krompirjev škodljivec z velikim potencialom za škodo. V naši raziskavi smo pokazali, da lahko *M. luci* povzroči na krompirju resen napad s poškodbami gomoljev, podobno kot karantenska krompirjeva škodljivca *M. chitwoodi* in *M. fallax*. Poleg tega je študija pokazala, da lahko *M. luci* povzroči latenten napad brez vidnih simptomov na površini gomoljev. Takšna latentna okužba predstavlja veliko tveganje za nenadzorovano širjenje škodljivega organizma, zlasti prek semenskega krompirja. Razvili smo učinkovite metode odkrivanja prisotnosti *M. luci* z namenom preprečevanja nenadzorovanega širjenja z napadenimi gomolji krompirja. Z uporabo hiperspektralnega slikanja in molekularnih pristopov je bilo mogoče odkriti *M. luci* tako v močno okuženih gomoljih krompirja kot v gomoljih brez vidnih simptomov. Odkrivanje napadenih gomoljev s hiperspektralnim slikanjem v kombinaciji z metodo delnih najmanjših kvadratov in podpornih vektorjev (PLS-SVM) je doseglo 100 % uspešnost, ne glede na način priprave gomolja. Pristop PCR v realnem času je zaznal prisotnost *M. luci* v krompirjevih olupkih iz 100 gomoljev krompirja na vzorec z visoko občutljivostjo. Ovrednotili smo dve metodi PCR v realnem času; prvo s skupinsko specifičnimi začetnimi oligonukleotidi - za skupino *M. ethiopica* (t.j. skupina treh vrst: *M. ethiopica, M. luci* in *M. inornata*) in drugo z vrstno specifičnimi začetnimi oligonukleotidi za *M. luci*. Študija je prvič pokazala uporabnost tehnologije hiperspektralnega slikanja za učinkovito odkrivanje gomoljev napadenih z ogorčicami in omogočila tudi identifikacijo latentno napadenih gomoljev. Vse razvite protokole bi lahko uporabili v programih fitosanitarnih pregledov za odkrivanje gomoljev krompirja napadnega z ogorčico *M. luci*. Zahvala: finančna podpora s strani ARRS (MR 38128, P4-0072).

ABSTRACT

Detection of potato tubers infested by root knot nematode *Meloidogyne luci* using hyperspectral imaging and real-time PCR methods

Root-knot nematodes (*Meloidogyne* spp.) are considered the most aggressive, damaging and economically important group of plant-parasitic nematodes and represent a significant limiting factor for potato production and tuber quality. *Meloidogyne luci*, a pest included on the EPPO Alert List, has previously been shown to be a potato pest with significant reproductive potential on potatoes. In our study, we showed that *M. luci* can develop severe tuber infestation with tuber damage similar to the quarantine potato pests *M. chitwoodi* and *M. fallax*. In addition, the study showed that *M. luci* may develop a latent infestation, i.e. without visible symptoms on the surface of potato tubers. This latent infestation may pose a high risk for uncontrolled spread of the pest, especially via seed potatoes. We developed efficient detection methods to prevent uncontrolled spread of *M. luci* through infested potato tubers. Using hyperspectral imaging and molecular approaches to detect nematode DNA with real-time PCRs, it was possible to detect *M. luci* in both heavily infested potato tubers and tubers without visible symptoms. Detection of infested tubers with hyperspectral imaging, combined with partial least squares support vector machines (PLS-SVM) achieved a 100% success rate, regardless of tuber preparation. The real-time PCR approach detected *M. luci* in potato-peels from 100 potato tubers per sample with high sensitivity. Two real-time PCR methods were evaluated; one with group specific primers - for *M. ethiopica* group (i.e. group of three species: *M. ethiopica, M. luci and M. inornata*) and one with species specific primers for *M. luci*. The study demonstrated for the first time the usefulness of hyperspectral imaging for the efficient detection of nematode-infested tubers and also allowed the identification of latently infested tubers. All protocols could be useful tools for detecting potato tubers infested with *M. luci* nematode in large-scale phytosanitary screening programs.

Stabilnost in prenos viroida razpokanosti skorje agrumov (CBCVd) z vodo na hmelj (*Humulus lupulus* L.)

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Neoporečnost vode v kmetijstvu v zadnjih desetletjih ogrožajo negativni okoljski vplivi, med katere uvrščamo tudi kontaminiranost z rastlinskimi patogeni. Vse težji dostop in pomanjkanje vode sta vodila v spremembe načinov pridelave rastlin. Uveljavlja se uporaba namakalnih sistemov, hidroponska vzgoja, vzgoja rastlin brez substratov ter številne druge, pri čemer so vodni viri za namen pridelave rastlin potoki, reke, jezera ali pa sistemi kroženja hranilne raztopine. Prisotnost rastlinskih patogenov v vodah je pomemben dejavnik onesnaženja in povzroča njihovo razširjanje med kmetijskimi površinami, kar lahko privede do večjih ekonomskih izgub in pojava novih gostiteljev. Takšni vodni viri so lahko pot prenosa rastlinskih patogenov, kot je viroid razpokanosti skorje agrumov (citrus bark cracking viroid, CBCVd), ki na hmelju povzroča visoko gospodarsko škodo. Hitro širjenje CBCVd v nasadih temelji predvsem na mehanskem prenosu in ostankih okuženih rastlin, še neraziskana pa je možnost prenosa z vodnimi viri. Predstavljena raziskava je

obsegala dva epidemiološka poskusa, pri čemer smo v prvem delu določali največjo redčitev viroida CBCVd v vodi, ki ga z diagnostično metodo RT-PCR v realnem času še zaznamo. V drugem delu pa smo proučevali periodično zaznavanje viroida CBCVd v vodi. V obeh poskusih smo nato preverjali infektivnost vodnih vzorcev z mehanskim okuževanjem zdravih rastlin hmelja sorte Celeia. Viroid CBCVd smo v prvem poskusu zaznali do redčitve 10^{-3}, njegovo infektivnost iz vode pa smo po analizi testnih rastlin zaznali le pri vhodnem, neredčenem vzorcu. V drugem poskusu smo viroid CBCVd inkubirali 42 dni v vodi, pri čemer smo viroid zaznali še 35. dan. Rastline smo nato s tem vodnim vzorcem mehansko inokulirali in vzgajali pod nadzorovanimi pogoji rastne komore ter po analizi prisotnost CBCVd zaznali tudi pri rastlinah, ki so bile inkubirane z vodnim vzorcem 35. dan.

ABSTRACT

Stability and transmission of Citrus bark cracking viroid (CBCVd) with water on hop (*Humulus lupulus* L.)

In recent decades water quality in crop production is threatened by different environmental impacts, like contamination with plant pathogens. Because of harder water access and water scarcity, crop production with irrigation systems or in soilless cultures, using closed or open hydroponic systems, has been increasing worldwide. Those types of crop production can be sourced from surface water supplies such as ponds, lakes, rivers, and reservoirs and, as such, can harbour disease causing microorganisms, including viroids, which causes many symptoms on plants and leads to production loss. Existence of plant pathogens in environmental waters is important for causing water pollution and dissemination among agricultural areas. Different water supplies could be pathway for many water-borne plant pathogens, such as Citrus bark cracking viroid (CBCVd), which causes agressive symptoms on hop (*Humulus lupulus* L.). CBCVd spreads mainly by mechanical means such as residues of plant sap of infected plants on tools and organic residues on hop fields. Unknown pathway of viroid spread is spread with water supplies. In our research we investigated stability and infection CBCVd from water samples. In first experiment we tested the higher dilution of viroid CBCVd in water sample that could be detected with real time RT-PCR. In second experiment we weekly tested presence of CBCVd in water. Both experiment we confirmed with diagnostic analysis (real time RT-PCR) and then mechanically infected testing Celeia hop plants. The results confirmed viroid CBCVd in dilution 10^{-3}, its infection from water samples we only confirmed in undiluted water sample. In second epidemiological experiment we incubated viroid CBCVd for 42 days and confirmed presence of CBCVd on 35th day. Then we mechanically infected testing Celeia hop plants with every water sample and cultivated plants under controlled conditions. After analysis we confirmed viroid CBCVd in plants, which we inoculated with water sample of 35th day.

Optimizacija in validacija diagnostične metode mRT-PCR za sočasno določanje viroidov v hmelju

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Viroidi so najmanjši rastlinski patogeni, ki lahko povzročijo velike gospodarske izgube. Viroidnih bolezni ni mogoče ozdraviti ali nadzorovati z uporabo fitofarmacevtskih sredstev, zato je edini način borbe proti njim odstranjevanje okuženih rastlin. V Sloveniji je od leta 2011 prisotnost hude viroidne zakrnelosti hmelja, ki jo povzročata viroid razpokanosti skorje agrumov (CBCVd) in hmeljev latentni viroid (HLVd), povzročila izkrčenje več kot 300 ha hmeljišč. Edinstvena kombinacija viroidov CBCVd in HLVd, ter občasno prisotnega viroida zakrnelosti hmelja (HSVd), ima za hmelj zelo negativne posledice, ki se kažejo v zakrnelosti rastlin, deformaciji listov in storžkov in suhi trohnobi korenike. Na hmelju se lahko pojavlja tudi viroid grbavosti jabolk (AFCVd), ki pa se trenutno nahaja samo na Japonskem. Ukrepi za preprečitev širjenja bolezni so usmerjeni k razvoju zanesljivih diagnostičnih metod, ki omogočajo odstranitev okuženega rastlinskega materiala. V raziskavi smo zato razvili metodo mRT-PCR za sočasno določanje viroidov CBCVd, HLVd, HSVd in AFCVd. Testirali smo več že objavljenih parov začetnih oligonukleotidov na različicah viroidov iz hmelja, agrumov in vinske trte. Analizirali smo tudi univerzalne začetne oligonukleotide za viroide iz družine Pospiviroidae in endogene kontrole, z namenom spremljanja kvalitete izolirane RNA. Izbrani začetni oligonukleotidi so specifično določili posamezne viroide, ne glede na gostitelja ali kombinacijo viroidov. Za endogeno kontrolo smo določili gena *nad*5 in *DRH*1, ki sta se neodvisno pomnoževala v vseh gostiteljih. V okviru analize diagnostične specifičnosti smo metodo mRT-PCR primerjali z RT-PCR in dot-blot, glede na RT-PCR smo dobili primerljive rezultate, pri dot-blot pa signale slabše intenzitete. Validacija metode mRT-PCR je pokazala, da je metoda 100-krat manj občutljiva kot RT-PCR, zaradi hkratnega pomniževanja več tarč. Kljub temu ima metoda pomembno vrednost, saj uporaba različnih kombinacij začetnih oligonukleotidov omogoča krajšo analizo, manjšo porabo reagentov in posledično tudi manjše stroške analize.

ABSTRACT

Optimization and validation of a diagnostic method mRT-PCR for the simultaneous detection of hop viroids

Viroids are the smallest plant pathogens that can cause plant diseases and subsequent economic losses. Viroid diseases cannot be cured or controlled by chemicals and infected plants need to destroyed. Since 2011 severe hop stunt disease caused by *Citrus bark cracking viroid* (CBCVd) and *Hop latent viroid* (HLVd) has led to destruction of more than 300 ha of hop gardens in Slovenia. The unique combination of CBCVd and HLVd in addition to occasionally present *Hop stunt viroid* (HSVd), has devastating effects on hop plants, which are reflected in stunted plants, deformation of leaves and cones, and dry rot root. Apple fruit crinkle viroid (AFCVd) can also appear on hops, but is found only in Japan. Control strategies are focused on development of reliable detection methods to exclude the infected plant material. In this study, we developed multiplex RT-PCR for detection of CBCVd, HLVd, HSVd and AFCVd. Several published primers were tested on viroid isolates from hops, citrus and grapevine. Futhermore universal primers for viroids from family Pospiviroidae and internal controls were tested, to monitor RNA extraction. Selected primers were able to specifically identify individual viroids, regardless of host or viroid combination. For internal control *nad*5 and *DRH*1 genes were selected, which were independently amplified in all hosts. As part of the analysis of diagnostic specificity the mRT-PCR method was compared with RT-PCR and dot-blot. With respect to RT-PCR comparable results were obtained, while dot-blot gave signals of lower intensity. Method

validation showed that mRT-PCR has 100 times lower sensitivity as RT-PCR, due to the simultaneous amplification of multiple targets. Nevertheless the method has an important value, as the use of different combination of primers enables shorter analysis, reduces the use of reagents and, consequently, the cost of analysis.

Virusi stročnic v Sloveniji – stari in novi znanci

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Zrnate stročnice, med katere sodijo tudi fižol, soja in grah, predstavljajo pomemben vir rastlinskih beljakovin in vlaknin v človeški prehrani. V Sloveniji smo leta 2018 pridelovali zrnate stročnice na manj kot 2% njivskih površin, točneje na 2833 ha. Virusne bolezni na stročnicah smo proučevali v letih 2016 do 2020. Največ pozornosti smo namenili soji, katere proizvodnja se je do leta 2017 povečevala, poleg soje pa smo na virusne okužbe analizirali tudi fižol in grah. Analizirali smo 420 vzorcev, od tega 310 vzorcev soje, 91 vzorcev fižola in 19 vzorcev krmnega graha. Poleg virusa navadnega mozaika fižola (BCMV), virusa navadnega mozaika in nekroze fižola (BCMNV), virusa rumenega mozaika fižola (BYMV) in virusa mozaika kumare (CMV), ki smo jih na fižolu že potrdili v preteklosti, smo na vseh analiziranih rastlinskih vrstah potrdili tudi druge viruse. Med njimi je bil najbolj razširjen virus mozaika soje (SMV), ki smo ga potrdili na številnih vzorcih soje.

ABSTRACT

Legume viruses in Slovenia – old and new acquaintances

Grain legumes like common beans, soybeans and peas are important sources of plant proteins and fibers in human diet. In 2018 grain legumes were grown in Slovenia on 2833 ha, which represents less than 2% of arable area. In the years 2016 to 2020 virus diseases of legumes were one of the topics of our research. Analyses were done primarily on soybeans, the production of which was increasing until 2017. Other analyzed crops were common beans and peas. Altogether 420 samples were collected and analyzed, of which 310 were soybean, 91 common bean and 19 fodder pea samples. Bean common mosaic virus (BCMV), bean common mosaic necrosis virus (BCMNV), bean yellow mosaic virus (BYMV) and cucumber mosaic virus (CMV) already known to infect common beans in Slovenia were again found on the same crop as before. Some other viruses were also confirmed on different crops. The most widespread was soybean mosaic virus (SMV) which was present in many soybean samples.

Karantenska bakterija *Curtobacterium flaccumfaciens pv. flaccumfaciens* kot povzročiteljica bolezni pri stročnicah

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Curtobacterium flaccumfaciens pv. *flaccumfaciens* (Cff) je gram pozitivna bakterija, ki povzroča venenje in madeže na listih pri užitnih stročnicah, kot so navadni fižol, soja, zeleni mungo fižol ter kitajski fižol. Bakterija ima v Evropi karantenski status in je uvrščena v prilogo II/A Izvedbene uredbe komisije (EU) 2019/2071 ter na seznam A2 pri Evropski organizaciji za varstvo rastlin (EPPO). Kot povzročiteljico fižolove bakterijske uvelosti pri navadnem fižolu so bakterijo opisali že leta 1922 v Severni Ameriki. V zadnjih 20 letih je bila bakterija najdena v večih evropskih državah, vendar poročil o večji gospodarski škodi na tem področju ni bilo. So pa poročila o večji gospodarski škodi iz Brazilije, Kanade, Avstralije, Irana ter centralnega področja ZDA. Na dolge razdalje se bakterija prenaša z okuženim semenskim materialom. Če pride do okužbe mladih rastlin, te navadno uvenijo in propadajo. Pri okužbi starejših rastlin pa se bolezenska znamenja najprej pojavijo kot listno venenje s klorotičnimi področji, ki s časom preidejo v nekroze na listih, ki so obdane z rumenim halojem. Sprva se venenje pojavi v najtoplejših urah dneva, nato pa si rastline opomorejo, ko se temperature znižajo. Venenje postane trajno ko bakterija zamaši rastlinske žile ter prekine dotok vode iz korenin v vrhnje dele rastline. Možno je, da ne pride do venenja ampak so bolezenska znamenja vidna kot zlato-rumene nekroze na listih, ki so podobne bolezenskih znamenjem navadne bakterijske pegavosti fižola (*Xanthomonas phaseoli pv phaseoli* in *X. citri pv. fuscans*). Od leta 2021 na Nacionalnem inštitutu za biologijo, v okviru programa preiskav, izvajamo tudi laboratorijsko detekcijo te bakterije v rastlinah z izraženimi bolezenskimi znamenji. Diagnostična shema vključuje izolacijo na gojiščih, MALDI- TOF ter različne molekularne metode kot so PCR, PCR v realnem času in določanje DNA črtnih kod. V prispevku bomo podrobneje predstavili bolezenska znamenja, gostiteljske rastline, epidemiologijo ter prve izkušnje z detekcijo te bakterije.

ABSTRACT

Quarantine bacteria *Curtobacterium flaccumfaciens pv. flaccumfaciens* as pathogens on legumes

Curtobacterium flaccumfaciens pv. *flaccumfaciens* (Cff) is a gram-positive bacterium that causes wilting and tan spot of edible legumes, such as common bean, soybean, mungbeen, and cowpea. It is a quarantine bacterium listed in Annex II/A of Commission Implementing Regulation (EU) 2019/2071 and in A2 List of the European Plant Protection Organization (EPPO). As a cause of bacterial wilt disease in common beans, the bacterium was described already in 1922 in North America. In the last 20 years, the bacterium has been reported in several European countries with no associated economic yield losses. However, economic yield losses are reported from Brazil, Canada, Australia, Iran and the central United States. The bacterium is spread over long distances with infected seeds. If infection of young plants occurs, they usually wither and decay. In older plants the disease is characterized by foliar wilting and chlorosis leading to necrosis on leaves surrounded by a yellow halo. Initially, wilting occurs in the warmest hours of the day, and then the plants recover as the temperature drops. Withering becomes permanent when the bacterium clogs the plant's veins and interrupts the flow of water from the roots into the foliage. Occasionally, typical wilting symptoms may be absent and symptoms of

golden-yellow necrotic leaf lesions develop which closely resemble those of common blight of beans (*Xanthomonas phaseoli* pv *phaseoli* and *X. citri* pv. *fuscans*). From 2021the National Institute of Biology is carrying out laboratory detection of Cff in plants with symptoms. The diagnostic scheme includes isolation on media, MALDI-TOF, and various molecular methods (PCR, real-time PCR, and DNA barcoding). In this presentation, we will present the disease symptoms, host plants, epidemiology and experience with the laboratory detection of this bacterium.

Varstvo sadnega drevja, oljk in jagodičja

Addressing invasive pests in European fruit production systems

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Biological invasions are currently, considered one of the main concerns affecting national and regional economies, ecosystems functions, sustainable production of agricultural goods, pesticide use, conservation and epidemiology of vector borne diseases. Despite intense efforts within the European Union to impose, support and coordinate the implementation of actions to address invasive pests, there is an increasing record of invasion events and a rather slow and often unsuccessful response. Fruit and vegetable production systems are amongst the most vulnerable to invasion, mainly because of fresh commodities trading and the human mobility that results in dispersion of propagules in long distances. Bringing true fruit flies as a model system, the Horizon 2020 funded project FF-IPM "*In-silico* boosted, pest prevention and off-season focused IPM against new and emerging fruit flies" tackles all phases of invasion (arrival, establishment, naturalization, and dispersion) and generates novel tools and approaches to enhance stakeholders' capacity to predict invasion risk, intercept, and detect invasive species, and apply novel, ecologically friendly management approaches. Novel e-nose systems to intercept fruit fly infested fruits in cargo shipments, as well as electronic traps and advanced detection and surveillance systems have been developed. Thorough climatic and population modelling that estimates establishment risk at a spatial and temporal continuum for three fruit fly species have been generated. Last but not least, computer assisted Integrated Pest Management (IPM) strategies for off and on season implementation are currently pilot tested. Bringing concepts, approaches, and developments of the FF-IPM project as a "live example" the current paper discusses the weaknesses of the European system to deal with ongoing invasion events and the opportunities to establish a more efficient preparedness strategy against biological invasions in fruit producing systems.

IZVLEČEK

Obravnava invazivnih škodljivcev pri pridelavi sadja v Evropi

Naravno širjenje invazivnih vrst škodljivih organizmov velja za eno glavnih skrbi, ki prizadene tako nacionalno kot tudi regionalno gospodarstvo. Invazivne vrste vplivajo na delovanje ekosistemov, proizvodnjo kmetijskih proizvodov v smislu trajnosti in stabilnosti proizvodnje, uporabe fitofarmacevtskih sredstev, obvladovanja prenašalcev vektorskih bolezni in poznavanje njihove epidemiologije. Kljub intenzivnim prizadevanjem Evropske Unije pri usklajenem izvajanju ukrepov za boj proti invazivnemu širjenju bolezni in škodljivcev, je vse več novih izbruhov, na katere se EU odziva precej počasi in neuspešno. Pri pridelavi sadja in zelenjave smo pogosto priča pojavom novih – invazivnih vrst škodljivih organizmov, saj gre za trgovanje svežih pridelkov na relativno dolge razdalje. Projektu sadne muhe - FF-IPM z naslovom: "*In-silico boosted, pest prevention and off-season focused IPM against new and emerging fruit flies*", ki ga financira Horizon 2020, je usmerjen v integrirano varstvo pred sadnimi vrstami muh, in sicer v vseh fazah (od pojava invazivne vrste, vzpostavitve sistema spremljanja, do njihove razširitve). V projektu so ustvarili nova orodja in pristope za povečanje zmogljivosti zainteresiranih deležnikov za napovedovanje tveganja pojava invazivnih vrst muh, njihovega prestrezanja in odkrivanja ter uporabo novih, okolju prijaznih pristopov obvladovanja. Razvili so nov

sistem »e-nos« za ugotavljanje in prestrezanje napadenega sadja s sadno muho v pošiljkah, pa tudi elektronske pasti ter napredni sistem za odkrivanje in nadzor. Izdelano je bilo natančno podnebno in populacijsko modeliranje, ki predvideva tveganje za naselitev treh sadnih vrst muh v določenem prostorskem in časovnem obdobju. Trenutno se pilotno testira računalniško podprta strategija integriranega varstva škodljivcev za izvajanje v sezoni kot tudi izven nje. Prenašanje konceptov, pristopov in razvoj pri projektu FF-IPM je kot "živ primer", kjer obravnava trenutni evropski sistem pri obravnavi nenehnih invazij škodljivih organizmov, z vsemi slabosti in priložnostmi za vzpostavitev učinkovitejše strategije pripravljenosti v boju proti biološkim invazijam pri pridelavi sadja.

Prvi korak na poti k biotičnemu varstvu marmorirane smrdljivke (*Halyomorpha halys* [Stål, 1855], Hemiptera, Pentatomidae) v Sloveniji

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Pojav in naselitev tujerodne invazivne stenice marmorirane smrdljivke *Halyomorpha halys* (Hemiptera: Pentatomidae) v Sloveniji sta povezana z nastankom velike gospodarske škode v pridelavi sadja in vrtnin ter s potrebo po uvedbi učinkovitih metod zdravstvenega varstva. V razvoj in preizkušanje metod za obvladovanje škodljivca, ki potekajo na globalni ravni, je bilo do sedaj vloženega veliko truda in finančnih sredstev. Uporaba protiinsektnih mrež ter biotično varstvo z jajčnimi parazitoidi sta se v praksi izkazali kot najbolj učinkoviti in okoljsko sprejemljivi metodi, ki nudita trajno rešitev problema. Ključnega pomena pri uvajanju biotičnega varstva marmorirane smrdljivke je poznavanje njenih naravnih sovražnikov ter interakcij med domorodnimi koristnimi vrstami in škodljivko v novem okolju. Namen triletne raziskave izvedene na območju zahodne Slovenije, kjer je bila leta 2017 prvič najdena marmorirana smrdljivka, je bil odkrivanje jajčnih parazitoidov stenic ter vrednotenje njihovega vpliva na populacijo marmorirane smrdljivke. V letih 2019 do 2021 smo na številnih lokacijah in različnih gostiteljskih rastlinah nabrali preko 300 jajčnih legel stenic. Skupno smo preiskali več kot 9500 jajčec in pri tem odkrili 4 nove vrste parazitoidov. Med domorodnimi je bila najštevilčnejše zastopana vrsta *Anastatus bifasciatus* (Hymenoptera: Eupelmidae), sledili sta vrsti *Trissolcus basali*s in *Telenomus sp*. (Hymenoptera: Scelionidae). V Sloveniji je bil prvič odkrit tudi tujerodni parazitoid *Trissolcus mitsukurii* (Hymenoptera: Scelionidae), ki je v izvornem okolju poznan kot zelo učinkovit naravni sovražnik marmorirane smrdljivke. V triletnem obdobju proučevanja jajčnih parazitoidov stenic smo ugotovili njihov hiter in relativno učinkovit odziv na novo tujerodno stenico, ki se je odražal v naraščajoči stopnji parazitizma. Z odkritjem domorodnih in tujerodnih jajčnih parazitoidov marmorirane smrdljivke, je bil storjen prvi korak v smeri uvedbe biotičnega varstva omenjene vrste v Sloveniji.

ABSTRACT

First steps towards biological control of brown marmorated stink bug (*Halyomorpha halys* [Stål, 1855], Hemiptera, Pentatomidae) in Slovenia

The occurrence and spread of the invasive alien Brown marmorated stink bug *Halyomorpha halys* (Hemiptera: Pentatomidae) in Slovenia have caused serious damage in fruit and vegetable production. Recently, many efforts have been undertaken to develop effective pest control measures to prevent crop damage. The use of insect exclusion netting and biological control of *H. halys* with egg parasitoids are considered as the most effective, environmentally sustainable and long-term solutions. Knowledge of the native egg parasitoids and host-parasitoid interactions in new areas is of key importance when implementing a biological control program. Therefore, the main objective of the study carried out in Western Slovenia, was to identify the presence of stink bug egg parasitoids and to evaluate their impact on *H. halys* population. From 2019 to 2021 more than 300 sting bug egg masses were collected on various plant species at different locations in the region. More than 9,500 eggs we examined and four egg-parasitoid species emerged from *H. halys* eggs. *Anastatus bifasciatus* (Hymenoptera: Eupelmidae) was the most abundant native species, followed by *Trissolcus basalis* and Telenomus sp. (Hymenoptera: Scelionidae). Non-native *Trissolcus mitsukurii* (Hymenoptera: Scelionidae), which is known to be an important *H. halys* parasitoid in its native range, was also detected. Rapid recruitment of native parasitoids and increasing parasitism rates were observed over a three-year study period. Encouraging results of the study represent the first steps towards biological control of Brown marmorated stink bug in Slovenia.

Preučevanje učinkovitosti privabilnih posevkov in okoljsko sprejemljivih pripravkov za zatiranje marmorirane smrdljivke (*Halymorpha halys* [Stål], Hemiptera, Pentatomidae)

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V bližini vasi Miren smo v letu 2021 izvedli poljski poskus, kjer smo preučevali različne okoljsko sprejemljive metode za zatiranje marmorirane smrdljivke (*Halyomorpha halys*). Poskus smo razdelili v dva dela. Pri prvem delu smo poskusno površino razdelili v tri bloke, znotraj katerih smo posejali štiri vrste privabilnih posevkov, z namenom privabljanja marmorirane smrdljivke. Posejali smo sončnice (*Helianthus annuus*), sojo (*Glycine max*), sirek (*Sorghum bicolor*) in lucerno (*Medicago sativa*). V 10- dnevnih intervalih smo med rastno dobo spremljali številčnost marmorirane smrdljivke (odrasli osebki, jajčna legla, ličinke) na privabilnih posevkih v primerjavi z glavno rastlinsko vrsto – jablano (*Malus domestica*). V drugem (ločenem) delu poskusa smo preučevali učinkovitost treh okoljsko sprejemljivih pripravkov za zatiranje preučevanega škodljivca na sončnicah, soji, sirku in lucerni. V poskus smo vključili pet različnih obravnavanj, in sicer pripravek Botanigard WP, Nemaplus®, NeemAzal – T/S, negativno kontrolo in pozitivno kontrolo. Omenjene pripravke smo na privabilne posevke nanašali v 10-dnevnih intervalih. Številčnost marmorirane smrdljivke (odrasli osebki, ličinke, jajčna legla) smo ugotavljali pred škropljenjem in 2-3 dneve po škropljenju. V prispevku bo predstavljena sezonska dinamika škodljivca v prvem delu poskusa, kjer smo ugotovili največjo privabilnost sirka. V drugem delu poskusa med okoljsko sprejemljivimi pripravki nismo

ugotovili razlik v delovanju na različne razvojne stadije marmorirane smrdljivke, nobeden od preučevanih pripravkov pa ni pokazal zadovoljivega delovanja pri zatiranju škodljivca.

ABSTRACT

Investigation on the efficacy of trap crops and environmentally friendly products for controlling brown marmorated stink bug (*Halymorpha halys* [Stål], Hemiptera, Pentatomidae)

In the vicinity of the village of Miren, we have conducted a field experiment in 2021, where we have studied various environmentally acceptable plant protection methods for controlling brown marmorated stink bug (*Halyomorpha halys*). We have divided the experiment into two parts. In the first part, the experimental area was divided into three blocks, within which we planted four trap crops, in order to attract the brown marmorated stink bug. We have sowed sunflowers (*Helianthus annuus*), soybean (*Glycine max*), sorghum (*Sorghum bicolor*), and alfalfa (*Medicago sativa*). At 10-day intervals, we have monitored the abundance of brown marmorated stink bug (adults, egg clusters, larvae) on trap crops compared to the main plant species – apple tree (*Malus domestica*). In the second (separate) part of the experiment, we have studied the effectiveness of three environmentally acceptable products for the control of the studied insect pest on sunflowers, soybean, sorghum and alfalfa. Five different treatments were included in the experiment, namely Botanigard WP, Nemaplus®, NeemAzal - T / S, negative control and positive control. These products were applied to trap crops at 10-day intervals. The abundance of brown marmorated stink bug (adults, larvae, egg broods) was determined before spraying and 2-3 days after spraying. In the paper we will present the seasonal dynamics of the pest in the first part of the experiment, where we have found the greatest attractiveness of sorghum. In the second part of the experiment, we did not find differences in the environmentally acceptable products in their action against different developmental stages of the brown marmorated stink bug, and none of the studied products has showed satisfactory efficacy in insect pest control.

Možnosti zatiranja marmorirane smrdljivke (*Halyomorpha halys* [Stål]) v nasadih jablan z ekološko pridelavo

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Na podlagi izkušenj pridobljenih v poljskem poskusu in opazovanj v sadovnjakih po Sloveniji podajamo informacije o možnih kemičnih konceptih zatiranja stenice marmorirane smrdljivke, v nasadih jablan z ekološko pridelavo. V poskusu v sadovnjaku v Šempetru pri Novi Gorici smo analizirali dinamiko pojava poškodb in populacije odraslih osebkov in ličink, v obdobju od sredina aprila do konca oktobra pri štirih sortah jablan. Z uporabo pripravkov na podlagi piretrina in azadiraktina ter nekaterih repelentnih pripravkov (Wetcit - eterično olje agrumov), Pipper (izvleček čilija - kapsicin), Vegex beta (rastlinsko milo iz izvlečkov 3 različnih rastlin), FOS soap (rastlinsko milo iz izvlečkov rastlin), Coccana (kokosovo milo), Cutisan (kaolin) ter Curatio (žvepleno-apnena brozga) smo ob izredno velikem pritisku škodljivca uspeli zmanjšati delež plodov s poškodbami za 78 % (iz 36,5 % v kontroli brez zatiranja na 8 % pri tretiranih drevesih).

ABSTRACT

Possibilities of controlling the brown marmorated stink bug (*Halyomorpha halys* [Stål]) in apple orchards with organic production

Based on the experience gained in a field experiment and observations in orchards across Slovenia, we provide information on possible chemical concepts for the control of marmorated stink bug in apple orchards with organic production. In an experiment in the orchard in Šempeter near Nova Gorica, we analyzed the dynamics of the occurrence of fruit damage and the population of adult specimens and larvae, in the period from mid-April to the end of October in four apple varieties. Using preparations based on pyrethrin, azadiractin and some repellent preparations; Wetcit - citrus essential oil, Pipper (chili extract - capsicin), Vegex beta (vegetable soap from extracts of 3 different plants), FOS soap (vegetable soap from plant extracts, Coccana (coconut soap), Cutisan (kaolin) and Curatio (sulfur-lime slurry), we were able to reduce the proportion of damaged fruits by 78% (from 36.5% in the control plots without stink bug suppression to 8% in treated trees), under extremely high pest pressure.

Vpliv napada marmorirane smrdljivke (*Halyomorpha halys* [Stål]) na kakovost izbranih vrst sadja in zelenjave

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Invaziven polifag, marmorirana smrdljivka (*Halyomorpha halys* [Stål]) predstavlja velik problem v pridelavi sadja in zelenjave, saj napada preko 100 različnih vrst. Njene poškodbe na rastlinah predstavljajo veliko gospodarsko škodo v tudi v Sloveniji. Z opravljenimi več poskusi smo analizirali biokemijski odziv poškodovanega tkiva plodov jablane, jagode, pekočih ter ne pekočih feferonih. Analizirali smo sladkorje, organske kisline, fenolne snovi ter kapsaicinoide. Vsebnost kapsaicinoidov je bila 15 krat višja pri pekočih feferonih napadenih z *H. halys.* Pri ne pekočih feferonih je imela *H. halys* negativen vpliv na vsebnosti sladkorjev v primerjavi s kontrolo. Jagoda, jablana ter ne pekoči feferoni so se odzvali z izrazitim povečanjem fenolih snovi v primerjavi s kontrolo. Pri jagodi so se skupne hidroksicimetne kisline ter antocianini povečali za 22,3 % in 38,4 % v primerjavi s kontrolo. Sladkorji so se zmanjšali za 22,6 % pri napadenih jagodah, v primerjavi s kontrolo. Pri napadenih plodovih jabolk je prišlo do izrazitega povečanja skupnih sladkorjev ter zmanjšanja organskih kislin. Poškodbe *H. halys* zaradi hranjenja, so povzročile močan fenolni odziv v jablani, s 117 % povečanjem v primerjavi s kontrolo. S poskusi smo pojasnili, kako napad *H. halys* vpliva na metabolno sestavo različnih vrst sadja in zelenjave. Ugotovili smo močne odzive sadja in zelenjave, s sintezo fenolnih snovi, ter pri pekočih feferonih povečano sintezo pekočih metabolitov kapsaicinoidov na napad *H. halys*.

ABSTRACT

Impact of brown marmorated stink bug (*Halyomorpha halys* [Stål]) feeding, on the quality of selected fruit and vegetables

The invasive polyphagous insect, the brown marmorated stink bug (*Halyomorpha halys* [Stål]), is a major problem in fruit and vegetable production, attacking more than 100 different plant species. The damage caused by their feeding causes massive economic losses also in Slovenia. In several experiments we studied the biochemical response of apples, strawberries, hot and non-hot peppers to *H. halys* feeding. We analyzed sugars, organic acids, phenols, and capsaicinoids. The total capsaicinoid content was 15 times higher in the attacked hot peppers compared to the control. In non-hot peppers, H. halys had a negative effect on total sugar content compared to the control. Strawberries, apples and non-hot peppers responded with increased phenolic content compared to control. In strawberries, the total content of hidroxycinnamic acids and antocianins increased by 22.3% and 38.4%, respectively, compared to the control. In apples, *H. halys* caused an increase in total sugars and a decrease in total organic acids. Injuries caused by *H. halys* infestation increased phenolic content in apples by 117 % compared to the control. In the experiments, we detected a strong response of phenolics of fruits and vegetables to *H. halys* infestation and an increased synthesis of pungent metabolites, capsaicinoids, in hot peppers.

Možnosti zatiranja marmorirane smrdljivke (*Halyomorpha halys* [Stål]) v nasadih jablan z integrirano pridelavo

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Na podlagi izkušenj pridobljenih v poljskem poskusu in opazovanj v sadovnjakih po Sloveniji podajamo informacije o možnih kemičnih konceptih zatiranja stenice marmorirane smrdljivke v nasadih jablan z integrirano pridelavo. V poskusu v sadovnjaku v okolici Dombrave (Vipavska dolina) smo analizirali dinamiko pojava poškodb in populacije odraslih osebkov in ličink v obdobju od sredine aprila do konca oktobra, pri dveh sortah jablan (Fuji in Jonagored) ter pri dveh škropilnih programih. S povprečno intenzivno uporabo insekticidov acetamprid, deltametrin, spinosad, spinetoram, piriproksifen in fosmet ter nekaterih repelentnih pripravkov (Wetcit – eterično olje agrumov), Pipper (izvleček čilija – kapsicin) in Vegex beta (rastlinsko milo iz izvlečkov 3 različnih rastlin) smo ob velikem pritisku škodljivca uspeli zmanjšati delež plodov s poškodbami za 70 - 88 % (iz 34,5 % v kontroli brez zatiranja na 4 % pri tretiranih drevesih sorte Jonagored in iz 33 % na 4,2 % pri drevesih sorte Fuji).

ABSTRACT

Possibilities of controlling the brown marmorated stink bug (*Halyomorpha halys* [Stål]) in apple orchards with integrated production

Based on the experience gained in the field experiment and observations in orchards across Slovenia, we provide information on possible chemical concepts for controlling the brown marmorated stink bug in apple orchards with integrated production. In an experiment in an orchard near Dombrava (Vipava valley), we analyzed the dynamics of fruit damage and the population of adults and larvae in the period from mid-April to late October in two apple varieties (Fuji and Jonagored) and two spraying programs. With average intensive use of insecticides acetamprid, deltamethrin, spinosad, spinetoram, pyriproxyfen, and phosmet and some repellent preparations (Wetcit - citrus essential oil),

Pipper (chili extract - capsicin) and Vegex beta (vegetable soap with various plant extracts) in conditions with high pest pressure we managed to reduce the proportion of damaged fruits by 70 - 88% (from 34.5% in the untreated plots to 4% in treated trees of the Jonagored variety and from 23% to 4,2% in the Fuji variety).

Spremljanje zastopanosti krvavkinega najezdnika (*Aphelinus mali*) pri uporabi različnih škropilnih programov za zatiranje krvave uši (*Eriosoma lanigerum*)

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V zadnjih letih se pridelovalci v nasadih jablan soočajo z naraščajočo problematiko obvladovanja populacije krvave uši (*Eriosoma lanigerum*). Prerazmnožitev in nastala škoda je posledica ugodnih vremenskih razmer za razvoj krvave uši, kakor tudi zmanjšanja števila učinkovitih kemičnih insekticidov za njeno zatiranje. Krvavkin najezdnik (*Aphelinus mali*) je naravni sovražnik krvave uši, ki ima pomembno vlogo pri vzdrževanju naravnega ravnovesja in omejevanju populacije krvave uši. Z namenom priprave učinkovite strategije obvladovanja krvave uši smo v poljskih poskusih na več lokacijah po Sloveniji (Kasaze, Gačnik, Brdo pri Lukovici) preizkušali učinkovitost različnih škropilnih programov (standardni, integriran in ekološki program) in njihov vpliv na populacijo krvavkinega najezdnika. Prisotnost in dinamiko pojava krvavkinega najezdnika smo pri uporabi različnih škropilnih programov spremljali s pomočjo rumenih lepljivih plošč. Na opazovanih lokacijah smo prve ulove parazitoida zabeležili v zadnjih dneh aprila, teden dni po začetku migracije krvave uši. Prvi vrh naleta krvavkinega najezdnika je bil zabeležen v prvi dekadi mesca julija. Na lokacijah (Kasaze, Gačnik), kjer je bila v nasadih prisotna velika populacija krvave uši, smo zabeležili še drugi vrh naleta v drugi dekadi avgusta. Pri tem gre poudariti, da v vseh treh škropilnih programih od zadnje dekade julija do avgusta ni bilo uporabljenih insekticidov. Let krvavkinega najezdnika se je zaključil v prvi dekadi septembra. Glede na preizkušene škropilne programe je bilo največje število osebkov krvavkinega najezdnika zabeleženo pri ekološkem programu, kjer so bile kolonije krvave uši najštevilčnejše in največji delež poškodovanih plodov. Ta program ni dal zadovoljivih rezultatov za zatiranje krvave uši. Primerna učinkovitost je bila dosežena le pri standardnem in integriranem programu, ki sta bila ocenjena kot primerna za nadaljnje preizkušanje. Strategija zatiranja krvave uši mora temeljiti na ravnovesju med kemičnim in biotičnim načinom varstva na način, da bodo uporabljena FFS v čim manjši meri negativno vplivala na razvoj krvavkinega najezdnika.

ABSTRACT

Monitoring of parasitoid (*Aphelinus mali*) under different spray programs for the control of apple woolly aphid (*Eriosoma lanigerum*)

In recent years, apple growers have been facing an increasing problem of controlling the population of woolly apple aphid (*Eriosoma lanigerum*). Overgrowth population of woolly apple aphid (WAA) and the resulting damage is caused due to favourable weather conditions for its development, as well as reducing the number of effective chemical insecticides. The natural enemies of WAA, especially *Aphelinus mali* plays an important role in maintaining the natural balance and limiting the WAA population. In order to prepare an effective strategy for the control of woolly aphid, field experiments were carried out at several locations across Slovenia (Kasaze, Gačnik, Brdo pri Lukovici) to assess the effectiveness of various spraying programs (standard, integrated and ecological program) and their impact on the population of *A. mali*. Yellow sticky traps were used to monitor the abundance and population dynamic of *A. mali* within the various spraying programs. The first catches of parasitoid were observed in the end of the April in all monitored sites, approximately one week after the beginning of the migration of WAA. The first peak of catches was recorded in the first decade of July. At two sites (Kasaze, Gačnik) with a high level of WAA infestation, another peak of *A. mali* population was observed in the second decade of August. It should be pointed out that in all three spraying programs no insecticides were used from the last decade of July to August. Flight of the *A. mali* ended in the first decade of September. According to the tested spraying programs, the highest number of parasitoid was recorded in the ecological program, where its population correlated with increased numbers of WAA colonies and higher levels of damaged fruits. However, ecological program did not show sufficient efficacy in the suppression of WAA population. Standard and integrated program provided good control, thus indicating a potential to be included in further testing. The strategy of controlling woolly apple aphid management should integrate chemical and biological control methods in a way to minimize possible negative impacts of PPPs on the development of the parasitoid *Aphelinus mali.*

Uporaba vodikovega peroksida za zatiranje škodljivih organizmov v nasadu jablan

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Pozna uporaba fitofarmacevtskih sredstev (FFS) pred obiranjem povzroča težave s preveč ostanki aktivnih snovi v pridelku. Pridelovalci jabolk iščejo možnosti za uporabo alternativnih pripravkov v obdobju pred obiranjem. V sezonah 2020 in 2021 smo izvedli poljska poskusa v nasadu jablan, da bi ocenili potencial biostimulatorjev na podlagi vodikovega peroksida (H_2O_2 VP) za zatiranje nekaterih škodljivih organizmov (ŠO) v drugem delu rastne sezone. Pripravke z različno vsebnostjo VP smo nanesli večkrat v drugem delu rastne dobe in po standardnih EPPO metodah ocenili stopnjo napada nekaterih bolezni ter velikost populacije opazovanih škodljivcev. Preliminarni rezultati poskusov kažejo, da ponavljajoče uporabe VP v odmerku 500 l/ha pri koncentraciji vsaj 500 ppm v zaključnem delu rastne dobe omogočajo povečanje učinkovitosti zatiranja nekaterih ŠO. Predstavljeni so tudi nekateri vidiki fitotoksičnosti VP in učinek na pojav skladiščnih bolezni jabolk. Izven EU uporabo VP v varstvu jablan poznajo, v EU pa se

pojavljajo zavore v registracijskih postopkih, ki omejujejo možnost izrabljanja dokaj učinkovitih, cenenih in okoljsko manj obremenilnih pripravkov.

ABSTRACT

Use of hydrogen peroxide to control pests in apple orchards

Late application of plant protection products (PPPs) before harvesting causes problems with too many residues of active substances in the crop. Apple producers are looking for possibilities to use alternative preparations in that period. In the 2020 and 2021 seasons, we conducted field trials in an apple orchard to assess the potential of hydrogen peroxide-based bio stimulators (H2O2 HP) to control some pests and diseases (P&D) in the final part of the growing season. Preparations with different HP content were applied several times in the second part of the growing season. The rate of attack from certain diseases and the size of the population of some pests were estimated according to standard EPPO methods. Preliminary results of the experiments show that repeated application of HP at a dose of 500 l/ha at a concentration of at least 500 ppm in the final part of the growing season allows increasing the control efficiency of some P&D. Some aspects of HP phytotoxicity and the effect on the occurrence of apple storage diseases are also presented. Outside the EU, the use of HP in protecting apple trees is well known. Still, in the EU, there are obstacles at registration procedures, which limit the possibility of using somewhat effective, cheap, and environmentally less harmful preparations.

Ugotavljanje razširjenosti vzhodnjaškega škržatka (*Orientus ishidae*) [Hemiptera, Cicadellidae] v Sloveniji

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Vzhodnjaški škržatek (*Orientus ishidae* Matsumura, 1902) je v Evropi tujerodna vrsta. V Sloveniji smo ga prvič odkrili v letu 2004, od takrat se je na posameznih območjih že zelo namnožil. Je izrazit polifag. Prehranjuje se s sokovi številnih lesnatih rastlin, vendar v strokovni literaturi skoraj ni podatkov o neposredni škodi, ki bi jo s tem povzročal. Potencialno nevarnost za nastanek gospodarske škode predstavlja, ker je prepoznan kot zelo verjeten prenašalec nekaterih pomembnih fitoplazmatskih bolezni sadnih rastlin in vinske trte. V letu 2021 smo od junija do septembra v nasadih jablan na 10 lokacijah po Sloveniji spremljali zastopanost in nalet vzhodnjaškega škržatka. Obravnavani so bili

sadovnjaki v integrirani in ekološki pridelavi. Število odraslih osebkov smo spremljali z rumenimi lepljivimi ploščami. Sočasno smo ugotavljali tudi vrstno pestrost drugih škržatov (Auchenorrhyncha), ki so se ulovili na plošče. Prvi odrasli osebki *O. ishidae* so se pojavili konec junija. Do sredine julija smo prisotnost škržatka potrdili na vseh lokacijah. Ulovi na vabah so bili največji v obdobju od sredine julija do začetka avgusta, ko so na nekaterih lokacijah presegli število 100 odraslih osebkov na vabo na dan. Proti drugi polovici avgusta in v septembru je ulov škržatkov upadal. Na velikost in dinamiko populacije je poleg lokacije sadovnjaka bistveno vplival tudi način pridelave. Določili smo še 42 vrst drugih škržatov, ki so se ujeli na RLP. Na 4 lokacijah sta se na vabe ulovila tudi glavni prenašalec zlate trsne rumenice, ameriški škržatek - *Scaphoideus titanus* (Ball, 1932) in potencialna prenašalka te fitoplazme, vrsta *Phlogotettix cyclops* (Mulsant & Rey, 1855). Na eni lokaciji smo na vabah našli tudi tujerodno vrsto *Graphocephala fennahi* (Young, 1977), ki je znana kot možna prenašalka nekaterih gospodarsko pomembnih bolezni.

ABSTRACT

Distribution of mosaic leafhopper (*Orientus ishidae*) [Hemiptera, Cicadellidae] in Slovenia

The mosaic leafhopper (*Orientus ishidae* Matsumura, 1902) is an alien species in Europe. In Slovenia it was first detected in 2004 and since then it has spread rapidly throughout the country. It is a highly polyphagous sap-feeding insect associated with many predominantly woody plant species. Although it is not considered to be a major pest of cultivated plants, the mosaic leafhopper is regarded as a potential threat for the grapevine and fruit trees because is suspected to be an important vector of some phytoplasma diseases. In 2021 its outbreak and spreading were monitored in apple orchards at 10 locations across Slovenia from June to September. The number of adults was monitored with yellow sticky traps. Apple orchards with different pest management regimes (integrated pest management, biological control) were observed. At the same time, the occurrence of other leaf- and planthoppers species (Auchenorrhyncha) was detected. The population of *O. ishidae* increased significantly from the end of June to July 2021, and by mid-July we confirmed its presence at all locations. The highest number of the leafhopper was recorded between mid-July and at the beginning of August when the number of adults caught per day even exceeded the number of 100 per trap at certain locations. After this peak, the population gradually declined. In addition to location, also the agricultural practice (biological, integrated), affected the population size and dynamics of *O. ishidae*. Furthermore, 42 other plant- and leafhopper species captured on yellow sticky traps were recognized during this monitoring. The leafhopper *Scaphoideus titanus* (Ball, 1932), known as the main vector of Grapevine flavescence dorée phytoplasma and *Phlogotettix cyclops* (Mulsant & Rey, 1855) known as potential vector of the same disease were caught in 4 locations. A specimen of the alien leafhopper *Graphocephala fennahi* (Young, 1977), known as a potential vector of certain economically significant diseases was also caught at one location.

Kakijeva listna pegavost (*Plurivorosphaerella nawae* Hiura, Ikata) – prve izkušnje z zatiranjem pomembne glivične bolezni kakija

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Še pred nekaj leti je kaki kot sadna vrsta veljala za neproblematično, saj razen občasnega pojava kaparjev in sadne muhe ni zahtevala redne uporabe fitofarmacevtskih sredstev. V letu 2019 pa je v posameznih nasadih kakija na območju Slovenske Istre prišlo do izbruha kakijeve listne pegavosti (*Plurivorosphaerella nawae*). Glivična bolezen je prizadela predvsem sorto Rojo brillante medtem, ko ostale sorte niso kazale značilnih bolezenskih znamenj. V sezoni 2020 smo poleg prej omenjene sorte pegavost zaznali tudi na sosednjih sadovnjakih, kjer prevladuje sorta Tipo, ki je pri nas najbolj razširjena. *Plurivorosphaerella nawae* je tujerodna gliva, katere razvojni cikel v celoti poteka na listih gostitelja. Bolezenska znamenja v obliki nekrotičnih peg s poudarjenim temnim robom se začnejo pojavljati v avgustu, v septembru in oktobru pa okuženi listi rumenijo in postopoma odpadajo. Zaradi popolne defoliacije rastline in pomanjkanja asimilatov sledi tudi odpadanje sadežev. Z namenom, da se določi ustrezno strategijo zatiranja bolezni smo leta 2021 v nasadu kakija v Strunjanu opravili škropilni poskus s katerim smo želeli ovrednotiti učinkovitost registriranega pripravka glede na število škropljenj. Tako smo poleg neškropljenega obravnavanja v treh dodatnih obravnavanjih posebej predvideli eno, dve in tri škropljenja s sredstvom na osnovi difenokonazola, in sicer v času od začetka pa do konca cvetenja. V posameznem obravnavanju, kjer smo opravili eno škropljenje s pripravkom iz skupine IBE pa smo dodatno še trikrat škropili s fungicidom na osnovi mikroorganizmov (*Bacillus amyloliquefaciens* sev FZB24). Zadnje škropljenje s pripravkom Taegro, ki je na kakiju registrirano za zatiranje listnih pegavosti iz rodu *Alternaria* smo opravili v fenofazi BBCH75. Po škropljenju je v dveh terminih v septembru in oktobru sledila ocena deleža okuženih listov ter deleža odpadlih listov. Pridobljene podatke smo ovrednotili s pomočjo analize variance. Iz pridobljeni rezultatov je razvidno, da brez ustrezne uporabe sredstev za varstvo rastlin ne moremo zagotoviti kakovostnega pridelka kakija.

ABSTRACT

Circular leaf spot of persimmon (*Plurivorosphaerella nawae* Hiura, Ikata) – first experience of chemical control of the important fungal disease of persimmon

Until a few years ago, persimmon fruit production was considered as non-problematic and did not require regular use of plant protection products, except for the occasional occurrence of scale insects and fruit fly. In 2019, there was an outbreak of circular leaf spot of persimmon (*Plurivorosphaerella nawae*) in some persimmon orchards in the area of Slovenian Istria. The fungal disease mainly affected the variety Rojo brillante, while the other varieties were not affected. However, in the 2020 the leaf spots were detected in the orchards where the Tipo variety is grown too. The mentioned variety is the most widespread in our country. *Plurivorosphaerella nawae* is an alien fungal species with the developmental cycle that entirely occurs on the host plant leaves. The first symptoms occur in August as necrotic spots with dark edges. In September and October, the infected leaves turn yellow and gradually fall off. Due to the complete plant defoliation and the lack of assimilates, the fruit also falls off. In order to optimise the disease control strategy, we performed a spray efficacy trial in the year 2021 in Strunjan. The aim of the experiment was to evaluate the efficacy of the already registered chemical product in relation to the number of fungicidal treatments. Beside the untreated plot there were three additional plots that were treated in order once, twice and three times with the difenoconazole based product. The treatments occurred in the period from the beginning

to the end of persimmon flowering. An individual plot which was treated once with the product from the EBI group was additionally treated three more times with a fungicidal product made from microorganisms (*Bacillus amyloliquefaciens* strain FZB24). However, in this plot the last spraying with the product Taegro, which is registered on persimmons for the control of leaf spot of the genus *Alternaria*, was performed in the BBCH75 phenological stage. After spraying, an estimation of infected leaves and fallen leaves was performed in September and October. The collected data was evaluated by the analysis of variance (ANOVA). The statistical results show that without the proper use of plant protection products quality fruit production cannot be achieved.

Pojav novih škodljivcev, ki ogrožajo pridelavo fig (*Ficus carica* L.) v Sloveniji

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Figa (*Ficus carica* L.) je ena izmed najstarejših sadnih rastlin, ki je bila namensko gojena že v davni preteklosti. Je tipična mediteranska vrsta, saj uspeva zlasti na legah, kjer temperature pozimi ne padejo pod - 10 °C. Izjemno občutljiva je predvsem spomladi, v fazi brstenja, saj brsti pomrznejo že pri temperaturi okoli ledišča. Figa je v zadnjem času priljubljena sadna vrsta, zato jo najdemo v vrtovih po vsej Sloveniji. Tržna pridelava fig pa je še vedno omejena na Slovensko Istro, Goriška Brda in Vipavsko dolino. Do sedaj je veljala za nezahtevno in za škodljivce in bolezni neobčutljivo sadno vrsto, a v zadnjih letih se to spreminja. Od leta 2010 pridelavo fig ogrožajo plodova vinska mušica (*Drosophila suzukii* (Matsumura)), črna figova muha (*Silba adipata* (McAlpine, 1956)), breskova muha (*Ceratitis capitata* [Wiedemann]) in marmorirana smrdljivka (*Halyomorpha halys* (Stål, 1855)). V zadnjih dveh letih pa smo kot nove škodljivce odkrili tudi kaparja (*Lepidosaphes conchiformis* (Gmelin, 1789)) in figovega rilčkarja (*Aclees taiwanensis* (Kôno)).

ABSTRACT

The appearance of new insect pests endangering the fig (*Ficus carica* L.) production in Slovenia

Fig is one of one of the earliest fruit trees, which was cultivated since ancient times. It is a typical Mediterranean fruit species, which primarily grows in places, where winter temperatures don't drop below -10°C. It is especially vulnerable in early spring, in budding stages, as buds often freeze at 0°C. Fig tree is becoming very popular in recent times and is often found in gardens all across Slovenia, while commercial fig production is concentrated in Slovenian Istria, Vipava Valley and Goriška brda. Until recently, the fig was known as low-maintenance fruit species, attract by very few pests or diseases. Due to the emergence of new pests, the pest control of fig orchards is becoming a challenging task. Since 2010 the fig production is affected by spotted wing drosophila (*Drosophila suzukii* (Matsumura)), black fig fly (*Silba adipata* (McAlpine, 1956)), Mediterranean fruit fly (*Ceratitis capitata* [Wiedemann]) and brown marmorated stink bug (*Halyomorpha halys* (Stål, 1855)). In last two years we have discovered two new pests: a scale insect

(*Lepidosaphes conchiformis* (Gmelin, 1789)) and exotic fig weevil (*Aclees taiwanensis* (Kôno)**).**

Načrtovanje statistično zanesljive preiskave za ugotavljanje navzočnosti *Xylella fastidiosa* na podlagi tveganja

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Xylella fastidiosa je nevarna bakterija, ki povzroča hude bolezni in omejuje gojenje vinske trte in agrumov v Ameriki ter oljk v južni Italiji. Okužuje lahko več kot 140 rodov rastlin, med njimipomembne kmetijske rastline, npr. koščičarje, ter okrasne in prostorastoče rastline. Zaradi velike nevarnosti, ki jo predstavlja, je bakterija v EU uvrščena med 20 prednostnih karantenskih škodljivih organizmov, države članice pa morajo obvezno izvajati preiskave za ugotavljanje njene navzočnosti. V Sloveniji program preiskave koordinira Uprava za varno hrano, veterinarstvo in varstvo rastlin s strokovnim koordinatorstvom KGZ Nova Gorica. Fitosanitarne službe letno pregledajo več kot 400 ha površin in odvzamejo vzorce, upoštevajoč tvegana območja in rastline. Za določanje *X. fastidiosa* je nujna uporaba laboratorijskih analiz, ki jih na odvzetih vzorcih z akreditiranimi testi opravlja Nacionalni inštitut za biologijo. V Sloveniji *X. fastidiosa* še ni bila ugotovljena. Evropska Unija z namenom harmonizacije in večje primerljivosti njihovih rezultatov uvaja statistično zanesljive preiskave, ki bodo z letom 2023 obvezne za *X. fastidiosa*. V statistično zanesljivi preiskavi se število vzorcev določi z uporabo statističnih tabel npr. z orodjem RIBESS+, ki ga je razvila Evropska organizacija za varno hrano (EFSA). Orodje nam omogoča izračun potrebnega števila rastlin za pregled in vzorčenje za vsako od določenih epidemioloških enot glede na število prisotnih gostiteljskih rastlin, željeno zanesljivost preiskave in občutljivost metod. Orodje lahko v izračunu upošteva tudi tveganja, ki smo jih identificirali in številčno ovrednotili. Pri tem se večji delež vzorcev dodeli kategorijam z manjšim tveganjem kot tistim z večjim tveganjem, celokupno število vzorcev pa se običajno zmanjša. V prispevku bomo predstavili naše izkušnje s pripravo statistično zanesljive in izvedljive preiskave za ugotavljanje navzočnosti *X. fastidiosa*.

ABSTRACT

Design of statistically sound and risk based detection survey for *Xylella fastidiosa*

Xylella fastidiosa is a dangerous bacterium that causes serious diseases and restricts the cultivation of grapevine and citrus in America and olives in southern Italy. It can infect more than 140 genera of plants, including important agricultural plants (e.g. stone fruits) and ornamental and wild plants. Due to the serious danger it poses, the bacterium is listed

among the 20 priority quarantine pests in the EU and the Member States shall conduct annual surveys of host plants for the detection of the pest. In Slovenia, the survey is coordinated by the Administration for Food Safety, Veterinary Sector and Plant Protection with the expert coordination of KGZ Nova Gorica. Phytosanitary services annually inspect more than 400 ha of area and take samples which are analysed using accredited laboratory tests by the National Institute of Biology. *X. fastidiosa* has not yet been detected in Slovenia. In order to harmonize and increase the comparability of surveys, the European Union is introducing statistically sound and risk based surveys which will be obligatory for *X. fastidiosa* from 2023. In such surveys the number of samples is determined using statistical tables e.g. RIBESS+ tool developed by the European Food Safety Authority (EFSA). The tool calculates the required number of plants for inspection and sampling for each of the defined epidemiological units according to the number of host plants present, the desired reliability of the survey and the method sensitivity. The tool can also take into account the risks identified and quantified in the calculation. In doing so, a larger proportion of samples are assigned to lower-risk categories than to higher-risk categories, and the total number of samples is usually reduced. In this paper, we will present our experience in preparing a statistically reliable and feasible detection survey for *X. fastidiosa*.

Prve najdbe gliv povzročiteljic bolezni lesa na oljkah v Slovenski Istri

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Že vrsto let v oljčnikih na območju Slovenske Istre opažamo sušenje in posledično propadanje posameznih dreves oljk *(Olea europaea)*. Do letošnjega leta so bili vsi vzorci vzeti na sum okužbe z glivo *Verticilium dahlie* negativni. V letu 2021 so bile na vzorcu propadajoče oljke iz Seče potrjene okužbe z lesno glivo *Phaeoacremonium scolyti*. To je prva identifikacija omenjene glive v naših oljčnikih. S sistematičnim spremljanjem bolezni lesa na oljkah bomo nadaljevali tudi v letu 2022. V prispevku so podani natančnejši opisi bolezenskih znamenj in morfološke značilnosti gliv ter agrotehnični ukrepi s katerimi omejimo pojav bolezni.

ABSTRACT

First findings of wood fungal diseases on olive trees in Slovenian Istria

For several years, we have been observing the withering and consequent decay of individual olive trees (*Olea europaea*) in olive orchard in the area of the Slovenian Istria. Until this year, all samples tested on *Verticilium dahlie* resulted negative. In the year 2021, the samples taken from decaying olive tree from Seča confirmed the presence of wood fungus *Phaeoacremonium scolyti*. Until now, this is the first identification of this fungus in our olive growing area. In the year 2022 we will continue the surveillance on olive trees affected with wither and decay symptoms. The article provides a more detailed descriptions of the disease symptoms and morphological characteristics of the fungus.

Besides that, in the paper there are description of agro-technical measures that can reduce the pathogen in olive orchards.

Učinkovitost različnih vab in pasti za spremljanje plodove vinske mušice (*Drosophila suzukii*)

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Vabe in pasti so pomemben del integriranih programov za zatiranje škodljivcev, ki vključujejo spremljanje škodljivcev za pravočasno uporabo insekticidov ali za njihovo uporabo v strategijah nadzora, kot so množično lovljenje. V tej študiji smo preverili učinkovitost različnih vab in pasti za spremljanje plodove vinske mušice (*Drosophila suzukii*, PVM) v nasadih malin. Uporabili smo past Drosal® Pro s tekočim atraktantom DrosaLure (proizvajalec Adermatt Biocontrol AG; Švica), past Droso Trap® s tekočim atraktantom Dros'Attract® (proizvajalec Biobest; Belgija), past narejeno iz prozorne plastenke (V=250 ml) s črnim in dvema rdečima lepljivima trakovoma ter z 9 odprtinami premera 6 mm. V plastenko smo dodali prehransko vabo iz vinskega kisa in rdečega vina. Preverili smo tudi vabo Droso Trap® v katero smo dali vodo z milnico in atraktantom PH-288-1BP (proizvajalca IPM Russell, Velika Britanija). Največ PVM se je ulovilo na komercialno past Droso Trap® v kombinaciji s suhim atraktantom PH-288-1BP (IPM Russell). Omenjena past je bila bolj privlačna za samičke plodove vinske mušice. Zelo dobre rezultate za spremljanje PVM smo imeli z doma narejeno pastjo, kjer smo uporabili vinski kis in rdeče vino v razmerju 3:1. S to pastjo se je ulovilo 33 % manj osebkov PVM kot z vabo, kjer smo uporabili suhi atraktant PH-288-1BP (IPM Russell). Na podlagi preiskušanja lahko zaključimo, da sta pasti Drosal® Pro s tekočim atraktantom DrosaLure ter Droso Trap® s tekočim atraktantom Dros'Attract® manj učinkoviti za spremljanje PVM. Atraktant PH-288-1BP (IPM Russell) daje optimizem glede uporabe za masovno lovljenje PVM.

ABSTRACT

Efficacy of different traps and lures for monitoring *Drosophila suzukii* flies

Traps and lures are an important part of integrated pest management programs that involve monitoring pests for timely insecticide applications, or for their use in control strategies such as mass trapping. In this study we tested different traps and lures for monitoring Spotted Wing Drosophila (SWD), *Drosophila suzukii*, in raspberry orchards. We used trap Drosal® Pro with liquid attractant DrosaLure (producer Adermatt Biocontrol AG; Switzerland), trap Droso Trap® with liquid attractant Dros'Attract® (producer Biobest; Belgia), plastic bottle (V=250mL) with black and two red adhesive tapes, with 9 holes 6 mm in diameter where we added mixer wine vinegar and red wine (3:1) and trap Droso Trap® where used water and soap and add dry attractant PH-288-1BP (producer IPM Russell, United Kingdom). Most SWD flies was caught on the commercial trap Droso Trap® with dry attractant PH-288-1BP (IPM Russell). The mentioned baits was more attractive for female SWD. Very good results for monitoring SWD had with homemade trap, where used wine vinegar and red wine in a ratio of 3:1. This bait caught 33% less

SWD than with bait where we used dry attractant PH-288-1BP (IPM Russell). After testing we can conclude that trap Drosal® Pro with lure DrosaLure and trap Droso Trap® with Dros'Attract® are less effective for monitoring SWD. Attractant PH-288-1BP (IPM Russell) gives optimism about the use it for mass monitoring SWD.

Vpliv entomopatogene glive *Metarhizium brunneum* na rastline navadnega jagodnjaka in nadzemske škodljivce

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Zmanjšanje odvisnosti od sintetičnih pesticidov in zmanjšanje eksternega vnosa (gnojil) v sodobnih kmetijskih dejavnostih je skupni cilj kmetijskih politik EU. Številni koristni mikrobi lahko izboljšajo prehrano rastlin in zaščitijo rastline pred biotskim in abiotskim stresom, zato imajo velik potencial za zmanjševanje vnosa gnojil in pesticidov v smeri trajnostnega kmetijstva in vrtnarstva, kar je glavni cilj EU projekta Excalibur. Leta 2020 je bil izveden dvofaktorski lončni poskus na frigo rastlinah jagod (*Fragaria* × *ananassa* Duch.) sorte 'Clery', na Kmetijskem inštitutu Slovenije. Raziskali smo vpliv inokulacije tal z entomopatogeno glivo *Metarhizium brunneum* 1868 (faktor 1) in nadzemnega škodljivca, jagodne uši, *Chaetosiphon fragaefolii* (Cockerell) (Hemiptera, Aphididae; faktor 2) na rastline jagod in njune medsebojne vplive. Ocenili smo več fizioloških, agronomskih in entomoloških parametrov: (1) rastline jagod smo posneli z dvema hiperspektralnima kamerama; (2) izmerili smo razne fotosintetske parametre, vključno z meritvami fluorescence klorofila a izmenjave plinov; (3) opravljene so bile meritve vsebnosti klorofila; (4) štiri tedne po okužbi s škodljivci so bile rastline jagod vzorčene za oceno možnih učinkov interakcij škodljivcev in mikrobov na mineralno prehrano rastlin; in (5), korenine rastlin so bile ocenjene za kolonizacijo njihove površine z *M. brunneum*. S kombinacijo hiperspektralnega slikanja, Savitzky-Golay derivatov 2. reda, jedrno analizo glavnih komponent in metodo podpornih vektorjev, smo lahko s 100-odstotno zanesljivostjo ločili med inokuliranimi in neinokuliranimi rastlinami ter med vsemi poskusnimi skupinami. Inokulacija rastlin jagod z *M. brunneum* je značilno vplivala na število cvetov in plodov na rastlino, maso plodov, kolonizacijo površine korenin in Fv/Fm (potencialna fotokemična učinkovitost PSII). Poleg tega je bil parameter Fv/Fm značilno pozitivno povezan (korelacijski koeficient = 0,44; R^2 = 19,72; p = 0,0067) s kolonizacijo površine korenin. Skladno s teorijo so listne uši *C. fragaefolii* znatno povečale incidenco okužbe s *Sphaerotheca macularis*. Zanimivo je, da je inokulacija korenin z *M. brunneum* značilno povečala število cvetov in posledično plodov, vendar se je povprečna teža plodov značilno zmanjšala; posledično mikrobni bioinokulant ni vplival na celoten pridelek na rastlino. Tako se sev *M. brunneum* 1868 ni obnašal kot pravi biostimulant na jagodah. Ker

pa je gliva *M. brunneum* pozitivno vplivala na nekatere fiziološke in agronomske parametre, bo v okviru projekta Excalibur dodatno testirana v terenskih poskusih.

ABSTRACT

Effect of entomopathogenic fungus *Metarhizium brunneum* on strawberry plants and aboveground pests

Reduction of the reliance on synthetic pesticides and lowering (fertilizer) inputs in modern farming operations is a common goal of EU agricultural policies. Many beneficial microbes can enhance plant nutrition and protect plants against biotic and abiotic stresses. For this reason they have a huge potential to help farmers reducing fertilizers and pesticides input toward a more sustainable agri-and horticulture, which is a main goal of the EU project Excalibur. A two-factor strawberry tunnel pot experiment was performed in 2020 on frigo strawberry plants (*Fragaria* × *ananassa* Duch.) cv. 'Clery', at the Agricultural Institute of Slovenia. We investigated the effect of soil inoculations (factor 1) of an entomopathogenic fungus *Metarhizium brunneum* 1868 and an aboveground pest, the strawberry aphid, *Chaetosiphon fragaefolii* (Cockerell) (Hemiptera, Aphididae; factor 2) on strawberry plants, and their interactions. Several physiological, agronomical and entomological parameters were evaluated: (1) the strawberry plants were imaged using two hyperspectral sensors; (2) photosynthetic evaluations were performed including pulse-amplitude-modulated fluorometry and photosynthetic gas exchange measurements; (3) measurements of chlorophyll content were performed; (4) four weeks after the insect pest infestation the strawberry plants were sampled to assess potential effects of crop-pest-microbe interactions on plant mineral nutrition; and (5) the plants' roots were assessed for their rhizoplane colonization by *M. brunneum*. Using hyperspectral imaging combined with Savitzky-Golay 2nd order derivatives, kernel principal component analysis and support vector machines, we were able to distinguish between inoculated and non-inoculated plants, as well as among all treatment groups with 100% accuracy. Inoculating strawberry plants with *M. brunneum* significantly affected the number of flowers and fruits per plant, fruit weight, rhizoplane colonization and Fv/Fm (potential photochemical efficacy of PSII). Furthermore, parameter Fv/Fm significantly positively correlated (Correlation Coefficient = 0.44; R^2 = 19.72; p = 0.0067) with parameter rhizoplane colonization. In sync with theory, the addition of aphids *C. fragaefolii* significantly increased the incidence of *Sphaerotheca macularis* infection. Interestingly, root inoculation with *M. brunneum* significantly increased the number of flowers and subsequently fruits, but the average fruit weight was significantly reduced, consequently the overall yield per plant was not affected by the microbial bioinoculant. Thus the *M. brunneum* strain 1868 does not behave like a true biostimulant in strawberry. However, due to the fact that *M. brunneum* positively affected some physiological and agronomic parameters it will be further tested in field experiments within project Excalibur.

Fenološke faze oljke in zastopanost oljčnega molja (*Prays oleae* Bern.) v Slovenski Istri

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Oljčni molj (*Prays oleae* Bern.) v Sloveniji samo občasno povzroča večjo gospodarsko škodo. Nazadnje je večjo škodo povzročil leta 2016, ko naj bi po ocenah povprečno izpadlo 25 % pridelka. Globalno segrevanje, bi zaradi večje absolutne vlažnosti, milejših zim in vse pogostejših poškodb oljk, ki nastajajo kot posledica ekstremnih vremenskih dogodkov lahko izzvalo tudi večje pritiske oljčnega molja (Prays oleae Bern.) na pridelavo oljk. Z željo, da bi ovrednotili zastopanost oljčnega molja in dejanski izpad pridelka zaradi omenjenega škodljivca v Slovenski Istri, smo na štirih geografsko različnih lokacijah, v času vegetacijske sezone v obdobju od leta 2018 do leta 2020, beležili prisotnost oljčnega molja v različnih fenoloških obdobjih oljke. Opazovanja prisotnosti oljčnega molja na rastlinskem materialu in na feromonskih vabah smo nadgradili tudi s preučevanjem interakcij antofagne in karprofage generacije z okoljskimi prametri. Ob koncu vsake vegetacijske sezone smo ovrednotili tudi izpad pridelka, ki jo povzroča karpofagna generacija. Rezultat raziskave so pokazali, da je oljčna muha bila na vseh štirih lokacijah poglavitni razlog odpadanja plodov – v povprečju je glede na pridelek zaradi delovanja oljčne muhe odpadlo 8% plodov, zaradi oljčnega molja pa manj kot 2%.

ABSTRACT

Phenological phases of olives and occurrence of olive moth (*Prays oleae* Bern.) in Slovenian Istria

The olive moth (Prays oleae Bern.) only occasionally causes major economic damage in Slovenia. The last time it caused major damage was in 2016, when an estimated 25% of the crop was lost. Global warming, leading to higher absolute humidity, milder winters and increasing damage to olives from extreme weather events, could increase the pressure of the olive moth (Prays oleae Bern.) on olive production. To evaluate the presence of olive moth and yield losses caused by this pest in Slovenian Istria, we recorded the presence of olive moth in different phenological periods of olives at four geographically different locations during the growing season from 2018 to 2020. Observations of olive moth presence on plant material and on pheromone traps were also used to study the interactions of antophage and carprophage generation with environmental parameters. At the end of each growing season, we also evluated crop losses caused by carpophage generation. The results of the surveys showed that olive fly was the main cause of fruit drop at all four sites - on average 8% of fruit dropped due to olive fly and less than 2% due to olive moth.

Spletna aplikacija za spremljanje in varstvo oljčne muhe (*Bactrocera oleae* [Gmelin]) pri Kmetijsko gozdarskem zavodu Nova Gorica

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Kot pomoč uporabnikom pri spremljanju pojava oljčne muhe (*Bactrocera oleae*), najpomembnejše škodljivke oljk, smo razvili grafično aplikacijo, ki omogoča enostavno spremljanje pojava škodljivke na celotnem območju pridelave oljk v Sloveniji. V opazovalno napovedovalno mrežo je bilo v letu 2021 vključenih 32 lokacij oljčnikov, kjer smo tedensko pregledovali ulov oljčne muhe na feromonskih vabah. Dodatno smo na omenjenih lokacijah tedensko vzorčili plodove ter določali aktivno poškodovanost plodov

in stadije oljčne muhe. Podatke o tedenskih ulovih in poškodovanosti plodov smo nato predstavili v grafični in tabelarni obliki na spletni strani Kmetijsko gozdarskega zavoda Nova Gorica. Na podlagi obdelanih podatkov so bila izdelana prognostična obvestila za zatiranje oljčne muhe. Vsi omenjeni podatki so objavljeni na spletni povezavi: https://www.kmetijskizavod-ng.si/oljcna-muha/, kjer so dostopne tudi tabele o ulovih iz prejšnjih let. Prognostična obvestila o varstvu in povezave glede spremljanja škodljivke so objavljena tudi na spletnem portalu Javne službe zdravstvenega varstva rastlin: http://agromet.mko.gov.si/PP/, s katerega prijavljeni oljkarji dobijo spletna in kratka SMS sporočila z navodili o ukrepanju proti oljčni muhi.

ABSTRACT

Web application for monitoring and protection of the olive fly (*Bactrocera oleae* [Gmelin]) at the Agricultural and Forestry Institute of Nova Gorica

In order to help the users of the Crop protection service of the Agricultural and Forestry Institute of Nova Gorica we developed a graphical application that allows monitoring of the occurrence of the olive fly (*Bactrocera oleae*) in the entire area of olive production in Slovenia. In year 2021, 32 olive orchard locations were included in the forecasting network. On these locations there were weekly monitored captures of the olive fly by using pheromone traps. Additionally, olive fruits were randomly collected and checked for damage. At the same time olive fly stages were monitored. All the collected data were than presented in graphic and table form on our website of the Agricultural and Forestry Institute of Nova Gorica. Based on the data, forecasting reports for the olive fly control were issued. All the mentioned data are published on the link: https://www.kmetijskizavod-ng.si/oljcna-muha/. On the mentioned link there are data available from previous years. Forecasting reports on olive fly control and links regarding pest monitoring are also published on the official web site of the Public Plant Health Service: http://agromet.mko.gov.si/PP/. From the link olive growers can receive e-mails or text messages with instructions on olive fly control.

Primerjava različnih vab za spremljanje oljčne muhe (*Bactrocera oleae* [Gmelin])

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V letih 2020 in 2021 smo izvedli primerjavo različnih komercialnih vab za spremljanje oljčne muhe. Poskus je bil izveden v oljčniku nad Ankaranom na površini 1 ha. Glede na način delovanja smo uporabili štiri različne vabe. Rumeno lepljivo ploščo, kot standard feromonsko vabo Dacotrap ter dve kombinirani feromonsko- prehranski vabi za množični ulov Cromotrap in Flypack dacus trap. Vabe smo postavili v začetku meseca junija ter vsak teden prešteli število ulovljenih muh. V posameznem letu smo opravili 24 tednov spremljanja. Na območju poskusa smo tedensko vzorčili 100 plodov, ter pregledali delež poškodb. S poskusom smo zaključili konec novembra, po spravilu pridelka. Sledila je statistična in grafična obdelava podatkov. Rezultati so pokazali, da med rumeno lepljivo

ploščo in feromonsko vabo ni statistično značilnih razlik, ravno tako ni statistično značilnih razlik med vabama za množični ulov. So pa statistično značilne razlike med rumeno lepljivo ploščo in vabama za množični ulov, ravno tako je razlika med feromonsko vabo in vabama za množični ulov. V letu 2021 se je največ muh ulovilo v vabe za množični ulov, ki vsebujejo feromonski dispenzor in prehransko vabo. Iz pridobljenih rezultatov lahko sklepamo, da so vabe, ki imajo feromonski dispenzor in prehransko vabo bolj učinkovite, saj poleg samcev lovijo še samice. Zaradi tega so omenjene vabe bolj primerne za množični ulov oljčne muhe predvsem v začetnih fazah razvoja plodov. V primerjavi z letom 2020 se je v letu 2021 ulovilo manj muh. Vzrok temu je predvsem spomladanska pozeba, ki je občutno zmanjšala pridelek. Dodatno je na manjši let muhe vplivalo tudi suho in vroče poletje.

ABSTRACT

Comparison of different traps for olive fly (*Bactrocera oleae* [Gmelin]) monitoring

Between the years 2020 and 2021 we have conducted a field trial where different commercially available traps for olive fly were tested. The trial was conducted in an olive orchard of 1 ha, that is situated above the town of Ankaran in the Slovenian Istria. We used 4 different traps: yellow stick plates, pheromone trap Dacotrap as control product and two different products for mass trapping with pheromone lure and food bait Cromotrap and Flypack dacus trap. Traps were positioned at the beginning of June and were monitored for catches every week. An overall monitoring of 24 weeks per single year was made. In the olive orchard we have collected 100 olives per week to check the percentage of damage. At the end of November, we finished with the trial, so after harvesting. Then we statistically and graphically analysed the data. From the results it was concluded that there are no statistically significant difference between yellow sticky plates and pheromone traps, and no statistically significant difference were between two traps for mass trapping. However, there were statistically significant differences between yellow sticky plates and mass trapping baits. At the same time there are differences between the pheromone traps and mass trapping baits. In the year 2021, the most effective baits were the products designed for mass-trapping which consists of a pheromone lure and food attractant. Based on the trial results, we can conclude that using traps activated with pheromone lure and food attractant is more effective because they attract both male and female flies. This is the reason why the mentioned traps are more suitable in mass trapping of olive fly especially at the beginning of fruit development. Compared to the year 2020, we caught less flies in the year 2021. The main reason was spring frost which resulted in low crop. Additionally, the smaller population of olive fly was attributed to dry and hot summer.

First results of catching olive flies on yellow plates by processing images using artificial intelligence techniques

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Precision agriculture is a concept based on the application of information technology, satellite navigation, sophisticated monitoring and adjustment of agricultural machinery and better sample analysis. One of the techniques is the processing of visual data in the visible spectrum (Red Green Blue (RGB)). It is carried out by autonomous artificial intelligence (AI), independent of man. AI technologies have faster data processing and a more detailed overview of objects, much more accurate than the "naked eye". Olive, on the other hand, is a significant Mediterranean culture, which is also a dependent for controlling harmful organisms by early prognosis. The aim of this paper is to acquaint the congress with the research of visual data processing for the purpose of early prognosis of the appearance of the olive fly (*Bactrocera oleae* (Rossi 1790)) wit AI. It is implemented within the project "SAN - Smart Agriculture Network" (SAN - KK.01.2.1.01.0100) in Zadar County in freely selected localities with different olive varieties. Python and C ++ programming languages and software (TensorFlow, Scikit, etc.) were used for model development. For the purposes of learning and classification using RGB images, 1,500 images of yellow plates were collected as a data base for the development of neural network models. The analysis system was established using machine learning (Faster R-CNN), the application of which enabled the detection and classification (Labeling) of individual plates. Developed models achieve from 83% and up to 93% reliability in recognizing an adult olive fly in an image in RGB format. Along with the development of the model, a prototype camera was developed that will be installed in the olive grove throughout the year. Images will arrive from the camera at regular intervals. The model will shorten the time required for visits and inspections and determine the need for the implementation of measures to control this pest, which is in line with the purpose of precision agriculture. This project was approved from the call for project proposals "Monitoring the development of new products resulting from research and development activities (IRI)". The total value of the project is HRK 11,496,067.00. The project was co-financed by the EU from the European Regional Development Fund (ERDF) in the amount of HRK 8,234,836.12.

Vpliv oljčne muhe *Bactrocera oleae* (Rossi) na kemijske in senzorične značilnosti oljčnega olja

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Prisotnost in napad oljčne muhe *Bactrocera oleae* (Rossi) v slovenskih oljčnikih se odraža na kakovosti predelanega oljčnega olja, saj vpliva na kemijske in senzorične značilnosti oljčnega olja. Vremenske razmere v letu 2014 so vplivale na dinamiko leta oljčne muhe in močno zaznamovale pridelek slovenskih oljkarjev, predvsem sorte 'Istrska belica', skupna škoda je presegla 75 % povprečne letne količine pridelanega oljčnega olja. Proučili smo vpliv oljčne muhe na obranih plodovih letnika 2014, ki smo jih razdelili glede na stopnjo napadenosti v vzorce z aktivno in škodljivo napadenostjo. Določili smo vsebnost in sestavo biofenolov, sterolov, triterpenskih dialkoholov in maščobnokislinsko sestavo predelanega olja. Večjo vsebnost skupnih biofenolov, olevropeinskih in ligstrozidnih derivatov smo določili v vzorcih, predelanih iz plodov z aktivno napadenostjo, medtem ko je bila

vsebnost obravnavanih spojin v oljih, predelanih iz plodov s škodljivo napadenostjo manjša. Ugotovili smo korelacijo med olevropeinskimi in ligstrozidnimi derivati: v vzorcih z aktivno napadenostjo so prevladovali olevropeinski derivati, medtem ko so v vzorcih s škodljivo napadenostjo prevladovali ligstrozidni derivati. Olja, predelana iz plodov s škodljivo napadenostjo, so se razlikovala od vzorcev z aktivno napadenostjo po večji vsebnosti stigmasterola in manjši vsebnosti kampesterola ter večji vsebnosti skupnih sterolov in triterpenskih dialkoholov. V vzorcih olj, predelanih iz plodov s škodljivo napadenostjo smo ugotovili tudi manjšo vsebnost oleinske kisline napram vzorcem z aktivno napadenostjo. Vpliv oljčne muhe na značilnosti oljčnega olja je razviden tudi na nekaterih vzorcih letnika 2020 s povečano kislostjo oziroma vsebnostjo prostih maščobnih kislin. Posamezni vzorci olj imajo porušeno razmerje med kampesterolom in stigmasterolom ter povečano vsebnost triterpenskih dialkoholov, podobno kot je bilo določeno v primeru škodljive napadenosti leta 2014. Pri proučevanju vsebnosti in sestave biofenolov smo v analiziranih vzorcih letnika 2020 ugotovili povečano vsebnost tirozola in hidroksitiroza. V večini primerov so bile prisotne tudi senzorične napake in povečana vsebnost nonanala in (E)-2-decenala.

ABSTRACT

Influence of Olive Fruit Fly *Bactrocera oleae* (Rossi) on Chemical and Sensory Characteristics of Olive Oils

The infestation of the olive fruit fly *Bactrocera oleae* (Rossi) in Slovenian olive orchards influenced the quality of produced olive oils. The olive fruit fly affects the chemical and the sensory characteristics of olive oils. Weather conditions in 2014 favoured the dynamics of the olive fly which caused serious economic damage to Slovenian's olive orchards, especially to the olive variety 'Istrska belica'. The total damage exceeded 75% of the average annual amount of produced olive oil. The influence of the olive fruit fly was studied on the collected samples of the year 2014, which were classified according to the degree of infestation into samples with active and damaging infestation. The content and composition of biophenols, sterols, triterpenic dialcohols and the fatty acids composition of the produced oils were determined. Oils produced from fruits with active infestation showed higher amounts of total biophenols, oleuropein and ligstroside derivatives, whereas, in contrast lower amounts were determined in oils produced from fruits with damaging infestation. A correlation between oleuropein and ligstroside derivatives was found: oleuropein derivatives were prevalent in oils form active infestation, whereas ligstroside derivatives were more present in oils from damaging infestation. Higher values of stigmasterol and lower values of campesterol were determined in oils from damaging infestation, as well as higher content of total sterols and triterpenic dialcohols. Lower amounts of oleic acid were determined in oils with damaging infestation. The influence of the olive fruit fly attack on the characteristics of olive oils was also observed in some samples of the year 2020 with higher acidity (free fatty acids content). Some samples showed higher amounts of stigmasterol, lower amounts of campesterol and higher amounts of triterpenic dialcohols, as it was determined in the case of damaging infestation in 2014. Studying the content and composition of biophenols, the samples from crop year 2020 showed a higher content of tyrosol and hydroxytyrosol. In most samples, sensory defects and higher content of nonanal and (E)-2-decenal were also determined.

Prve izkušnje z množičnim ulovom oljčne muhe *(Bactrocera oleae* [Gmelin*]) v spodnji Vipavski dolini

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V oljčniku v spodnji Vipavski dolini smo v letu 2021 izvedli poskus omejevanja škode zaradi napada oljčne muhe s pomočjo prehranskih vab za množičen ulov na osnovi lambda-cihalotrina – Karate Trap. Vabe so bile nameščene v mesecu aprilu, tedensko smo spremljali število ulovljenih muh po vabah ter ugotavljali razmerje med ulovljenimi samci in samicami. Vsak teden smo v oljčniku vzorčili plodove oljk in jih pregledali na poškodovanost zaradi napada oljčne muhe. Na koncu smo podatke statistično in grafično analizirali. Med številom ulovljenih samcev in samic ni bilo statistično značilnih razlik. Od postavitev vab pa do avgusta so bili ulovi nizki. Večji ulov muh smo zaznali konec avgusta, v začetku oktobra pa se je ulov muh zmanjšal. Potrebno je poudariti, da je na količino pridelka v letu 2021 vplivala zlasti spomladanska pozeba. Poleg tega je bil pojav oljčne muhe zaradi visokih poletnih temperatur manjši kot v prejšnjih letih. Zaradi navedenega ni bilo mogoče statistično ovrednotiti kako je na zmanjšanje poškodovanosti plodov vplival množični ulov oljčne muhe. Da bi lahko bolje ovrednotili učinkovitost množičnega ulova pri zatiranju oljčne muhe bo potrebno v naslednjih letih opraviti dodatne poskuse s pripravkom Karate Trap.

ABSTRACT

First experience of olive fly (*Bactrocera oleae* [Gmelin]) mass trapping in lower Vipava valley

In the year 2021 we have conducted a mass trapping trial with Karate mass traps in an olive orchard in lower Vipava valley. Karate trap is shaped as a plastic cup which contains food bait lure, while the lid is covered inside with lambda-cyhalothrin gel solution. The trap attracts both male and female olive flies. When the pests enter the trap, they come into contact with insecticidal solution and fall to bottom of the cup. In April we set up the traps. Each week, we counted the captured flies and determined the ratio between males and females. In the olive orchard we have monitored olive fruits every week in order to check the damage rate. At the end of November, we graphically and statistically analysed the trial data. There was no statistically significant difference between males and females caught. Since we set up traps till August we noticed small number of captured flies. At the end of August the amount of captured flies has significally raised and remained high till start of October. However, the yield in the year 2021 was seriously affected by the spring frost. Additionally, the population of the olive fly was lower due to high summer temperatures. Because of the mentioned, it was not possible to statistically evaluate how the mass trapping of olive flies affected the damage of olives. For better evaluation and understanding the efficacy of mass trapping with the product Karate Trap further trials should be performed.

Globalno segrevanje in razvoj oljčne muhe (*Bactrocera oleae* Gmelin)

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Na podlagi projekcije podnebnih sprememb se bodo tveganja v pridelavi oljk in oljčnega olja povečala, kar bo lahko ogrozilo ekonomsko stabilnost oljkarske panoge. V Sloveniji, zadnja desetletja meritve že kažejo znaten trend dvigovanja temperatur zraka, ki v poletnih mesecih vse pogosteje dosega tudi temperaturne rekorde. Temperaturna zraka je v veliki meri tudi glavno gonilo bionomije in razvojnega kroga oljčne muhe (*Bactrocera oleae* Gmelin). Oljčna muha je ektotermna vrsta znana tudi kot poikilotermni ali hladnokrvni organizem, katerega telesna temperatura je močno odvisna od temperature okolja. Zaradi višanja temperatur zraka ter velikega vpliva le teh na razvojne stadije in populacijo oljčne muhe, obstaja velika nevarnost, da bo globalno segrevanje sprožilo hitro rast populaciji, večanje števila generaciji ter večjo uspešnost prezimitve in razširitve oljčne muhe tudi na druga geografska območja. Posledice globalnega dviga temperature, bodo lahko tudi spremembe v interakcijah oljčne muhe z gostiteljsko rastlino (razklop fenološke odvisnosti med oljčno muho in oljko) in naravnimi sovražniki (večji pojav naravnih sovražnikov) ter rastlinskimi boleznimi (oljčna muha posreden prenašalec rastlinskih bolezni). Dejstvo je, da je napoved vpliva podnebnih sprememb na oljčno muho zelo kompleksna, saj je poleg vpliva okolijskih pogojev potrebno upoštevati tudi vpliv okolijskih pogojev na razvoj fenoloških faz gostiteljske rastline (oljko) in naravnih sovražnikov s katerimi mora biti pojav oljčne muhe zelo dobro sinhroniziran. Z namenom, da bi ugotovili, ali trend dvigovanja temperatur zraka že vpliva na dinamiko pojavljanja, razvoj in velikost populacije oljčne muhe, smo izvedli obsežno analizo, meteoroloških in fenoloških podatkov ter podatkov o pojavnosti oljčne muhe v obdobju med 2005 in 2021. Rezultati raziskave so pokazali, da se trend dviga minimalnih povprečnih temperatur zraka, že odraža na zgodnejšemu pojavu začetka rastne dobe, razvoju reproduktivnih organov in skrajšanemu časa za rast in razvoj oljk oziroma v krajšanju razvojnih fenofaz oljk (krajši čas cvetenja, krajši čas dozorevanja). Čeprav vpliv na zgodnejši začetek cvetenja ni bil opazen, smo z raziskavo dokazali tudi vpliv dviga temperatur na zgodnejši pojav oljčne muhe na feromonskih vabah in v plodovih oljke ter večjo prisotnosti naravnih sovražnikov oljčne muhe.

ABSTRACT

Global warming and development of olive fruit fly (*Bactrocera oleae* Gmelin)

In the predicted climate change scenarios, the risks for the olive sector will increase, which may threaten its economic viability. In Slovenia, measurements over the last decades have already shown a clear trend of increasing air temperatures, reaching temperature records in the summer months. Air temperature is also the main factor affecting the bionomy and development cycle of the olive fruit fly (Bactrocera oleae Gmelin). The olive fruit fly is an ectothermic species, also known as a poikilothermic or cold-blooded organism, and its body temperature is highly dependent on ambient temperature. Since temperature is the most important environmental factor affecting insect population dynamics, it is expected that global climate warming could trigger an expansion of their geographic range, increased overwintering survival, and increased

number of generations. The consequences of global temperature increase could also be changes in olive fruit fly interactions with the host plant (breakdown of the phenological relationship between olive fruit fly and olive) and natural enemies (increased occurrence of natural enemies), as well as plant diseases (olive fly could be an indirect vector of plant diseases). In fact, predicting the impact of climate change on the olive fly is very complex because, in addition to the impact of climatic conditions, the impact of environmental conditions on the development of the phenological phases of the host plant (olive) and natural enemies must also be taken into account. There must be a good synchronization between olive fruit fly, host plant and also natural enemies. In order to determine whether the trend of increasing air temperatures is already affecting the dynamics of olive fruit fly population occurrence, development and size, we conducted a comprehensive analysis of meteorological, phenological and olive fruit fly occurrence data between 2005 and 2021. The result showed that the trend of increasing average minimum air temperatures is already reflected in an earlier onset of the growing season and reproductive development, as well as in a shortened time for olive growth and development (shorter flowering period, shorter ripening period). Although the effects on an earlier onset of flowering were not observed, the study also showed the effects of increasing temperatures on the earlier appearance of the olive fruit fly on pheromone traps and in olive fruit, as well as the greater presence of natural enemies of the olive fruit fly.

Prve izkušnje pri spremljanju oljčne muhe (*Bactrocera oleae* [Gmelin]) z uporabo elektronske feromonske vabe Trapview

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Leta 2021 smo za spremljanje oljčne muhe prvič uporabili elektronsko feromonsko vabo Trapview proizvajalca Efos d.o.o. Delovanje naprave smo preizkušali v oljčniku, kjer škodljivko že vrsto let spremljamo s feromonskimi vabami znamke Dacotrap. Ker smo želeli oba izdelka primerjati glede na učinkovitost ulova in uporabnost smo v obe pasti vstavili feromonske dispenzorje istega proizvajalca. Glede na dolgoletne izkušnje z vabo Dacotrap smo le-to vzeli za standard in na podlagi tedenskih spremljanj ulova oljčne muhe opravili primerjavo med obema izdelkoma. Pridobljene rezultate smo statistično obdelali s pomočjo analize variance. Za razliko od feromonske vabe Dacotrap, katero sestavlja plastično ohišje z lepljivim premazom v notranjosti in kovinske žice s katero se izdelek pritrdi na vejo, je vaba Trapview sestavljena iz plastičnega ohišja v katerem je pogonska enota ter lepljiva folija, katera prehaja na zunanji rob naprave in na katero se lepijo samci oljčne muhe. Na zunanjem delu pasti je dodatno ohišje, ki skrbi za zajem slik lovilne površine. Za delovanje naprave skrbi električno napajanje pridobljeno iz sončne celice, oddaljeni prenos podatkov pa poteka preko mobilnega omrežja. Povezavo med ulovom škodljivke in škropljenji smo ugotavljali z deležem aktivnih okužb. Tako smo v tedenskih intervalih naključno nabirali 100 plodov in jih pod stereomikroskopom podrobno pregledali. Pridobljene podatke o deležu poškodb smo statistično in grafično obdelali. Ugotovili smo, da se je pri uporabi enakega feromonskega dispenzorja na elektronski vabi Trapview ujelo več samcev oljčne muhe kot na standardni vabi Dacotrap. Razlika glede učinkovitosti izdelkov so bile statistično značilne.

ABSTRACT

First experience of olive fly (*Bactrocera oleae* [Gmelin]) monitoring by using the pheromone trap station Trapview

In the year 2021, we monitored the olive fly for the first time with the pheromone trap station Trapview produced by the company Efos d.o.o.. We have tested the device in an olive orchard where the pest has been monitored for several years using the pheromone trap Dacotrap. In order to compare the two products by efficacy and usefulness we activated them with the same olive fly pheromone dispensers. Regarding many years of experience with the Dacotrap product, they were used as control treatment. We have monitored the captures on both products in weekly periods, the records were compared by using the ANOVA. The Dacotrap is made of plastic liner with the glue cover inside. On the top there is a metal hook to tight the trap on the branch. On the other hand, the Trapview is made from a solid plastic housing with the electric engine and the sticky glue roll inside. The glue tape rolls outside the housing. Once outside the males of the olive fly can stick on it. Attached to the plastic housing there is another unit with camera and electronic unit. The trap station is powered by a solar panel; the remote connection is possible by mobile network. The relation between fly catches and chemical treatments was studied by the percentage of active infections. To get these data we weekly collected 100 olive fruits and checked them with a stereo microscope. The percentage of the damage was then statistically and graphically evaluated. We discovered that the Trapview stations were able to catch more olive fly males than the Dacotrap.

Varstvo vrtnin

Bakterijski rak paradižnika (*Clavibacter michiganensis* subsp. *michiganensis* (Smith) Davis *et* al.) — najpomembnejša bakterijska bolezen paradižnika

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Pri pridelavi paradižnika tako na prostem kot v zavarovanih prostorih se pridelovalci soočajo s pojavom nekaterih bakterijskih bolezni. Med bolj pogoste povzročitelje spadajo *Pseudomonas corrugata*, *Pseudomonas syringae* pv. *tomato* in *Clavibacter michiganensis* subsp. *michiganensis*. Za razliko od *Pseudomonas* spp. slednja sodi med grampozitivne bakterije. V ugodnih pogojih visoke vlažnosti in temperatur med 25 in 30 °C lahko v kratkem času privede do popolnega propada gojenih rastlin. Škodljivi organizem se prenaša s semenskim in sadilnim materialom. Bakterija, katere razvoj poteka v ksilemu, v rastlino vstopa preko listnih rež in ran, ki nastanejo ob mehanskih poškodbah nadzemnega dela. Vstopno mesto za bakteriozo predstavljajo tudi korenine. Bakterijski rak paradižnika prepoznamo po različnih bolezenskih znamenjih kot so ožigi listov, venenje rastlin, propadanje prevodnega sistema ter neenakomerno dozorevanje plodov. Pogosto na okužbo opozori tudi bakterijski izcedek s katerim se bolezen širi po nasadu. Do širjenja okužb prihaja predvsem med odstranjevanjem zalistnikov in pri pobiranju plodov. Posebno težavo pri omejevanju škode predstavlja varstvo, saj podobno kot pri drugih bakteriozah ni učinkovitih kemičnih pripravkov. V tujih virih se pogosto omenja le pripravke na osnovi 8-hidroksikinolina, kateri naj bi prispevali k manjšemu pojavu okužb na sadikah paradižnika. Škodo na pridelku omejimo predvsem z izvajanjem ustreznih preventivnih ukrepov, ki temeljijo na zdravem semenu in dobri higieni. V prispevku je opisana biologija bakterije z bolezenskimi znamenji, ki jih povzroča in načini omejevanja škode.

ABSTRACT

Bacterial canker of tomato (*Clavibacter michiganensis* subsp. *michiganensis* (Smith) Davis *et* al.) – The most important bacterial disease of tomato

The producers of tomato crop grown in the fields or in greenhouses are faced with several bacterial diseases. The more common are those caused by bacteria such as P*seudomonas corrugata*, *Pseudomonas syringae* pv. *tomato* and *Clavibacter michiganensis* subsp. *michiganensis*. The *Clavibacter michiganensis* subsp. *michiganensis* belongs to the Gram-positive bacteria. In favourable conditions of high humidity and temperatures between 25 and 30 °C, infection may lead to the complete decay of the plant in a short time. The disease can be transmitted by tomato seeds or seedlings. The bacterium multiplies in the xylem after entering the host plant through leaf stomata or wounds caused by mechanical damage on the aerial part of the plant. Bacteria can also enter the plants via roots. Symptoms of bacterial canker include leaf blight, plant wilting and degradation of the vascular tissue. The fruit development is also affected and results in uneven maturation. One common symptom of the infection is the bacterial ooze which contributes to the disease spread. This happens especially during leaf removal and when harvesting. Lack of effective crop protection products makes management of bacterial diseases particularly difficult. However, only products based on the active ingredient 8-hydroxyquinoline are cited to prevent the infections on seedlings. Preventive measures, namely use of healthy seeds and good hygiene are paramount. The

presentation will describe the biology of bacteria, disease symptoms and approaches to disease management.

Pomen vode za razširjanje virusa rjave grbančavosti plodov paradižnika

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V zadnjih desetletjih postajajo rastlinske bolezni, povzročene z novimi virusi, ekonomsko vedno pomembnejše. Trenutno je gospodarsko najpomembnejši virus rjave grbančavosti plodov paradižnika (tomato brown rugose fruit virus; ToBRFV), ki je bil prvič odkrit leta 2014 v Izraelu. Od takrat se izbruhi tega virusa pojavljajo po vsem svetu in ogrožajo pridelavo paradižnika in paprike, ki sta glavna gostitelja virusa ToBRFV. Najpomembnejši način vnosa ToBRFV v nove države ali regije je preko okuženega semenskega in sadilnega materiala. Ko je virus vnesen v novo okolje, se zaradi visoke stabilnosti preko različnih mehanskih načinov hitro prenese na druge rastline. Sposobnost naglega razširjanja ToBRFV in njegovega visokega potenciala za povzročitev epifitocij izhajata iz njegovih fizikalnih in bioloških lastnosti. Študije poročajo, da je virus ToBRFV sposoben dolgotrajnega preživetja na različnih površinah in pod različnimi okoljskimi pogoji, zaradi česar ga je z uporabo že razvitih dezinfekcijskih tehnik izredno težko odstraniti iz pridelovalne verige oziroma sistema. Njegovo RNA smo zaznali tudi v nekaterih vzorcu odpadne vode iz čistilne naprave, v vzorcih vode iz rek, namakalnih sistemov in zajetij v Sloveniji, vendar pa mehanizem virusnega prenosa preko vodnih medijev, predvsem namakalne vode, še ni v celoti razumljen in je predmet raziskav v okviru nacionalnega aplikativnega projekta ARRS L4_3179 (Tobamo) v okviru katerega preučujemo prenos virusa preko korenin in hidroponije. S pridobljenimi rezultati raziskav bomo bolje razumeli sicer kompleksno epifitocijo virusa ToBRFV, obenem pa bo to omogočilo izvedbo analize tveganja, s katero bomo definirali kritične točke za zajezitev virusa in načrtovanje ukrepov.

ABSTRACT

Water-linked epidemiology of tomato brown rugose fruit virus

Diseases caused by emerging viruses have become increasingly important in recent decades in terms of their incidence and economic impact. Currently, the most economically important emerging virus is the tomato brown rugose fruit virus (ToBRFV), which emerged in Israel around 2014. Since then, outbreaks of ToBRFV have occurred around the world. This threatens the production of tomatoes and peppers, the main host plants for ToBRFV. The main route of introduction of tobamoviruses into new countries and regions is through infested seeds and infected planting material. Due to its physical and biological properties, ToBRFV is particularly stable and can be easily transferred to

other plants by mechanical transmission after introduction into a new region. It has already been confirmed that ToBRFV can survive on various surfaces for long periods of time and is environmentally stable. Therefore, once ToBRFV has entered the greenhouse, it is difficult to eradicate using existing disinfection techniques. ToBRFV RNA has been detected in some wastewater samples, in samples from rivers, and in samples from irrigation systems. However, the transmission of ToBRFV by irrigation water to plants (via roots and in hydroponic systems) is not yet known and is therefore the subject of studies under the ARRS L4_3179 national project (Tobamo). This knowledge is needed to define the complex epidemiology and conduct risk assessment studies to identify the critical points for monitoring and control.

Učinkovitost različnih biofungicidov za preprečevanje verticilijske uvelosti in fuzarijskih obolenj paradižnika

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V okviru ciljnega raziskovalnega projekta (CRP) z naslovom »Uporaba metod z nizkim tveganjem za varstvo zelenjadnic« (šifra V4-1602) smo proučevali učinkovitost biotičnih pripravkov na osnovi mikroorganizmov za preprečevanje verticilijske uvelosti (*Verticillium dahliae* (VD)) in fuzarijskih obolenj (*Fusarium oxysporum* f.sp. *lycopersici* (FOL), *F. oxysporum* f.sp. *radicis-lycopersici* (FORL)) paradižnika. Z namenom zagotovitve homogene prisotnosti infekcijskega potenciala smo testiranja zasnovali v obliki lončnega poskusa v rastlinjaku z uporabo umetno okuženih substratov. V testiranje smo vključili tri komercialne pripravke na osnovi gliv; Remedier, Prestop®, Polyversum in pripravka na osnovi bakterij rodu *Bacillus*; Serenade® ASO in Cilus® Plus. Rezultati so potrdili delovanje posameznih pripravkov, vendar ob visoki variabilnosti ter odvisnosti od vrste povzročitelja in načina uporabe. Učinkovitost pripravkov je dosegala do 50% na nivoju preprečevanja okužb, pri čemur smo boljše rezultate dosegli v primeru namakanja koreninskega dela sadik v pripravke pred sajenjem kot v primeru zalivanja rastlin po sajenju. Ker uspešno preprečevanje okužb talnih gliv temelji le na kombiniranih pristopih (odpornost sort, kolobar, razkuževanje tal…) smo s poskusi potrdili upravičenost uporabe testiranih pripravkov, predvsem v smislu preventivne uporabe in pa kot dopolnilo metodam izboljševanja zdravstvenega stanja tal.

ABSTRACT

Efficacy of various biofungicides for control of verticillium and fusarium diseases of tomato

As part of a targeted research project (CRP) entitled "Use of low-risk methods for the protection of vegetables" (code V4-1602), we evaluated the efficacy of microorganism-based biotic products for the prevention of *Verticillium* wilt (*Verticillium dahliae* (VD)) and *Fusarium oxysporum* f.sp. *lycopersici* (FOL), *F. oxysporum* f.sp. *radicis-lycopersici* (FORL)) in tomato. To ensure a homogeneous presence of the infectious potential, the tests were carried out in the form of a pot experiment in a greenhouse with artificially

infected substrates. Three commercial products based on fungi; Remedier, Prestop®, Polyversum and one product based on bacteria of the genus *Bacillus;* Serenade® ASO and Cilus® Plus were included in testing. The results confirmed the efficacy of each biofungicide, but with high variability and depending on the type of pathogen and the application method. The effectiveness of the preparations reached up to 50% at the level of infection prevention, with better results when the roots of the seedlings were soaked in the preparations before planting than when the plants were irrigated after planting. Since successful prevention of soil fungal infections is based on combined approaches (plant resistance, crop rotation, soil disinfection...), we have confirmed the justification for the use of the tested preparations, especially in terms of preventive application and as a complement to other methods of improving soil health.

Parazitski ogorčici polžev *Phasmarhabditis papillosa* in *Oscheius myriophilus* – potencialna biotična agensa za zatiranje španskega lazarja (*Arion vulgaris*)?

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Polži predstavljajo gospodarsko pomembne škodljivce v kmetijstvu, saj s svojim hranjenjem poškodujejo dele rastlin in tako posledično vplivajo na zmanjšan pridelek, okrasno in tržno vrednost rastlin, ter povečajo tveganje za okužbo z mikroorganizmi. Za zatiranje polžev se uporabljajo razne ne-kemijske prakse, limacidi na podlagi železovega (III) fosfata in metaldehida ter biotično varstvo s parazitsko ogorčico *Phasmarhabditis hermaphrodita*. Slednja se v ta namen v tujini uporablja že več let, v Sloveniji pa je še vedno na seznamu tujerodnih organizmov, kar prepoveduje njeno uporabo. V letih 2018 in 2021 smo potrdili zastopanost dveh za Slovenijo novih vrst parazitskih ogorčic polžev *Phasmarhabditis papillosa* Schneider Andrássy in *Oscheius myriophilus* (Poinar). V laboratorijskem poskusu smo preučevali učinkovitost ogorčic na hranjenje in smrtnost španskega lazarja (*Arion vulgaris*) pri različnih temperaturah (15 in 20 °C) in pri različnih koncentracijah suspenzije ogorčic (0, 10, 50, 100, 250, 500 IL/polža). Rezultati so obetavni in kažejo na potencial obeh vrst ogorčic pri zatiranju španskega lazarja. Njuna učinkovitost je močno odvisna od koncentracije suspenzije ogorčic, temperature, časa izpostavljenosti polžev ogorčicam in interakcije teh treh dejavnikov. Največji vpliv gre pripisati temperaturi - višja kot je bila (20 °C) prej so polži prenehali s hranjenjem in poginili. Velik poudarek je tudi na interakciji dejavnikov, saj je koncentracija vplivala na polže zgolj pri višji temperaturi (20 °C). Prav tako ni bilo razlik o učinkovitosti ogorčice med najvišjo (500 IL/polža) in najnižjo (10 IL/polža) koncentracijo, pri temperaturi 20 °C. Posebnost okuženih polžev je bila v njihovem zvijanju za 360° okoli svoje osi in v plašču, ki je uplahnil.

ABSTRACT

Slug parasitic nematodes *Phasmarhabditis papillosa* and *Oscheius myriophilus* – a possible biological control agents against the Spanish slug (*Arion vulgaris*)?

Slugs are economically important pests in agriculture, as their feeding damages parts of plants and consequently affects the reduced yield, ornamental and market value of plants, and increases the risk of infection with microorganisms. Various non-chemical practices, molluscicides based on iron (III) phosphate and metaldehyde, and biological control with the parasitic nematode *Phasmarhabditis hermaphrodita* are used to control slugs. Abroad, the latter has been used for this purpose for several years, but in Slovenia it is still on the list of non-native organisms, which prohibits its use. In 2018 and 2021, we confirmed the presence of two new species of parasitic nematodes for Slovenia, *Phasmarhabditis papillosa* Schneider Andrássy and *Oscheius myriophilus* (Poinar). We evaluated the efficacy of two slug parasitic nematodes on feeding and mortality of the Spanish slug (*Arion vulgaris*) at different temperatures (15 and 20 °C) and at different concentrations of nematode suspension. The results are promising and indicate the potential of both slug parasitic nematodes against the Spanish slug. The temperature shows the biggest impact – the higher the temperature (20 °C) the sooner the slugs stopped feeding and died. There is also a strong emphasis on the interaction of the factors, as the concentration affected the slugs only at a higher temperature (20 °C). At 20 °C there were also no differences in nematode efficacy between the highest (500 IL/slug) and lowest (10 IL/slug) concentration. The peculiarity of the infected slug was in their 360° twisting around their axis and in the mantle that collapsed.

Čebulni rilčkar (*Oprohinus suturalis* Fabricius)

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Čebulni rilčkar (*Oprohinus suturalis,* sinonim *Ceutorhynchus suturalis*), spada v družino rilčkarjev (Coleoptera, *Curculionidae*). Je monofagni škodljivec, ki napada družino čebulnic (Alliaceae), najpogosteje čebulo (*Allium cepa*), drobnjak (*Allium schoenoprasum*) in hrušico (*Muscari* spp.). Škodljivec je v zadnjih vročih in suhih letih (v letih 2018, 2019 in 2021) povzročil škodo v posameznih posevkih čebule in drobnjaka v Nemčiji. Težave v pridelavi povzroča tudi v Srbiji in na Češkem. Konec julija 2021 smo škodljivca in značilne poškodbe, ki jih povzroča, opazili na čebuli, pridelovani v nizkem tunelu na Koroškem (na nadmorski višini 730 m). Ali gre za rilčkarja, ki do sedaj ni povzročal škode na čebuli? Ali gre za novega škodljivca, ki lahko povzroči težave v pridelavi čebule in ostalih čebulnic v Sloveniji? V prihodnje velja več pozornosti nameniti spremljanju njegovega pojavljanja, saj lahko poškodbe na čebulnicah zamenjamo s poškodbami, ki jih povzroča porova zavrtalka (*Phytomyza gymnostoma*).

ABSTRACT

Onion weevil (*Oprohinus suturalis* Fabricius)

Onion weevil (*Oprohinus suturalis,* syn. *Ceutorhynchus suturalis*) (Coleoptera, *Curculionidae*) is a monophagous pest that attacks the onion family (Alliaceae), most commonly the onion (*Allium cepa*), chives (*Allium schoenoprasum*) and *Muscari* spp.. In

the last hot and dry years (2018, 2019 and 2021), the pest caused damage to individual onion and chives crops in Germany. It also causes production problems in Serbia and the Czech Republic. At the end of July 2021, the pest and the characteristic damage it caused were observed on onions grown in a low tunnel in Carinthia (at an altitude of 730 m). Is it a pest that hasn't caused any damage to onions so far? Is it a new pest that can cause problems in the production of onions and other bulbs in Slovenia? In the future, more attention should be maid to monitoring its occurrence, as damage to bulbs can be replaced by damage caused by onion leaf miner (*Phytomyza gymnostoma*).

Stranski učinki uporabe biostimulatorjev na razvoj dveh sort čebule poškodovane od herbicidov

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V poljskem poskusu smo v sezoni 2020 preučevali vpliv nanosa biostimulatorjev na razvoj čebule, močno poškodovane od herbicidov in vpliv na uspešnost zatiranja bolezni in škodljivcev. Biostimulatorja Batallon 6,5 l/ha (encimi, mikrobi in fulvo kisline) in Bombardier (proteini, mikrobi, rastlinski izvlečki) 5 l/ha, proizvedena s strani podjetja Kimitec iz Španije smo nanesli dvakrat v sezoni. Pri čebuli sorte Ptujski luk in hibridu Talon smo analizirali parametre rasti, pojav glivičnih bolezni (*Peronospora destructor* (Berkeley) Caspary, *Stemphylium allii-cepae* X.G. Zhang & T.Y. Zhang) in škodljivca tobakovega resarja (*Thrips tabaci* Lindeman). Uporaba biostimulatorjev je imela značilen vpliv na povečanje pridelka od herbicida prizadete čebule in na uspešnost zatiranja preučevanih bolezni, a ne na uspešnost zatiranja resarja. Ker so poljščine in vrtnine vse bolj pogosto pod različnimi vrstami stresa, bo potrebno izvesti veliko raziskav za razumevanje možnosti vplivanja biostimulatorjev na razvoj rastlin in na zatiranje škodljivih organizmov. Pomembno je pridobiti znanje glede tega, kako obsežen je lahko vpliv uporabe biostimulatorjev na obrambni odziv rastlin v stresnih razmerah. Pod domeno varstva rastlin poleg zatiranja ŠO sodi tudi varovanje pred stresom in sanacija škode od stresa.

ABSTRACT

Side effects of the use of biostimulators on the development of the two varieties of onion damaged by herbicides

In a field experiment in the 2020 season, we studied the impact of biostimulator application on the development of onions severely damaged by herbicides and the impact on disease and pest control performance. Biostimulators Batallon 6.5 l/ha (enzymes, microbes and fulvic acids) and Bombardier (proteins, microbes, plant extracts) 5 l/ha produced by Kimitec from Spain were applied twice a season. The growth parameters, the occurrence of fungal diseases (*Peronospora destructor* (Berkeley) Caspary, *Stemphylium allii-cepae* X.G. Zhang & T.Y. Zhang) and the tobacco thrips (*Thrips tabaci* Lindeman) were analysed at onions of the Ptujski luk variety and the Talon hybrid. The use of bio stimulators had a significant effect on the increase in yield from the herbicide-affected

onion and on the effectiveness of the control of the studied diseases, but not on the effectiveness of the control of the thrips. As crops and vegetables are frequently under different types of stress, much research will be needed to understand the potential impact of bio stimulators on the development of crops and control of pests. It is important to gain knowledge about how extensive the impact of the use of biostimulators can be on the defence response of plants in stressful situations. In addition to pest control, the discipline of plant protection also includes protection against stress and remediation of stress damage.

Zatiranje plevelov v čebuli (*Allium cepa* L.) s herbicidi

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Zatiranje plevelov je eden od najpomembnejših agrotehničnih ukrepov v pridelavi čebule. Pridelovalci se spomladi pogosto soočajo s sušnimi obdobji. Vznik plevelov je zaradi tega neenakomeren, kar ima za posledico nezadostno učinkovitost delovanja herbicidov. V tujini za zatiranje plevelov uporabljajo herbicide oziroma kombinacije herbicidov v nižjih in deljenih odmerkih, da tako zatrejo vznik plevelov skozi daljše obdobje. Odmerki večkratne uporabe herbicidov ne presegajo skupnega enkratnega odmerka. Z uporabo nižjih odmerkov se prepreči izpiranje aktivnih snovi uporabljenih herbicidov v nižje plasti tal in onesnaževanje podtalnice. Poleg tega je hitrejša tudi mikrobiološka razgradnja aktivnih snovi herbicidov v tleh. Z namenom preverbe v naših pogojih smo v letu 2021 na Inštitutu za hmeljarstvo in pivovarstvo Slovenije, Kmetijsko gozdarskem zavodu Maribor in Kmetijskem inštitutu Slovenije izvedli poljske poskuse za zatiranje plevelov v čebuli (*Allium cepa* L.). Preverjali smo učinkovitost herbicidov Sharpen plus (a.s. *pendimetalin*) in Lentagran WP (a.s. *piridat*). Herbicida smo preizkušali samostojno, v kombinaciji obeh in v kombinaciji obeh v dveh in treh deljenih odmerkih. Bločno zasnovani poskusi so bili opravljeni na treh lokacijah, s šestimi obravnavanji, v štirih ponovitvah. Tekom poskusov smo ocenjevali učinkovitost in fitotoksičnost posameznih herbicidov po njihovi aplikaciji ter ob koncu ovrednotili pridelek posameznih obravnavanj. Poudarek je bil na zatiranju plevelov v zgodnjih razvojnih fazah v kombinaciji z deljenimi odmerki, s katerimi smo uspeli podaljševati učinkovitost herbicidov na plevelne vrste. Posledično so bili pri obravnavanjih z deljenimi odmerki herbicidov pridelki čebule večji. V poskusih nismo zaznali fitotoksičnosti herbicidov za čebulo.

ABSTRACT

Weed control in onion (*Allium cepa* L.) with herbicides

Weed management is one of the most important agro-technical measures in onion production. Drought periods are common in spring. The emergence of weeds is therefore

uneven, resulting in insufficient performance of herbicides. Split application of herbicides at reduced rates or multiple herbicide applications can be used in order to control weeds emerging over a prolonged time period. Combined, reduced rates should not exceed the rate allowed for weed management in a crop. Reduced rate of herbicide prevents leaching through soil profile and groundwater pollution. In addition microbiological decomposition of active substances is faster. Weed control trials in onion (*Allium cepa* L.) were conducted by Inštitut za hmeljarstvo in pivovarstvo Slovenije, Kmetijsko gozdarski zavod Maribor and Kmetijski inštitut Slovenije in 2021. Effect of two herbicides (Sharpen Plus –*pendimethalin* and Lentagran WP – *pyridate*) applied once at labelled rate and split applied as two or three equal applications was tested. A block design experiment with six treatments in four blocks was set at each of the three locations. Herbicide efficacy and fitotoxicity was assessed visually and yield of the crop was assessed at the end of each experiment. Individual applications of herbicides were timed to control weeds in early growth stages. Herbicide efficacy was prolonged with the use of split application which resulted in higher yield of onion in treatments where split application was used. During the trials no fitotoxicity was observed.

Glivični povzročitelji propadanja špargljev v nasadih

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Z namenom ugotavljanja povzročiteljev simptomov propadanja špargljev smo vzorčili skupno 56 rastlin s 14 polj v treh različnih območjih Slovenije (srednja in jugovzhodna Slovenija ter Primorska). Pridobili smo skoraj 350 izolatov gliv, osamljenih iz simptomatskih ali nesimptomatskih stebel, brstov, korenike in korenin. Čeprav so posamezne vzorčene rastline pokazale različne vzorce bolezni, ki odražajo različne stopnje propadanja v nasadih, je bila večina rastlin (32) okuženih tako s *F. proliferatum* kot tudi s predstavniki kompleksa vrste *Fusarium oxysporum* (FOSC) ter samo s *F. proliferatum* (5) ali samo FOSC (11). Podobne rezultate so pokazle tudi analize sadik špargljev, sorte Athos (pridobljene iz Italije) in sorte Dariana (iz Španije in Nemčije), ki sta jih naseljevali predvsem vrsti *F. proliferatum* in FOSC. Izolati iz skupine FOSC so pokazali primerljivo visoko genetsko raznolikost, ki se je odražala v različnih haplotipih zaporedij DNK zapisov. Izolate identificirane kot *F. oxysporum* f.sp. *asparagi* smo pridobili tako iz sadik iz uvoza kot tudi iz vzorcev iz domačih nasadov. Tudi izolate *Neocosmospora* spp. (= kompleks vrst *Fusarium solani*) smo osamili iz različnih lokacij vzorčenj, druge vrste zlasti iz kompleksa vrst *Fusarium incarnatum / equisetii*, pa le sporadično. Pogosto smo iz različnih rastlin in lokacij osamili tudi vrste rodov *Stemphylium* in *Penicillium*. Vijoličasta morilka korenin (gliva *Helicobasidium brebissonii*), ki povzroča popoln propad številnih poljščin, je bila doslej potrjena na posameznih vzorcih s Posavja in Gorenjske, pojavlja pa se verjetno tudi v nasadih špragljev na Primorskem. Študija je bila del Integriranega varstva rastlin za leto 2021 in je podlaga za oblikovanje strategij varstva špargljev v naslednjih letih.

ABSTRACT

Causal agents of fungi associating Asparagus field decline symptoms

To investigate the causal agents of *Asparagus* decline symptoms, a total of 56 individual plants from 14 fields in 3 different production areas (Central and Southeast Slovenia and Primorska) were sampled. A total of almost 350 fungal isolates obtained from symptomatic or non-symptomatic stems, buds, rhizoms, and roots. Although individually sampled plants showed different disease patterns mirroring differing plant decay levels in sampled orchards, the majority of plants (32) were infected with both, *F. proliferatum* and members of the *Fusarium oxysporum* species complex (FOSC) or with only *F. proliferatum* (5) or only FOSC (11). Similar results were also obtained from *Asparagus* seedlings, cultivar Athos (obtained from Italy), and cultivar Dariana (Spain and Germany), that accommodated mainly *F. proliferatum* and FOSC. FOSC members showed a comparably high genetic diversity displaying various sequence-based haplotypes. Taxa identified by others as *F. oxysporum* f.sp. *asparagi* were obtained from foreign seedlings and from native field samples. Also *Neocosmospora* spp. (= *Fusarium solani* species complex) were encountered from various locations, while species especially of the *Fusarium incarnatum* / *equisetii* species complex were encountered sporadically. Species of *Stemphylium* and *Penicillium* were encountered from various plants / locations. *Helicobasidium brebissonii*, causal agent of the destructive violet root rot on numerous crop plants, was so far confirmed from fields in Posavje and Gorenjska and occurs possibly also in *Asparagus* fields in Primorska. The study was part of the Integrated plant protection program for 2021 and provides the basis for the establishment of *Asparagus* protection strategies in the next years.

Fitofarmacevtska sredstva in okolje

Toksikovigilanca glifosata v severovzhodni Sloveniji

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Neselektivni herbicid, glifosat, je bil 2017 v Evropski uniji (EU) razvrščen kot dražilen in nevaren za okolje. Mednarodna agencija za raziskave raka (IARC) pri Svetovni zdravstveni organizaciji ga je razvrstila v 2A skupino rakotvornosti (verjetno rakotvoren za človeka). Razvrstitev IARC ni zakonsko zavezujoča, vendar je stališče IARC sprožilo burne odzive v strokovni in splošni javnosti. Ne glede na obširnost študij pred registracijo aktivne snovi je nemogoče natančno predvideti vse možne škodljive učinke. Zato je potrebno budno spremljanje tudi po registraciji. V nekdanji tovarni Pinus v Račah proizvajajo herbicid na osnovi glifosata. Register raka pri Onkološkem Inštitutu Ljubljana je 2019 zaradi zaskrbljenosti lokalnega prebivalstva pregledal incidenco raka na Dravskem Polju. V raziskavi niso ugotovili povečanega tveganja za nastanek proučevanih vrst raka v 40 območjih na Dravskem polju z izjemo Kidričevega. V nobenem od 40 območij na Dravskem polju niso ugotovili za nobeno izmed preučevanih vrst raka v nobenem od treh desetletnih obdobij kopičenja primerov rakavih obolenj, ki bi lahko nakazovalo na vpliv lokalnega dejavnika. V nedavni študiji izpostavljenosti v Prekmurju sta bila glifosat in njegov metabolit aminometilfosfonska kislina (AMPA) določena v urinu 149 otrok in 97 mladostnikov. Pozimi sta bila glifosat in AMPA določena v 27% oziroma 50% vzorcev, pozno spomladi v 22% oziroma 56%. Geometrična sredina in mediana obeh snovi sta bili pod mejo določanja (LOQ ≤ 0.1 µg/L). Na podlagi koncentracij glifosata in AMPA v urinu je bil ocenjen dnevni vnos 0,003 µg/kg tm (sprejemljivi dnevni vnos je 0,5 mg/kg tm). Za genotoksične rakotvorne snovi v hrani je sprejemljivi količnik izpostavljenosti (MOE) ≥ 10 000. MOE of 16 667 zagotavlja zadostno varnost, četudi bi bil glifosat genotoksično rakotvoren. Toksikovigilančno spremljanje glifosata ne nakazuje zaskrbljujoče izpostavljenosti glifosatu niti povečane incidence raka pri prebivalcih kmetijsko intenzivne severovzhodne Slovenije. Vendar pričakujemo nadaljnje razgrete izmenjave mnenj, saj na ravni EU poteka ponovna presoja glifosata.

ABSTRACT

Toxicovigilance of glyphosate in north-eastern Slovenia

In 2017, a non-selective herbicide glyphosate was classified as irritant and harmful to the environment in the European Union (EU). The International Agency for Research on Cancer (IARC) at the World Health Organization classified glyphosate to group 2A (probably carcinogenic to humans). Although IARC classification is not legally binding, IARC's position triggered turbulent response among the professional and general public. Despite the extensiveness of pre-registration studies on an active substance, it is impossible to predict all possible harmful effects. Thus, post-registration vigilance is necessary. The former factory Pinus in Rače produces a gylphosate based herbicide. In 2019, in view of public concern, the Cancer Registry at the Institute of Oncology Ljubljana examined cancer incidence at Dravsko polje. The research did not show an increased risk for the examined types of cancer in 40 areas of Dravkso polje with the exception of a market town Kidričevo. No accumulaton of cancer cases, which could have been ascribed to local factors, was noted in any of the 40 areas for any of the examined types of cancer in any of

the three ten-year periods. In a recent study in Prekmurje, gylphosate and its metabolite aminomethylphosphonic acid (AMPA) were determined in urine of 149 children and 97 adolescents. In winter glyphosate and AMPA were determined in 27% and 50% of the samples, respectively; in late spring in 22% and 56%, respectively. The geometric mean and median were below the level of quantification (LOQ ≤ 0.1 µg/L). Based on gylphosate and AMPA concentrations in urine, the daily intake was estimated to 0,003 µg/kg bw (Acceptable Daily Intake is 0,5 mg/kg bw). The acceptable Margin of Exposure (MOE) for genotoxic carcinogens in food is ≥ 10 000. A MOE of 16 667 assures sufficient safety, even if gylphosate was a genotoxic carcinogen. Toxicovigilance of glyphosate does not indicate a concern raising exposure to gylphosate nor an increased incidence of cancer in the inhabitants of the agriculturally intensive north-eastern Slovenia. As gylphosate is currently being reviewed at the EU level, further heated exchange of opinions is to be expected.

Integrirano varstvo rastlin v sledenju ciljem nacionalnega akcijskega programa za doseganje trajnostne rabe fitofarmacevtskih sredstev

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Glavni cilj Nacionalnega akcijskega programa za doseganje trajnostne rabe fitofarmacevtskih sredstev (NAP), ki je bil sprejet leta 2012 in dopolnjen leta 2018, je zmanjšanje vplivov in učinkov uporabe FFS na zdravje in okolje. Pomemben cilj v okviru NAP je krepitev integriranega varstva rastlin. Integrirano varstvo rastlin pred škodljivimi organizmi pomeni skrbno upoštevanje vseh razpoložljivih metod varstva rastlin, kar ima za posledico povezovanje ustreznih ukrepov, ki preprečujejo razvoj populacij škodljivih organizmov. Hkrati poudarja rast zdravih rastlin s čim manjšimi vplivi na kmetijske ekosisteme in spodbuja naravne mehanizme varstva pred škodljivimi organizmi. V sledenju ciljem NAP v Sloveniji v zadnjih letih med drugim krepimo spremljanja in napovedi škodljivih organizmov (opazovalno napovedovalno dejavnost) ter preverjanje različnih praks uporabe nekemičnih metod varstva rastlin in metod varstva rastlin z majhnim tveganjem (integrirano varstvo rastlin). Krepi se ozaveščanje in informiranje uporabnikov FFS s prenosom novih znanj in primerov dobrih kmetijskih praks integriranega varstva rastlin. V podporo prenosu aktualnih informacij, povezanih z varstvom rastlin, do svetovalcev in pridelovalcev se oblikujejo in dopolnjujejo nacionalne smernice integriranega varstva za posamezne kmetijske rastline, številna tehnološka navodila in izvajajo različne predstavitve dobrih praks. V ta namen je bil na Kmetijskem inštitutu Slovenije vzpostavljen tudi IVR portal, kjer se objavljajo tudi strokovna gradiva strokovnjakov z drugih inštitucij. V podporo IVR so tudi informacije, zbrane na Agrometeorološkem portalu RS. Sledenje ciljem zmanjšanja odvisnosti od uporabe FFS se odraža tudi v predlogu nacionalnega Strateškega načrta Skupne kmetijske politike 2023-2027 (zlasti v predlogu nekaterih podintervencij v intervenciji Kmetijsko-okoljska-podnebna plačila in v intervenciji Biotično varstvo rastlin).

V prispevku bomo predstavili dejavnosti in ukrepe, s katerimi v Sloveniji razvijamo in podpiramo uporabo integriranega varstva rastlin v rastlinski pridelavi, vključno s prenosom strokovnega znanja in dobrih praks do uporabnikov ter v podporo oblikovanju in izvajanju ukrepov skupne kmetijske politike.

ABSTRACT

Integrated pest management in pursuit of the objectives of the National Action Plan for Sustainable Use of Plant Protection Products

The principal objective of the National Action Plan for Achieving Sustainable Use of Plant Protection Products (NAP), adopted in 2012 and amended in 2018, is to reduce the impacts and effects of the use of PPPs on health and the environment. Strenghtening of integrated pest management (IPM) is an important specific goal of the NAP. IPM means careful consideration of all available methods of plant protection, resulting in the integration of appropriate measures to prevent the development of pest populations. In the same time, it emphasizes the growth of healthy plants with the least possible impact on agricultural ecosystems and promotes natural mechanisms of protection against pests. In recent years, following the objectives of the NAP in Slovenia, we have been strengthening monitoring and forecasting of pests (observational forecasting activity) and verifying various practices of using non-chemical plant protection methods and low-risk plant protection methods. By transferring new knowledge and examples of good agricultural practices of IPM, we build on awareness raising of PPP users. In support of the transfer of up-to-date information related to plant protection to advisors and growers, national guidelines for integrated protection for individual agricultural plants, numerous technological guidelines and various presentations of good practices are being developed and supplemented. For this purpose, IPM portal was established by Agricultural Institute of Slovenia, where technical materials are published which are prepared in cooperation with experts from other institutions. IPM related contents are also available on the Agrometeorological portal of the Republic of Slovenia. The pursuit of the objectives of reducing dependence on the use of PPPs is also reflected in the proposal of the National Strategic Plan of the Common Agricultural Policy 2023-2027 (especially in the proposed sub-interventions in the intervention Environmental, climate related payments and in the intervention Biological plant protection). In this paper we will present the activities and measures which we develop to support and promote the use of IPM in crop production in Slovenia, including the transfer of expertise and good practices to the farmers and the support in development and implementation of common agricultural policy measures.

RemDry® - Trajnostna rešitev za ravnanje z odpadnimi tekočinami, ki vsebujejo ostanke fitofarmacevtskih sredstev (FFS)

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Pri ravnanju s fitofarmacevtskimi sredstvi (FFS) je ključna pravilna uporaba in preprečevanje onesnaženja okolja. Znano je, da več kot polovica onesnaženja voda s FFS izvira iz t.i. točkovnih virov. Mednje sodijo predvsem izlitja ob polnjenju, praznjenju in čiščenju škropilnih naprav, zato je pomembno, da se vse te aktivnosti odvijajo na pravilen

način in na ustreznem mestu. Sistem RemDry® skupaj s premično čistilno platformo predstavlja enostavno, uporabniku prijazno in učinkovito rešitev za ravnanje z odpadno vodo, ki vsebuje ostanke FFS. RemDry® deluje po principu dehidracije, zato je osmerokotni rezervoar s prozorno streho narejen tako, da omogoča čim večje segrevanje notranjosti in cirkulacijo zraka. Čistilna platforma iz odporne PVC folije, na kateri se zbirajo odpadne tekočine, se enostavno namesti na ravno površino in ne zahteva betoniranja tal. Odpadna tekočina se prečrpa iz čistilne platforme v rezervoar, kjer voda s pomočjo sonca in vetra izhlapeva, na dnu rezervoarja pa na foliji ostane suha usedlina, ki vsebuje ostanke FFS. Suha usedlina se nato skupaj s folijo zavrže kot nevaren odpadek, količina odpadka pa je zaradi izhlapele tekočine izredno majhna. Raziskave so pokazale, da količina izhlapele vode variira v odvisnosti od lokacije, oziroma predvsem od zračne vlažnosti in temperature, ugodno pa na samo izhlapevanje vpliva tudi veter. Tako so merjenja v obdobju 108 dni (15. julij do 31. oktober 2018) pokazala bistveno večje izhlapevanje v Grčiji (1788 L) kot npr. v Belgiji (1242 L). RemDry® je primerna rešitev za manjše kmetije, vendar to za njih še vedno predstavlja dokaj velik strošek in dodatno vloženo delo. Ravnanje z odpadno vodo, ki vsebuje ostanke FFS, je ključnega pomena za zmanjševanje onesnaženja voda, zato bi bilo v sklopu Strateškega načrta skupne kmetijske politike potrebno razmisliti o spodbujanju RemDry® in podobnih rešitev za upravljanje z odpadnimi vodami, ki vsebujejo ostanke FFS.

ABSTRACT

RemDry® - A sustainable on-farm solution for managing remnant waste liquids containing plant protection product residues

When handling plant protection products (PPP), the key is to use them correctly and avoid the environment contamination. It is well known that more than half of water pollution from PPP comes from so-called point sources. These include mainly spillages during filling, emptying, and cleaning of spraying equipment, so it is important that all these activities are done in the right way and in the right place. The RemDry® system, together with the mobile cleaning platform, represents a simple, user-friendly, and effective solution for the management of wastewater containing PPP remnants. RemDry® works on the principle of dehydration, so the octagonal tank with a transparent roof is designed to allow maximum heating of the interior and air circulation. The cleaning platform made of resistant PVC foil, on which the waste liquids are collected, is easily installed on a flat surface, and doesn't require concrete floor. The waste liquid is pumped from the cleaning platform into a tank where the water evaporates with the help of the sun and the wind, leaving a dry residue, containing PPP remnants, on the inner foil. The dry residue is then disposed of as hazardous waste together with the foil, and the amount of waste is extremely small due to the evaporated liquid. Research has shown that the amount of evaporated water varies with location, or rather with humidity and temperature, and that wind also has a positive effect on evaporation. For example, measurements over a 108-day period (15 July to 31 October 2018) showed significantly higher evaporation in Greece (1788 L) than in Belgium (1242 L). RemDry® is a suitable solution for smaller farms, but it still represents a relatively high cost and additional work for them. The management of wastewater containing PPP remnants is crucial to reduce water contamination and the promotion of RemDry® and similar solutions should be considered in the context of the CAP Strategic Plan.

»Corteva tehnologija pridelave« s poudarkom na varstvu rastlin

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Uspešno varstvo rastlin je pomemben, vendar le eden od dejavnikov, ki vplivajo na končni uspeh rastlinske pridelave. Zato smo se na podjetju Corteva odločili za celovitejši pristop z upoštevanjem čim več dejavnikov, ki vplivajo na končni uspeh. Poimenovali smo ga »Corteva tehnologija pridelave«, ki zaenkrat obsega področje varstva rastlin, vrhunsko genetiko semena koruze, oljne ogrščice, sončnic, soje…, dodelavo in pripravo semena za trg, silirne dodatke, analizo silaže in tal, gospodarjenje z dušikom s pomočjo pripravka N-Lock™ SUPER in nekaterimi drugimi v tujini že uveljavljenimi pripravki ter strokovno svetovanje za omenjene aktivnosti. Na področju varstva rastlin uvajamo sodobna sredstva za varstvo rastlin (ZORVEC™ Endavia™, Closer™, Lumiposa™ 625 FS, Flexidor™…) na osnovi novih in v kombinacijah z že znanimi aktivnimi snovmi. Varstvo semena in mladih rastlinic smo s tretiranjem semena dodelali do potankosti, saj npr. na koruzno seme dodajamo fungicid, insekticid, hranila za seme, odvračalo in sredstvo za boljši oprijem v natančno določenem odmerku na posamezno seme. Uvajamo določene metode digitalnega kmetijstva, prav tako pa s sedanjimi (tehnologija Optynite™) in prihajajočimi aktivnostmi ter strokovnim svetovanjem skrbimo za varovanje okolja in tako prispevamo k trajnostnemu kmetovanju. K trajnostnemu kmetijstvu pa bomo prispevali še z uvedbo nekaterih sredstev, ki bodo dovoljena tudi v ekološki pridelavi.

ABSTRACT

“The Corteva crop technology” with an emphasis on plant protection

Even though successful crop protection is an important factor, it constitutes only one of several factors impacting the ultimate crop technology success. For this reason, Corteva has decided to undertake a more comprehensive approach taking into consideration as many factors impacting the ultimate success as possible. Our approach has been called “The Corteva Crop Technology” currently encompassing crop protection, state-of-the-art maize, rapeseed, sunflower, soya, etc. kernel genetics, seed processing and packing, silage additives, an analysis of both the silage and soil, nitrogen management by means of the N-Lock™ SUPER preparation and some other already established preparations abroad in addition to professional advice on the aforementioned activities. As far as plant protection is concerned, state-of-the-art plant protection products (ZORVEC™ Endavia™, Closer™, Lumiposa™ 625 FS, Flexidor™…) based on new and in combination with already known active substances are being introduced. Seed and young plant protection has been perfected through seed treatment by, for example, adding a fungicide, insecticide, seed nutrients, a repellent and a seed dressing binding agent in a specific dosage for each individual seed. Specific digital agriculture methods are being introduced, in addition to concerning ourselves with protecting the environment and thus contributing to sustainable farming through existing (Optynite™ technology) and upcoming activities and professional advice. The introduction of specific agents allowed also in organic farming shall also serve to contribute to sustainable farming.

ZORVEC™ Endavia™ - nov sistemični fungicid za varstvo pred krompirjevo plesnijo (*Phytophthora infestans*) in čebulno plesnijo (*Peronospora destructor*) podjetja CORTEVA™ Agriscience

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Fungicid ZORVEC™ Endavia™ vsebuje najnovejšo aktivno snov *oksatiapiprolin* (30 g/L), ki je edini predstavnik nove skupine piperidinil tiazol izoksazolnih fungicidov (FRAC 49 – inhibicija proteina za vezavo oksisterola – OSBP), za zatiranje krompirjeve in čebulne plesni. Aktivna snov *oksatiapiprolin* deluje na popolnoma novem biokemičnem mestu v razvojnem ciklu glive in ni znane navzkrižne rezistence z obstoječimi fungicidi. Ker pa deluje na enem mestu v celici glive, je končni formulaciji sredstva (oljna disperzija – OD) ZORVEC™ Endavia™, dodana aktivna snov *bentiavalikarb-izopropil* (70 g/L), ki pripada drugi kemični skupini fungicidov (FRAC 40 – valinamid karbamati). Na ta način dobimo vsestranski in visoko učinkovit fungicid z izjemnim okoljskim profilom ter nizkim odmerkom na hektar 0,4 L/ha (skupaj 40 g aktivne snovi/ha). ZORVEC™ Endavia™ deluje preventivno, kurativno, eradikativno in antisporulantno. Je zelo zanesljiv fungicid, z izredno sistemičnim in dolgotrajnim delovanjem in s tem postavlja nove standarde varstva pred krompirjevo in čebulno plesnijo. Zaradi svoje sistemičnosti varuje tudi novo zrastle dele rastlin in že 20 minut po aplikaciji je odporen proti spiranju zaradi padavin. Zato je mesto njegove uporabe v času intenzivne rasti krompirja in čebule, ko je pritisk bolezni največji in vremenske razmere najtežje. Zaradi vseh zgoraj naštetih dobrih lastnosti je fungicid ZORVEC™ Endavia™ zanesljiv fungicid v vseh programih varstva krompirja in čebule, saj ponuja pridelovalcem številne koristi zaradi podaljšanja škropilnih intervalov, robustno in sistemično varstvo ter s tem posledično tudi manjšimi operativnimi stroški. Zaradi izboljšane kvalitete samih pridelkov je omogočeno tudi daljše skladiščenje in doseganje višje prodajne cene.

ABSTRACT

ZORVEC™ Endavia™ - a new systemic fungicide for disease control against late blight *(Phytophthora infestans)* on potato and downy mildew *(Peronospora destructor)* on onion from CORTEVA ™ Agriscience

ZORVEC™ Endavia™ contains the latest active ingredient *oxathiapiprolin* (30 g/L) the first in a new class of piperidinyl-thiazole-isoxazoline fungicides to control late blight on potato and downy mildew on onion (FRAC 49 - inhibition of oxysterol binding protein - OSBP). Active ingredient *oxathiapiprolin* acts at a completely new biochemical site in the fungal development cycle and there is no known cross-resistance with existing fungicides. However, because it acts in one place in the fungal cell, the active ingredient *benthiavalikarb* (70 g/) which belongs to the second group of fungicides (FRAC 40 – Valinamide Carbamate), has been added to the final formulation (oil dispersion - OD) of ZORVEC™ Endavia™. In this way, we obtain a versatile and highly effective fungicide with an exceptional environmental profile and a low dose per hectare 0.4 L/ha (total amaount 40 g of active ingredient per ha). ZORVEC™ Endavia™ has a preventive, curative, eradicative and antisporulant activity. It is a very reliable fungicide, with extremely systematic and long-lasting action, and thus sets new standards of protection against late blight on potato and downy mildew on onion. Due to its systematic nature, ZORVEC™ Endavia™ also protects newly grown parts of plants, it is rainfast after only 20

minutes after aplication, so its place of use is during the intensive growth of potatoes and onions, when disease pressure is very high and weather conditions are most severe. Due to all the above-mentioned good properties, the ZORVEC™ Endavia™ fungicide is sure to find a place in the potato and onion spraying programs, as it offers growers many benefits due to extended spraying intervals, robust and systematic protection, and consequently lower operating costs. Due to the improved quality of the products themselves, it is also possible to store them longer and achieve a higher selling price.

Stanje implementacije integriranega varstva pred pleveli v Sloveniji - se poraba herbicidov res zmanjšuje?

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Intenzivna kmetijska pridelava se v zadnjih desetletjih sooča z velikimi izzivi kako zmanjšati odvisnost od uporabe sintetičnih pesticidov. Kljub ambicioznim ciljem in precejšnjimi napori vloženimi tako v zakonodajni okvir, kakor tudi podporo raziskavam s tega področja. Zadnji podatki nakazujejo, da se poraba sintetičnih pesticidov v večini evropskih držav ni bistveno zmanjšala. Implementacija intergriranega pristopa uravnavanja plevelne vegetacije v okviru direktive o trajnostni rabi pesticidov je v zadnjem obdobju zastala in obstaja vse več pokazateljev, da je izvajanje strategij uravnavanja plevelne vegetacije z manjšimi vnosi herbicidov v praksi zelo omejeno. Z namenom preučevanja sociološkega vidika povezanega z odločitvami o uporabi postopkov uravnavanja plevelne vegetacije smo na Kmetijskem inštitutu Slovenije v letu 2019 pripravili anketo, ki bi osvetlila ovire za privzem bolj trajnostnih praks uravnavanja plevelne vegetacije, z manjšo porabo herbicidov. Rezultati analize so pokazali, da vlada pri naših kmetijskih pridelovalcih visoka stopnja ozaveščenosti o ekološki vlogi plevelov, načinih zatiranja le-tega ter naboru obstoječih strategij integriranega pristopa uravnavanja plevelne vegetacije. Kmetijski pridelovalci so mnenja, da so tveganja povezana s stroški in izgubo pridelka ter slaba opremljenost s kmetijsko mehanizacijo glavni dejavniki, ki vplivajo na njihove odločitve o izbiri načina zatiranja plevela. Čeprav podatki o količinski prodaji herbicidov v zadnjih desetih letih kažejo ugoden trend njihovega zmanjševanja, v zadnjem obdobju prihaja do precejšnjih sprememb v strukturi rabe posameznih aktivnih snovi povezanih predvsem z zakonodajnimi omejitvami na vodovarstvenih območjih. V primerjalni analizi prodaje in rabe aktivnih snovi za zatiranje plevelov koruzi med leti 2011 in 2018 so rezultati pokazali, da je po letu 2014 poraba triazinskih herbicidov upadla kar za polovico. Nasprotno pa se je v istem obdobju poraba herbicidov iz skupine izoksazolov, z bistveno manjšim odmerkom aktivne snovi na hektar, povečala kar za štirikrat. Naši izsledki nakazujejo, da je v Sloveniji velika potreba po zbiranju podatkov o realni rabi herbicidov in razvoju indikatorja, ki ne bo temeljil na volumenski oziroma utežni prodaji ampak porabi stadardnih odmerkov aktivne snovi na enoto površine.

ABSTRACT

Implementation status of integrated weed management in Slovenia - is herbicide use really decreasing?

Intensive agricultural production is facing a major challenge how to reduce dependence on the use of synthetic pesticides aand significant efforts were invested in both, the legislative framework and and the support of research in this area.However, recent data suggest that in majority of European countries the consumption of synthetic pesticides has not significantly decreased. Furthermore, the implementation of Integrated weed management within the Sustainable Pesticides Directive has been slow and there is increasing evidence that the use of weed management strategies in practice is rather limited. In order to study the sociological aspect related to weed management decisions and highlight the bariers to the adoption of more sustainable weed management practices with lower herbicide inputs, a survey was conducted by the Agricultural Institute of Slovenia in 2019. Analysis of the farmers responses showed that the majority of our agricultural producers are highly aware about environmental benefits of the weeds and the available conventional and integrated weed management control tools. The survey also revealed, that the farmers consider weed control costs, yield losees due to weeds and the lack of machinery for weed control as the main factors influencing their weed management decisions. Although the herbicide sales data in the last decade showed a decreasing trend, legislative restrictions in the recent period considerably altered the structure of active ingredient consumption. Results of a comparative analysis of the active ingredients used for weed control in maize for a period between 2011 and 2018 showed that, from 2014 onwards, the sales and consumption of triazine group herbicdes was reduced by half due to the imposed ban in the water protection areas. Their use was largely subsituted by the isoxazole group herbicides, where fourfold increase in their consumption was identified for the observed period. Furthermore, a significantly lower dose of active ingredient per unit of area is needed for isoxazole herbicides. Our results indicate that there is a great need in Slovenia to collect field or survey based herbicide consumption data which will facilitate development of indicators not based on a weight/volume sales data but rather on the number of applications of standard dose per unit area.

Rezultati ankete glede izvajanja pranja naprav za nanos fitofarmacevtskih sredstev

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V obdobju od 2019 do 2021 smo v okviru TOPPS demonstracijskih delavnic za prikaz metod pranja naprav za nanos fitofarmacevtskih sredstev (FFS) izvedli anketo v kateri je sodelovalo 395 profesionalnih uporabnikov FFS (190 aktivnih v pridelavi poljščin in vrtnin in 105 aktivnih v trajnih nasadih). 70 % anketiranih je bilo iz vzhodne in osrednje Slovenije. Z anketo smo želeli pridobiti informacije o poznavanju tehničnih postopkov pranja, o mestu izvedbe pranja in o ravnanju z vodo, ki nastane pri pranju naprav. Rezultati kažejo, da manj kot polovica uporabnikov FFS pranje izvaja na njivi ali v trajnih nasadih, ko zaključijo nanos FFS in da skoraj polovica anketiranih vodo od pranja sprosti na kmetiji v neustreznih točkah (npr. na gramozno pot ali pa na površine, ki so povezane preko odtokov s površinskimi vodami). Ugotovili smo primanjkljaj znanja o pravilni izvedbi pranja in zabeležili želje po posodobitvi naprav, ki pa je otežena zaradi slabih finančnih razmer na kmetijah. Precej verjetno je, da določene najdbe ostankov FFS v površinskih in podtalnih vodah izvirajo iz neustreznih načinov pranja naprav na dvoriščih številnih kmetij. S trenutnim stanjem glede izvedbe pranja naprav za nanos FFS ne moremo biti zadovoljni. Potrebno je dodatno izobraževanje in posodobitev opreme.

ABSTRACT

Results of the survey regarding the performance of cleaning of equipment for the application of plant protection products

In the period from 2019 to 2021, as part of TOPPS demonstration workshops intended to demonstrate the methods of cleaning of equipment for application of plant protection products (PPPs), we conducted a survey in which 395 professional PPP users participated (190 active in crop and vegetable production and 105 active in permanent crop production). 70% of respondents were from eastern and central Slovenia. The aim of the survey was to obtain information on the knowledge of technical cleaning procedures, about the place of washing and about the handling of water generated during the cleaning of equipment. The results show that less than half of PPP users clean their equipment in the field or in permanent crops when they have finished PPP application, and that almost half of respondent's release water from cleaning on the farm at inappropriate points (e.g. on a gravel path or on areas which are connected to surface or underground waters via drainage or sewer system). We found a lack of knowledge about the correct performance of cleaning and recorded a desire of farmers to modernize their equipment, which is hampered by poor financial conditions on farms. It is quite probable that certain findings of PPP residues in surface and groundwater originate from inappropriate cleaning methods in the yards of many farms. We cannot be satisfied with the current situation regarding the cleaning of PPP application equipment. Additional training and equipment upgrades are needed.

Učinkovitost alternativnih sredstev za zatiranje plevelne vegetacije na železniški infrastrukturi

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Uporaba glifosata predstavlja že več desetletij učinkovit in stroškovno ugoden postopek za zatiranje plevelne vegetacije na železniški infrastrukturi tako v Sloveniji, kakor tudi drugod po svetu. S 1. aprilom 2021 je v Sloveniji stopila v veljavo nova zakonodaja, ki prepoveduje uporabo fitofarmacevtskih sredstev za zatiranje plevela na javnih površinah ter infrastrukturi, kot so ceste in železnice. V obdobju med julijem in oktobrom leta 2021 je bila na šestih lokacijah izvedena terenska raziskava preučevanja alternativnih pripravkov za zatiranje plevelne vegetacije na železniški infrastrukturi. V raziskavo so bili vključeni pripravek z aktivno snovjo na osnovi pelargonske kisline (680 g/L) ter pripravek, ki vsebujejo mešanico mravljinčne in citronske kisline (25 g/L + 30 g/L), v različnih volumnih škropilne brozge (250 L/ha and 350 L/ha) in v različnih terminih uporabe. Vsi postopki z alternativnimi pripravki so bili primerjani z uporabo glifosata (1800 g a.s./ha) kot standardnega postopka pred uvedbo prepovedi uporabe FFS na javnih površinah ter gospodarski in javni infrastrukturi. Naši rezultati nakazujejo, da ima uporaba alternativnih pripravkov na osnovi organskih kislin omejeno učinkovitost delovanja na večino plevelnih vrst prisotnih na poskusnih lokacijah železniške infrastrukture. Učinkovitosti delovanja alternativnih pripravkov v zgodnjem terminu ocenjevanja (po 10 dneh) večinoma ni presegla 60 % in je v mesecu dni padla na vrednosti med 10 in 20 %. Na vseh poskusnih lokacijah so bile površine, kjer smo uporabili glifosat tudi po šestih tednih ustrezno čiste,

medtem ko je bilo tudi v postopkih z zaporedno (dvojno) uporabo alternativnih sredstev že opazen ponoven razvoj plevelne vegetacije. Izjemi sta bili le lesnata vrsta navadna trdoleska (*Euonymus europaeus* L.) in trdovratna večletna njivska preslica (*Equsiteum arvense* L). Iz rezultatov je moč sklepati, da preučevana kontaktna sredstva na osnovi organskih kislin tudi ob večkratni uporabi ne dosegajo ravni učinkovitosti primerljive z enim odmerkom glifosata.

ABSTRACT

Efficacy of the alternative herbicides for weed management on the railway infrastructure

The use of glyphosate has been for several decades an effective and cost-effective weed control practice on railway infrastructure. From 1st of the April 2021, new legislation came into force in Slovenia, which prohibits the use of plant protection products for weed control in public areas and infrastructure, such as roads and railways. In the period between July and October 2021, a field study was conducted at six locations to study the efficacy of alternative products for weed control on railway infrastructure. The study included a product with the active substance based on pelargonic acid (680 g/L) and a product containing a mixture of formic and citric acid (25 g/L + 30 g/L). Treatments also included different application timings and two spray volumes (250 L/ha and 350 L/ha). All treatments with alternative products were compared to glyphosate (1800 g a.i./ha) as a standard procedure before the introduction of the new legislation. Our results suggest that the use of alternative products based on organic acids has limited efficacy on most of the weed species present at experimental sites. The efficacy of alternative products in the early evaluation period (after 10 days) did not exceed 60 % and dropped to between 10 and 20 % in a following month. At all experimental sites, weed control with glyphosate was effective even after six weeks, while the re-growth of weed vegetation was not prevented even in the treatments with sequential use of alternative products. The only exceptions were the woody species spindle tree (*Euonymus europaeus* L.) and difficult to control perennial species common horsetail (*Equsiteum arvense* L). Our results indicate that the studied contact herbicide products, based on organic acids, do not reach a required level of efficiency comparable to a single application of glyphosate even if they are applied repeatedly in high dosages.

Revysol, inovacija, ki prinaša revolucijo v varstvu rastlin

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Aktivna snov Revysol® je inovacija, ki prinaša resnične koristi za proizvajalce in izpolnjuje vse zahteve sodobne kmetijske proizvodnje. Predstavnik nove generacije triazolov, ki zahvaljujoč Flexi Power mulekulo prinaša edinstven način delovanja v varstvu rastlin, prilagojen najvišjim regulativnim standardom. Flexi Power molekula vsebuje "izopropanolično povezavo" z enostavno prilagoditvijo na kraj delovanja. Poleg vpliva na široko paleto bolezni prinaša tudi novo dimenzijo kurativnega dolgotrajnega delovanja neodvisno od temperatur in UV sevanja. Revysol® je še posebej učinkovit pri nadzoru glivičnih bolezni pri žitih. Nekatere bolezni, kot je septoria, je zaradi razvoja odpornosti

vse težje nadzorovati, vendar smo zaradi testov v lokalnih pogojih proizvodnje sposobni ponuditi najboljšo zaščito brez tveganja negativnega vpliva škodljivih podnebnih razmer. Proizvod Revycare® vsebuje aktivni snovi Revisol® in piraklostrobin in je tako zanesljiva rešitev za raznolik segment proizvajalcev. Revycare® prinaša veliko prožnost v različnih pogojih uporabe. Zaradi izjemnih kemijskih lastnosti bo Revysol® imel ključno vlogo pri zaščiti pridelkov zdaj in v prihodnosti.

ABSTRACT

Revysol®, an innovation that brings revolution in plant protection

Active substance Revyso®® is an innovation that brings real benefits to producers and meets all the requirements of modern agricultural production. Representative of the new generation of triazoles, which thanks to Flexi Power mulecula brings a unique way of working in plant protection, adapted to the highest regulatory standards. Flexi Power molecule contains an "isopropanolyte connection" by easily adjusting to the place of action. In addition to the impact on a wide range of diseases it also brings a new dimension of curative long-term action independent of temperatures and UV radiation. Revysol® is particularly effective in controlling fungal diseases in cereals. Some diseases, such as septoria, are becoming increasingly difficult to control due to the development of resistance, but due to tests in local production conditions we are able to offer the best protection without the risk of adverse climate impact. Revycare® contains the active substances Revisol® and piraclostrobin and is thus a reliable solution for a diverse segment of manufacturers. Revycare® brings great flexibility in different conditions of use. Due to its exceptional chemical properties, Revysol® will play a key role in protecting crops now and in the future.

Problematika omejevanja in prepovedi rabe FFS

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Za uspešno varstvo rastlin, ki je temelj prehranske varnosti vsake države, potrebujemo čim širši nabor FFS. Ker imamo v Sloveniji več kot polovico manj dovoljenih aktivnih snovi (209) kot na nivoju EU (454), si dodatnih omejitev registracij ne moremo privoščiti. Znano je, da nove tehnologije in rešitve ne bodo v celoti nadomestile izgube obstoječih FFS. Njihova implementacija je dolgotrajna in povezana spremembami regulatornega okvira. Zato je pred sprejetjem kakršnihkoli ukrepov v povezavi z EU zelenim dogovorom nujno narediti analizo učinkov na slovensko kmetijstvo ter zagotoviti alternative in prenos znanja pridelovalcem.

ABSTRACT

The issue of limiting and banning the use of plant protection products

For successful plant protection, which is the basis of each country's food security, we need the widest possible range of plant protection products (PPP). In total, 454 active

substances are available to farmers on EU level, in Slovenia only 209. Since Slovenian farmers have access to less than half of EU authorized active substances, we cannot afford additional registration restrictions. It is well known that new technologies and solutions will not fully compensate for the loss of existing PPP. Their implementation is a long-term and related to change in the regulatory framework. Therefore, before taking any measures in connection with EU Green Deal, it is essential to carry out an analysis of the effects on Slovenian agriculture, as well as to provide alternatives and transfer of knowledge to producers.

Splošna sekcija

IVR.si: predstavitev in novosti na spletnem portalu integrirano varstvo rastlin

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Integrirano varstvo rastlin (IVR) temelji na povezovanju vseh razpoložljivih metod varstva rastlin ukrepov v celovit, trajnostno naravnan program, ki zmanjšuje tveganja za gospodarnost kmetijske pridelave ter zdravje ljudi in okolja. IVR je živ proces, ki združuje tradicionalna znanja ter izkušnje in je hkrati odprt za nove ideje, znanstvena spoznanja in tehnološki napredek. Prenos znanja in informacij je ključen za spodbujanje kmetijske pridelave z uporabo načel IVR in hkrati eden izmed pomembnih ciljev sprejetega nacionalnega akcijskega programa za doseganje trajnostne rabe fitofarmacevtskih sredstev (NAP). Spletni viri danes predstavljajo ključen vir informacij in usmeritev tudi v kmetijstvu in z njim povezanih dejavnostih. Na spletnem portalu IVR (https://www.ivr.si/) so zbrane informacije o škodljivih organizmih, priporočila za njihovo zatiranje in številne druge aktualne vsebine s področja zdravstvenega varstva rastlin. Spletna stran deluje od leta 2017 in je v slovenskem prostoru prepoznana kot osrednja spletna podatkovna zbirka s področja varstva rastlin, ki je neprestano na voljo pridelovalcev, svetovalcem ter drugi zainteresirani javnosti. Vsebina se sproti razvija in dopolnjuje z novimi informacijami, ki temeljijo na pripravi specifičnih smernic za varstvo posameznih kultur, s poudarkom na nekemičnih metodah varstva rastlin in drugih ukrepih s katerimi lahko zmanjšamo porabo fitofarmacevtskih sredstev.

ABSTRACT

IVR.si: presentation and updates of the web portal on integrated pest management

Integrated Plant Protection (IPM) is based on integrating all available plant protection methods into a comprehensive, sustainable program that reduces economic risks in agricultural production and protect human health and the environment. IPM is a living process that combines traditional knowledge and experience and is open to new ideas, scientific and technological progress. The transfer of knowledge and information is crucial for the promotion of integrating IPM principles in the agricultural practice which is also one of the main goals of the adopted National Action Program for sustainable use of plant protection products (NAP). Today, internet sources are a key source of information and guidance in agriculture and related activities. The IVR web portal (https://www.ivr.si/) contains information on plant pests and diseases, recommendations for their control and many other contents related to plant health. The website has been operating since 2017 and is recognized as the central online database in the field of plant protection in Slovenia, which is constantly available to growers, consultants and other interested public. The content is constantly evolving and updated with new information based on the preparation of specific guidelines for the protection of different crops, with emphasis on non-chemical methods of plant protection and other measures that could contribute to reducing the use of plant protection products.

Study on entomopathogenic nematodes in Bosnia and Herzegovina

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Entomopathogenic nematodes (EPN) are extensively used as biological control agents for several decades. Research on EPN in Bosnia and Herzegovina started a decade ago and included a survey on the presence and evaluation of their potential against some insect pests. The survey revealed EPN presence of four species *Steinernema feltiae, S. carpocapsae, S. kraussei* and *H. bacteriophora.* Laboratory and field studies were conducted with the aim to evaluate the potential of commercial and local EPN strains against plum sawflies (*Hoplocampa flava* and *H. minuta*), cherry fruit fly (*Rhagoletis cerasi*), buxus moth (*Cydalima perspectalis*) codling moth (*Cydia pomonella*) and ragweed weevil (*Ophraella communa*). The staudies revealed potential of EPN in bicontrol of some insects pests, but their application must be done at specific stage of the life cycle of insects and ecological conditions.

IZVLEČEK

Študija o entomopatogenih ogorčicah v Bosni in Hercegovini

Entomopatogene ogorčice (EPN) se že več desetletij uporabljajo kot biotični agensi za zatiranje škodljivih žuželk. Raziskave o EPN v Bosni in Hercegovini so se začele pred desetletjem in so vključevale raziskavo o njihovi zastopanosti in oceni njihovega potenciala proti nekaterim škodljivim žuželkam. Raziskava je pokazala na zastopanost EPN štirih vrst, *Steinernema feltiae, S. carpocapsae, S. kraussei* in *H. bacteriophora*. Laboratorijske in terenske študije so bile opravljene z namenom oceniti potencial komercialnih in lokalnih sevov EPN proti vrstam *Hoplocampa flava* in *H. minuta*, *Rhagoletis cerasi*, *Cydalima perspectalis*, *Cydia pomonella* in *Ophraella communa*. Študije so razkrile potencial EPN pri biotičnem zatiranju nekaterih škodljivih žuželk, vendar jih je treba uporabljati v določenih razvojnih stadijih žuželk in ustreznih ekoloških razmerah.

Bakterija Dickeya fangzhongdai - ali ogroža tudi naše rastline?

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Bakterijski rod *Dickeya* združuje izolate, ki povzročajo bolezen mehkih gnilob številnih gostiteljskih rastlin, vključno s pomembnimi poljščinami in okrasnimi rastlinami. *Dickeya fangzhongdai* je prva vrsta iz rodu *Dickeya*, o kateri poročajo, da lahko okuži drevesa. Opis vrste je prvotno temeljil na treh bakterijskih izolatih, ki so na azijskih hruškah na Kitajskem povzročali razjede lubja z izcedkom. Od takrat so o novih sevih vrste *D. fangzhongdai* poročali z različnih predelov sveta. Številni izolati iz zelnatih rastlin nakazujejo, da je njena sposobnost okuževanja dreves najbrž razmeroma nova prilagoditev. Glede na poročila je bakterija razširjena v Aziji, vendar se sporadično pojavlja tudi širše, na drugih celinah. *D. fangzhongdai* ni uvrščena na seznam karantensko škodljivih organizmov, niti ni predmet nadzora znotraj držav EU. Zaradi pomanjkanja specifičnega testiranja na prisotnost povzročiteljev bolezni, kot je *D. fangzhongdai*, vnosi najverjetneje

ostajajo neopaženi. Za ustrezno soočanje z omenjenimi izzivi smo razvili diagnostično orodje na osnovi molekularne detekcije, ki omogoča specifično in zanesljivo določanje *D. fangzhongdai*. Razviti test smo uporabili za izvedbo presejalnega testiranja prisotnosti bakterije v slovenskem okolju, na gojenih rastlinah in v vodah.

ABSTRACT

***Dickeya fangzhongdai* – a threat to plants in Slovene environment?**

The genus *Dickeya* groups diverse isolates that cause soft-rot disease in a wide variety of plant species, including economically important crops and ornamental plants. Until recently reports of soft-rot disease caused by the genus *Dickeya* have been limited to herbaceous plants. *Dickeya fangzhongdai* is the first *Dickeya* species reported to infect trees, causing bleeding canker necrosis. The description of the species was based on three isolates from pear trees in China. Since then, a number of strains of *D. fangzhongdai* were reported from various geographical origins, associated with soft rot symptoms of many herbatious plants, thereby indicating that its ability to infect trees may be a relatively novel adaptation. Bacteria seems to be established in Asian environment and is continuously introduced further. . *D. fangzhongdai* does not have a quarantine pathogen status nor is monitored in EU. The lack of testing that provide specific detection of *D. fangzhongdai* species, it can be easily overlooked. Therefore, its introductions can very well stay unnoticed. To address stated problems, we have developed a diagnostic tools that enable specific and reliable monitoring the presence and spread of *D. fangzhongdai*. The developed screening test was used for assessment of *D. fangzhongdai* presence in Slovene environment, screening cultivated plants and water sources.

Uporaba črtnih kod DNA za identifikacijo različnih bakterijskih vrst iz rodu *Pantoea*

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Bakterija *Pantoea stewartii* subsp. *stewartii* povzroča bakterijsko uvelost koruze. Je avtohtona na ameriškem kontinentu. Beležimo tudi nekaj najdb v Evropi. Bakterijo smo v omejenem obsegu v okviru letnih programov preiskav, ki jih koordinira UVHVVR, nekajkrat zaznali tudi v pridelavi koruze v Sloveniji. Pri listih koruze z madeži smo ob tem pogosto naleteli tudi na druge bakterije rodu *Pantoea*, katerih pomen še ni popolnoma razjasnjen. Med njimi so tudi znani rastlinski patogeni kot je *P. ananatis,* ki okužuje veliko gospodarsko pomembnih rastlin in dreves po svetu. Za identifikacijo različnih bakterij iz rodu *Pantoea* smo preizkusili določane DNA črtnih kod. Uporabili in primerjali smo dva para oligonukleotidnih začetnikov za pomnoževanje in določane zaporedja dela gena *recA* (Wensing in sod., 2010; Cesbron in Manceau, 2010). Uspelo nam je pridobiti zaporedja *recA*, ki so omogočila identifikacijo vrst bakterij za veliko večino izolatov iz rodu *Pantoea*. Pri tem smo ugotovili, da sta za uspešno karakterizacijo potrebna oba para oligonukleotidnih začetnikov, saj se razlikujeta v specifičnosti. V listih koruze smo potrdili

prisotnost *P. stewartii* subsp. *stewartii*, *P. agglomerans* in *P. ananatis*, ki je eden od pomembnejših povzročiteljev bolezni koruze v južni Ameriki. Uporaba različnih oligonukleotidih začetnikov je zamudna in oteži interpretacijo rezultatov, zato bi bilo smiselno v prihodnje razviti test, s katerim bi lahko identificirali večji nabor bakterijskih vrst iz rodu *Pantoea.* Program preiskave se predvidoma nadaljuje tudi v naslednjih letih.

ABSTRACT

The use of DNA barcoding for the detection of different bacterial species of the genus *Pantoea*

The bacterium *Pantoea stewartii* subsp. *stewartii* is the causal agent of bacterial leaf blight of maize and is native to America. However, some findings have also been made in Europe. The bacterium has also been detected during the regular annual monitoring of maize production coordinated by the UVHVVR. Other bacteria from genus *Pantoea* have also been frequently encountered on leaves of symptomatic maize, the effects of which are not yet fully understood. These include well-known plant pathogens such as *P. ananatis*, which infects many commercially important plants and trees around the world. We used DNA barcoding to identify bacteria of the genus *Pantoea*. Two pairs of oligonucleotide primers which amplifying sequence of the *recA* gene were used (Wensing et al. 2010; Cesbron and Manceau 2010). We were able to obtain sequences of the *recA* gene that allowed the identification of most isolates from the genus *Pantoea*. It was found that both pairs of oligonucleotide primers are required for successful identification, as they differ in specificity. In the isolates from maize leaves, we confirmed the presence of *P. stewartii* subsp. *stewartii*, *P. agglomerans* and *P. ananatis*, one of the main causal agents of maize diseases in South America. The use of two different primer pairs is time consuming and complicates the interpretation of the results. This suggests the need for a new assay that allows simultaneous detection of a greater number of bacterial species. It is planned to continue the monitoring program in the following years.

Uporaba visokozmogljivega sekvenciranja za iskanje karantenskih rastlinskih virusov

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Posebno tveganje za kmetijstvo predstavljajo karantenski škodljivi organizmi, ki v EU niso navzoči ali pa so navzoči v omejenem obsegu. Če so vneseni v novo okolje, so praviloma zelo invazivni in lahko negativno vplivajo na: gospodarstvo, kmetijstvo, naravo in biotsko raznovrstnost, za družbo pa imajo lahko hude socialne posledice. Med njimi so številni virusi, za katere ni niti vpeljanih niti razvitih ustreznih tarčnih diagnostičnih metod. Razvoj posameznih tarčnih metod za vse te viruse pa bi bil časovno in cenovno precej potraten. V tem primeru je najbolj smiselno uporabiti metodo, s katero lahko ne-tarčno ugotovimo

prisotnost kateregakoli virusa. Z uporabo generične metode, kot je visokozmogljivo sekvenciranje (HTS), lahko določimo nukleotidno zaporedje vsem nukleinskim kislinam v preiskovanih vzorcih in tako znotraj ene preiskave ne-tarčno zaznamo tudi morebitne viruse. V preteklosti smo na tak način analizirali rastlinske vrste z nepojasnjenimi bolezenskimi znaki, pri katerih s klasičnimi tarčnimi metodami nismo zaznali patogenih mikrobov, ter na ta način odkrili nove ali nepričakovane znane viruse. Ena prvih najdb je bil virus mozaika zobnika (HMV), ki je bil prvič odkrit na novem gostitelju – paradižniku, in prvič v Sloveniji. Z uporabo HTS smo nato odkrili viruse, ki so smo jih zaznali prvič v Sloveniji: virus Y zelene (ApVY) in virus ozkolistnosti korenja (CTLV) na peteršilju ter z listnimi ušmi prenosljivi virus rumenice buče (CABYV) na oljni buči in buči velikanki. Odkrili smo tudi virus bele lisavosti zlatice (RWMV) na novem gostitelju (paradižniku). Do sedaj je sekvenciranje potekalo pri zunanjem izvajalcu na platformi Illumina, vendar ker je časovno dolgotrajno, smo uvedli HTS sekvenciranje v našem laboratoriju, z uporabo sekvenatorja MinION (Oxford Nanopore Technologies), pri čemer so rezultati na voljo bistveno (4x) hitreje. Trenutno je v teku validacija te tehnologije. V prispevku bodo predstavljeni trenutni primeri uporabe HTS (sekvenciranje kumulativnih diagnostičnih vzorcev) za namen ugotavljanja prisotnosti karantenskih rastlinskih virusov.

ABSTRACT

The use of high-throughput sequencing for detection of quarantine plant viruses

Quarantine pests, which are not present in the EU or are present to a limited extent, pose a particular risk to agriculture. When introduced into a new environment, they tend to be highly invasive and can have a negative impact on the economy, agriculture, nature and biodiversity, as well as having serious social consequences for society. Among them, there are a number of viruses for which appropriate targeted diagnostic methods have not been established or do not exist. Developing individual target methods for all these viruses would be very time consuming and costly. In this case, it makes the most sense to use a method that can detect the presence of each virus in a non-targeted manner. Using a generic method such as high-throughput sequencing (HTS), we can determine the nucleotide sequence of all nucleic acids in the test samples and thus detect potential viruses in a single test in a non-targeted manner. In the past, we have used this approach to analyze plant species with unexplained disease symptoms in which no pathogenic microbes could be detected using classical target methods, and in this way discovered new or unexpected known viruses. One of the first finds was henbane mosaic virus, which was discovered on a new host, tomato, and for the first time in Slovenia. With HTS we have also detected for the first time in Slovenia apium virus Y and carrot thin leaf virus on parsley, and cucurbit aphid-borne yellows virus on cucurbita pepo and cucurbita maxima. We also detected ranunculus white mottle virus on a new host (tomato). Previously, HTS sequencing was outsourced using the Illumina platform. However, as this is very time consuming, we have introduced HTS sequencing in our laboratory using a MinION sequencer (Oxford Nanopore Technologies), with which results are available significantly (4x) faster. Validation of this technology is currently underway. We will present examples of the use of HTS (sequencing of bulk samples) for the detection of quarantine plant viruses.

Agrometeorološki portal Slovenije kot informativno okno za prognozo škodljivih organizmov rastlin

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V Sloveniji deluje prognostična služba za varstvo rastlin kot del javne službe zdravstvenega varstva rastlin pod okriljem Uprave za varno hrano, veterinarstvo in varstvo rastlin (UVHVVR). 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, 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). Osnovo pri napovedih za varstvo rastlin pred glavnimi gospodarsko škodljivimi organizmi v vinogradništvu, sadjarstvu, hmeljarstvu, oljkarstvu, poljedelstvu in vrtnarstvu predstavljajo meritve iz agrometeoroloških postaj, ki so povezane v agrometeorološko mrežo UVHVVR. Podatki postaj in različni izračuni so uporabnikom dostopni na Agrometeorološkem portalu Slovenije (AGROMET) v realnem času in brezplačno. V obdobju 2021 do 2022 je bil portal v celoti prenovljen glede na nove trende in dostopnosti podatkov. Prenovljen je bil tudi podatkovni model sistema. V portal so dodatno vključene meritve postaje ARSO in DRSI ter nekatere druge, ki dopolnjujejo mrežo UVHVVR. Dodani so prostorski prikazi meritev in opazovanj. Vključen je sistem za podporo pri izvajanju ukrepov proti pozebi in njenih posledicah. Agrometeorološki portal Slovenije (AGROMET) je vzpostavljen z namenom, da ima uporabnik na enem mestu dostop do informacij, ki jih potrebuje: podatki, prognostična obvestila ter uporabne informacije glede na podnebne spremembe, suše in namakanja, zato predstavlja informativno okno za prognozo škodljivih organizmov.

ABSTRACT

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

In Slovenia, forecasting plant protection service have been operating as part of public plant health service under the frame of Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection (AFVSPP). The main goals are 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). The measurements from agrometeorological stations, which are connected into the agrometeorological network of AFVSPP are the basis for the prognostic notices at viticulture, fruit growing, hop growing, olive growing, agriculture and horticulture. Station data and different calculations are available to users via the Slovenian

Agrometeorological portal (AGROMET) in real time and free. In the period 2021-2022, the portal was completely renewed according to new trends and data availability. Data model was changed and upgraded. Measurements from ARSO and DRSI stations and some others are also included and thereby complement network of AFVSPP. Spatial presentation of measurements and observations is now available. Data support in frost protection is also included. The Slovenian Agrometeorological portal has been established with the aim of providing the user with all available data in one place, includes forecast notifications and useful information regarding climate change, drought and irrigation and thus represent as informational window for the weather-based prognosis of pests.

Digitalizacija spremljanja in napovedovanja gospodarsko pomembnih škodljivih žuželk, kot ena od rešitev za nove zahteve v varstvu rastlin

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V zadnjem času opažamo tri ključne dejavnike, ki drastično spreminjajo pristop v varstvu rastlin: 1. Zahteve povezane s trajnostjo (ter posledično ukinjanjem obstoječih pripravkov), 2. Spreminjajoče klimatske razmere in s tem povezanimi boljšimi pogoji za gospodarsko pomembne škodljivce ter 3. Pogosti pojavi novih/invazivnih vrst škodljivcev. Pri vseh primerih je pomembno, da znamo na nivoju posamezne kmetije oz. pridelovalnega zemljišča razumeti kdaj, kje in kako velik (če sploh) bo problem povezan z določenim škodljivcem. Na ta način lahko zelo učinkovito naslovimo enega ključnih strahov pridelovalca: "Ali sem se pravilno odločil?" V prispevku bomo na treh primerih predstavili, kako so uporabniki s pomočjo digitalnih rešitev (sistemom Trapview) uspeli nasloviti nekatere ključne izzive pri spopadanju s škodljivci. Ti primeri so: pridelava jabolk v Franciji (pomembno zmanjšanje škropljenj); pridelava oljk v Italiji (prehod na nova sredstva za varstvo rastlin) ter spremljanje in napovedovanje grozdnih sukačev na obmejnem območju med Slovenijo in Italijo.

ABSTRACT

Digitalization of monitoring and forecasting pest insects as one of responses to new crop protection requirements

Three key drivers that significantly change crop protection strategies have emerged recently: 1. Sustainability (and expired registration of some of key active ingredients), 2. Climate changes (especially higher temperatures) that are more favorable for pest insect development and 3. New/invasive pest insect species. In all cases it's crucial to understand – on farm level – where, when and how big will be the pest insect problem. In that way we can efficiently address one of the key fears of a grower: "Did I make the right decision?". Article will focus on three cases where users were able to successfully address some of the key challenges related to pest insects using digital solution (Trapview system). These examples are: apple growing in France (significant spraying application reduction); olive production in Italy (transition to new crop protection products) and grape/wine production in cross-border area between Slovenia and Italy (monitoring and forecasting of grape berry moth population).

Varstvo gozdnega drevja

Varstvo gozdov v območnih gozdnogospodarskih načrtih

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Slovenija ima bogato tradicijo načrtnega upravljanja z gozdovi. Z gozdarskim načrtovanjem uresničujemo cilje trajnostnega, sonaravnega in večnamenskega gospodarjenja z gozdovi. V letu 2021 poteka obnova območnih gozdnogospodarskih in lovskoupravljavskih načrtov. Ti načrti bodo usmerjali razvoj slovenskih gozdov v obdobju 2021-2030. V postopku priprave načrtov se na podlagi opisa in razvoja gozdov izvede presoja doseganja ciljev in učinkovitosti gospodarjenja v preteklem obdobju, opredeli se glavne probleme pri gospodarjenju z gozdovi. Izvede se valorizacija proizvodnih, ekoloških in socialnih funkcij gozdov, v postopku katere se usklajuje številne interese, ki jih lastniki gozdov in družba od gozdov pričakuje. Določijo se cilji, usmeritve in ukrepi za nadaljnje 10-letno gospodarjenje z gozdovi. Opredelijo se nevarnosti oziroma tveganja pri gospodarjenju z gozdovi, ki v prihodnjem desetletju lahko ogrozijo postavljene cilje. Varstvu gozdov se v okviru gozdnogospodarskega načrtovanja namenja vedno večji pomen. Potrebe družbe po materialnih in nematerialnih dobrinah iz gozda so vse večje, na drugi strani pa so gozdovi vse bolj ogroženi, v prvi vrsti zaradi podnebnih sprememb ter zaradi povečanja obsega globalne trgovine. Varstvo gozdov je najbolj učinkovito, če je integrirano v redno gospodarjenje z gozdovi, s poudarkom na preventivnih ukrepih. Seznam preventivnih ukrepov, ki povečujejo odpornost gozdov na pričakovane negativne vplive je dolg, v prvi vrsti pa gre za varovanje in povečevanje biotske pestrosti na vseh nivojih, kot je npr. oblikovanje strukturno pestrih gozdnih zgradb z rastišču prilagojeno drevesno sestavo in ohranjeno genetsko pestrostjo znotraj drevesne vrste, upoštevajoč spreminjanje rastiščnih razmer zaradi segrevanja ozračja. Potrebno je redno spremljanje zdravja gozdov, zagotavljanje sanitarnega poseka poškodovanih dreves in sanacijske obnove gozdov ter intenziviranje rednega gospodarjenje z gozdovi.

ABSTRACT

Forest protection in regional forest management plans

Slovenia has a rich tradition of planned forest management. Through forestry management planning, we achieve goals of sustainable, closed-to-nature and multifunctional forest management. In 2021, the renewal of regional forestry and hunting management plans is underway. These plans will guide the development of Slovenian forests in the period 2021-2030. Forest management plans describe the state of forests and their development trends. An assessment is made of the achievement of goals and efficiency of management in the past period, the main problems in forest management are identified. The valorisation of the productive, ecological and social functions of forests is being carried out, reconciling the many interests that forest owners and society expect from forests. Objectives, guidelines and measures for further 10-year forest management are determined. Threats and risks in forest management that may jeopardize the set goals in the next decade are identified. Forest protection is becoming increasingly important in the context of forest management planning. Society's needs for tangible and intangible goods from the forest are growing, but on the other hand, forests are increasingly endangered, mainly due to climate change and the icrease in global trade. Forest protection is most effective when it is integrated into regular forest management, with an emphasis on preventive measures. The list of preventive measures that increase the resilience of forests to the expected negative impacts is long. Primarily it is about protecting and increasing biodiversity at all levels, such as establishment of diverse forest structures with site-adapted tree composition and preserved genetic diversity within, taking into account site changes due to global warming. It is

necessary to regularly monitor the health of forests, ensure the sanitary felling of damaged trees and reestablishment of forests and to intensify regular forest management.

Prve najdbe nekaterih bolezni gozdnega drevja v Sloveniji v obdobju 2018–2020

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V zadnjih letih smo zabeležili več bolezni na gozdnem drevju, ki smo jih v Sloveniji opazili in o njih poročali prvič. V letu 2018 smo prvič opazili rjavo pegavost bukovih listov, ki jo povzroča gliva *Petrakia liobae*. Naredili smo teste patogenosti in potrdili patogenost glive *P. liobae* na listih *Fagus sylvatica*, *F. orientalis* in *Quercus petraea*. V laboratoriju je gliva povzročila nekroze tudi na listih *Castanea sativa*, vendar re-izolacija glive iz listov domačega kostanja ni bila uspešna. Ugotovili smo, da ima gliva potencialno večji nabor gostiteljev, kot je bilo znano do sedaj. Nadalje, leta 2019 smo na *Acer pseudoplatanus* prvič potrdili glivo *Cryptostroma corticale*, ki povzroča sajasto odmiranje skorje javorjev. S testi patogenosti smo potrdili njeno patogenost na gorskem javorju. Ugotovili smo tudi, da gliva veliko uspešneje naseljuje tkiva tistih rastlin, ki so pod sušnim stresom. Zato lahko glivo *C. corticale* uvrščamo med šibke, fakultativne patogene, ki povzročajo več škode v vročem in suhem vremenu. Najdba glive *C. corticale* je pomembna tudi zato, ker lahko povzroča hud preobčutljivostni pnevmonitis pri ljudeh. Ogroženi so predvsem delavci, ki imajo neposreden stik z okuženimi drevesi, t.j. gozdarji, sekači in delavci na žagah. Od 1990-ih do danes se je na večji del Evrope razširil jesenov ožig, ki ga primarno povzroča gliva *Hymenoscyphus fraxineus*. V Sloveniji smo značilne simptome jesenovega ožiga in glivo *H. fraxineus* potrdili leta 2006. Leta 2018 smo izvedli ponovno vzorčenje propadajočih jesenov na petih vzorčnih ploskvah, izolacijo in identifikacijo gliv z namenom, da bi ugotovili glavne povzročitelje jesenovega ožiga. Ugotovili smo, da je le manjši delež izolatov pripadal *H. fraxineus*, prevladovale so vrste iz družine Botryosphaeriaceae, najpogostejši pa sta bili *Diplodia fraxini* in *D. subglobosa*, ki sta bili obenem prvi najdbi teh gliv na velikem jesenu v Sloveniji. Rezultati študije nakazujejo, da je stanje propadanja jesenov sedaj posledica mnogih vpletenih gliv, kar nakazuje na kompleksno bolezen.

ABSTRACT

First reports of some forest tree diseases in Slovenia in the period 2018–2020

In the last few years, we recorded some forest tree diseases, that were reported in Slovenia for the first time. In 2018 leaf blotch of *Fagus sylvatica* caused by *Petrakia liobae* was first observed. Pathogenicity tests were performed, and we confirmed the pathogenicity of *P. liobae* towards *Fagus sylvatica*, *F. orientalis*, and *Quercus petraea*. The fungus also caused necroses on *Castanea sativa* leaves in vitro, but re-isolation of the fungus from the leaves of *C. sativa* was not successful. The results showed that *P. liobae* has potentially greater number of hosts that was know until now. Furthermore, in 2019 we identified *Cryptostroma corticale*, causal agent of sooty bark disease of Sycamore maple. With pathogenicity test we proved, that the fungus more successfully invades tissues of *Acer pseudoplatanus* that are under drought stress. Therefore, *C.*

corticale could be described as weak, opportunistic pathogen, that expresses itself under hot and dry periods. First report of *C. corticale* in Slovenia is also important, because the fungus can cause severe hypersensitivity pneumonitis in humans. Persons who have intensive occupational contact with infested trees, e.g., woodsmen, foresters, and sawyers are at particular risk. Since 1990s ash dieback has been spread to the most parts of Europe. Ash dieback is primarily caused by the fungus *Hymenoscyphus fraxineus*. In Slovenia, characteristic ash dieback symptoms and the fungus *H. fraxineus* was first observed in 2006. In 2018, a thorough study was conducted to isolate, identify, and characterize the main causal agents of ash dieback. Only a few symptomatic ash samples yielded colonies of *H. fraxineus*, whereas Botryosphaeriaceae species were isolated with a high frequency, with *Diplodia fraxini* and *D. subglobosa* as the dominant species. Both species were reported for the first time on European ash in Slovenia. The results suggest that current ash dieback is a result of coinfections by multiple pathogens suggesting a complex disease.

Najpogosteje izolirane vrste gliv v lesu odmrlih vej mladih gorskih javorov in vpliv nekaterih na *Eutypella parasitica*

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Eutypella parasitica R. W. Davidson and R. C. Lorenz je povzročiteljica javorovega raka, uničujoče bolezni javorov v Evropi in Severni Ameriki. Gliva *E. parasitica* verjetno okuži deblo gostitelja skozi odmrle veje ali rane v skorji. Zaradi morebitnega vpliva glivne združbe na okužbo in razrast *E. parasitica* smo na petih vzorčnih lokacijah v okolici Ljubljane preučili sestavo gliv v lesu odmrlih vej gorskega javora (*Acer pseudoplatanus* L.). Izvedli smo izolacije gliv v čiste kulture iz lesa v zunanjem delu odmrle veje in iz razbarvanega lesa v deblu, ki je izviral iz odmrle veje. Čiste kulture smo razvrstili v morfotipe in izbrali po eno reprezentativno kulturo na morfotip za nadaljnjo molekularno določitev. V širokem spektru gliv smo najpogosteje izolirali: *Eutypa maura* (Fr.) Sacc., *Eutypa* sp. Tul. and C. Tul., *Fusarium avenaceum* (Fr.) Sacc., *Neocucurbitaria acerina* Wanas., Camporesi, E.B.G. Jones and K.D. Hyde in *E. parasitica*. V raziskavi smo preverjali razlike v pestrosti glivnih vrst med različnimi lokacijami in debelinami vej. Analizirali smo tudi podobnost glivnih združb med različnimi vzorčnimi lokacijami in med različnimi mesti izolacije. *Eutypella parasitica* je bila izolirana iz vzorcev z vseh petih vzorčnih lokacij, kljub temu, da so bili primeri javorovega raka opaženi le na treh lokacijah, kar kaže na morebitne asimptomatske okužbe. V nadaljevanju smo izmerili tudi vpliv najpogostejših vrst gliv v lesu odmrlih vej gorskega javora na rast glive *E. parasitica* v čisti kulturi in ugotavljali njihov morebitni antagonizem. Na podlagi izračuna antagonističnega indeksa in uspešnosti reizolacij iz interakcijske cone smo ugotavljali potencial opazovanih antagonistov, kot možne biološke kontrole javorovega raka. Med zanimivejše izzivalne izolate lahko uvrstimo glivo *Neonectria* sp. Wollenw., ki se je izkazala za enega večjih inhibitorjev rasti *E. parasitica*. Obetaven pa je tudi rezultat neuspešnih reizolacij *E. parasitica* iz interakcijske cone. Z dodatnimi poskusi bi lahko podali trdnejše zaključke o medsebojnemu delovanju in učinkovanju vrst.

ABSTRACT

Frequently isolated fungi in wood of dead branches of young sycamore maple and the influence of some on *Eutypella parasitica*

Eutypella parasitica R. W. Davidson and R. C. Lorenz is the causative agent of Eutypella canker of maple, a destructive disease of maples in Europe and North America. The fungus *E. parasitica* infects the trunk probably through a branch stub or bark wound. Because the fungal community may have an impact on infection and colonization by *E. parasitica*, we investigated the composition of fungi colonizing wood of dead branches of sycamore maple (*Acer pseudoplatanus* L.) in five sampling sites near Ljubljana. Isolations were made from the wood in the outer part of dead branches and from discoloured wood in the trunk that originated from a dead branch. Pure cultures were divided into morphotypes, and one representative culture per morphotype was selected for further molecular identification. The most frequently isolated species in a broad spectrum of fungi were *Eutypa maura* (Fr.) Sacc., *Eutypa* sp. Tul. and C. Tul., *Fusarium avenaceum* (Fr.) Sacc., *Neocucurbitaria acerina* Wanas., Camporesi, E.B.G. Jones and K.D. Hyde and *E. parasitica*. In this study, we analysed differences in species diversity between the sampling sites and between the branch thickness classes. Furthermore, we analysed similarity of fungal communities between the sampling sites and between the isolation sources. *Eutypella parasitica* was isolated from all five investigated sampling sites, although Eutypella cankers were observed in only three sampling sites, indicating the possibility of asymptomatic infection. Furthermore, we tested the most frequently isolated fungi from the wood of the dead branches of *A. pseudoplatanus* in dual cultures to evaluate their *in vitro* antagonistic activity against *E. parasitica*. Based on calculating an index of antagonism and re-isolations success from the interaction zone the potential of the observed antagonists as a possible biocontrol of Eutypella canker of maple was discussed. *Neonectria* sp. Wollenw. is one of the most interesting challenge isolate which has been shown to be a good inhibitor of *E. parasitica* growth and especially successful in the interaction zone. Further experiments would provide stronger conclusions about the interactions and effects of species.

Sušenje orehov – iskanje vzrokov in verifikacija molekularne metode za določanje *Geosmithia morbida* v različnih tipih vzorcev

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Zadnja leta v Sloveniji opažamo sušenje orehov (*Juglans* spp.), ki se začne s sušenjem posameznih poganjkov in vej in postopoma zajame celo krošnjo. Drevesa se v večini primerov posušijo v le nekaj letih. Simptomi so zelo podobni tistim, ki jih povzroča bolezen tisočerih rakov, nevarna bolezen orehov, ki je posledica napada podlubnika *Pityophthorus juglandis* (orehov vejni lubadar) in okužbe z glivo *Geosmithia morbida*. Tako gliva kot podlubnik, ki je njen prenašalec (vektor), sta karantenska škodljiva organizma za Unijo, uvrščena v prilogo II, del B Izvedbene uredbe Komisije (EU) 2019/2072. Bolezen tisočerih rakov izvira iz ZDA, kjer povzroča obsežno sušenje različnih vrst orehov in s tem veliko gospodarsko škodo. Za bolezen so dovzetni orehi (*Juglans* spp.) in oreškarji (*Pterocarya* spp.). Bolezen je bila leta 2013 najdena v Italiji, v Benečiji, kjer je povzročila sušenje navadnega oreha (*J. regia*) in črnega oreha (*J. nigra*). Bolezen se širi

proti jugu in na zahod in je prisotna že v več italijanskih pokrajinah. Podlubnik pa je bil najden tudi v pasteh v Furlaniji Julijski Krajini, ki meji na Slovenijo. V Sloveniji izvajamo vsakoletne programe preiskav za ugotavljanje navzočnosti bolezni tisočerih rakov, oz. *G. morbida* in *P. juglandis*. Na celotnem slovenskem ozemlju izvajamo vizualne preglede z vzorčenjem gostiteljskih rastlin, na območjih ob slovensko-italijanski meji pa uporabljamo tudi feromonske pasti. Pri diagnostiki *G. morbida* izvajamo izolacijo glive v čisto kulturo in morfološko identifikacijo, rezultat pa potrdimo z molekularnimi tehnikami. V 2021 smo v Laboratoriju za varstvo gozdov začeli z vpeljevanjem molekularne metode za hitro zaznavanje *G. morbida* s konvencionalnim PCR, povzeto po Moore in sod. (2019), ki bo omogočala hitrejšo detekcijo glive direktno iz okuženega rastlinskega materiala ali vektorja. V prispevku predstavljamo preliminarne rezultate dosedanjih analiz, izvedenih v sklopu programov preiskav in strokovnih nalog zdravstvenega varstva rastlin, ter verifikacije molekularne metode za zaznavanje *G. morbida* v različnih tipih vzorcev.

ABSTRACT

Dieback of walnuts – searching for its causes and the verification of a molecular method for the detection of *Geosmithia morbida* in different types of samples

In recent years, we are witnessing dieback of walnuts (*Juglans* spp.). The process begins with death of individual twigs and branches, which spreads to the larger branches and gradually to the whole crown. Trees usually die in just a few years. The symptoms are almost identical to those developed by the thousand cankers disease, a dangerous disease of walnuts, caused by a bark beetle *Pityophthorus juglandis* (walnut twig beetle) and a fungus *Geosmithia morbida*. According to the new plant health law, both organisms are designated quarantine pests and are listed in Annex II, Part B of the Commission Implementing Regulation (EU) 2019/2072. Thousand cankers disease originates from the USA, where it has been causing widespread walnut tree mortality and significant economic losses. It affects different species of walnuts and wingnuts (*Pterocarya* spp.). In 2013, the disease was reported from Italy. It was discovered in the Veneto region, where it caused dieback of black walnut (*J. nigra*) and English walnut (*J. regia*). The disease has spread towards the South and West and is now present in several Italian regions. *P. juglandis* was found also in traps in Friuli Venezia Giulia, which borders Slovenia. In Slovenia, we perform survey programmes for thousand cancers disease and its causative agents, *P. juglandis* and *G. morbida*, since 2015. We carry out visual surveys across the Slovenian territory and use pheromone traps in the areas bordering Italy. For the identification of *G. morbida* we apply morphological analysis. In 2021, the Laboratory for Forest Protection has introduced a molecular method for rapid detection of *G. morbida* using conventional PCR. The method was adopted from Moore et al. (2019) and it allows the identification of the fungus directly from plant material or its vector. Preliminary results of the analyses and verification of the new molecular method for the detection of. *G. morbida* are presented in the article.

Količinska napoved sanitarne sečnje navadne smreke zaradi napada podlubnikov v Sloveniji

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Osmerozobi smrekov lubadar (*Ips typographus* L.) je gozdni škodljivec, nagnjen k namnožitvam, ki je zaradi vse večjih vremenskih ekstremov v zadnjih desetletjih povzročil veliko škode na navadni smreki (*Picea abies* (L.) H. Karst.). Za namen ustrezne pripravljenosti na njegove prenamnožitve je pomembno predvideti količino in prostorsko razporeditev poškodovanih dreves. V študiji smo razvili model za napoved sanitarne sečnje navadne smreke zaradi podlubnikov. Uporabili smo časovno serijo podatkov o sanitarni sečnji zaradi podlubnikov od leta 1996 do 2020. Za pojasnjevalne spremenljivke smo uporabili tla, lego, podnebje, naklon terena in poškodovanost dreves v preteklem letu. Model, ki smo ga razvili, je pokazal, da sanitarna sečnja negativno korelira z naklonom (količina sanitarne sečnje je večja na bolj ravnih zemljiščih), globino tal (količina sanitarne sečnje je večja na bolj plitkih tleh), deležem nasičenosti tal z bazami in standardiziranim padavinskim indeksom (SPI) (manj sanitarne sečnje je na vlažnih tleh). Po drugi strani pa s sanitarno sečnjo pozitivno korelirajo spremenljivke: kationska izmenjevalna kapaciteta tal, temperatura, sanitarna sečnja zaradi podlubnikov in drugih abiotskih dejavnikov ter lesna zaloga smreke. Model ima R^2 vrednosti 0,38. Model lahko uporabimo za napovedovanje količine sanitarne sečnje navadne smreke zaradi podlubnikov v naslednjem letu in za izpopolnitev zemljevida tveganja za prihodnje leto, ki ga lahko uporabimo za načrtovanje gospodarjenja z gozdovi in ekonomsko napoved donosa gozda.

ABSTRACT

Quantitative prediction of the sanitary felling of Norway spruce because of bark beetles in Slovenia

The European spruce bark beetle (*Ips typographus* L.) is an eruptive forest pest which made a lot of damage to Norway spruce (*Picea abies* (L.) H. Karst.) in the last decades because of increasing climatic extremes. In order to anticipate these outbreaks, it is important to predict a quantity and spatial distribution of damaged trees. In this study we developed a prediction model for the sanitary felling of Norway spruce because of bark beetles. We used a time series of sanitary felling of Norway spruce because of bark beetles from 1996 to 2020. For the explanatory variables we used soil, site, climate, geographic and tree damage in the previous year. The model we developed showed that the sanitary felling was negatively correlated with the slope (in more straight land there is a larger amount of sanitary felling), soil depth (less soil depth has a larger amount of sanitary felling), soil cation exchange capacity, and SPI (less sanitary felling in wet years). On the other hand, soil base saturation percentage, temperature, sanitary felling because of bark beetles, and other abiotic factors and the wood stock of spruce positively correlated with the sanitary felling. The model had an R^2 of 0.38. The model can be used for predicting the amount of sanitary felling of Norway spruce due to bark beetles and refine a risk map for the next year which could be used for forest management planning and the economical prediction within yield.

Ocenjevanje učinkovitosi različnih pasti za spremljanje vrst iz rodu *Agrilus* v hrastovih gozdovih Slovenije

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Rod *Agrilus* (Coleoptera, Buprestidae) je najobsežnejši rod, v katerega spadajo tudi ekonomsko pomembne vrste, kot sta *Agrilus planipennis* in *Agrilus anxius*. Zgodnje zaznavanje invazivnih in škodljivih vrst je pomembno za pravočasno ukrepanje, omejevanje širjenja ali zatiranje škodljivcev. Za hitro detekcijo in posledično pravočasno ukrepanje, so potrebne učinkovite metode spremljanja ciljnih vrst. Izkazalo se je, da je uporaba pasti najučinkovitejša metoda spremljanja vrst iz rodu *Agrilus*, potrebno pa je raziskati kateri tip pasti je najboljši. Z raziskavo želimo ugotoviti, katera izmed dveh tipov pasti, zelena lepljiva prizmatična ali zelena več lijakasta past, je bolj ustrezna na našem območju. V okolici Ljubljane smo v pretežno hrastov sestoj postavili pet zelenih lepljivih prizmatičnih in pet zelenih več lijakastih pasti. Pasti so bile postavljene v srednji del krošenj na sončno ali polsenčno lego. Kontrola in pobiranje vzorcev se je izvajala vsaka dva tedna, in sicer od 26. 5. do 31. 8. 2021. Ulov je bil determiniran v laboratoriju. Ulovili smo osem različnih vrst iz rodu *Agrilus*, in sicer *A. angustulus*, *A. biguttatus*, *A. convexicollis*, *A. laticornis*, *A. obscuricollis*, *A. olivicolor*, *A. sulcicollis* in *A. hastulifer*. Najštevilčnejša je bila vrsta *A. laticornis*, ki je predstavljala 43,98% vseh ulovljenih osebkov iz rodu *Agrilus*, sledili sta ji vrsti *A. olivicolor* s 28,22% in *A. obscuricollis* s 12,86%. Večino ulovljenih *Agrilus* osebkov je bilo v zelenih več lijakastih pasteh, in sicer približno dva in polkrat več, kot v zelenih lepljivih prizmatičnih pasteh. Ugotovljena je tudi razlika v vrstni pestrosti med uporabljenima tipoma pasti. V zelene več lijakaste pasti smo ujeli sedem različnih *Agrilus* vrst, v zelene lepljive prizmatične pasti pa pet.

ABSTRACT

Evaluating the efficiency of different trap types for capturing *Agrilus* spp. in Slovenian oak forests

The genus *Agrilus* (Coleoptera: Buprestidae) is the largest genera, and includes several economically important species, such as *Agrilus planipennis* and *Agrilus anxius*. Early detection of invasive and harmful species is necessary for initiating prompt action, containment, or eradication programmes. Therefore, effective pest surveillance and monitoring methods are needed for early detection and instigating subsequent action. For *Agrilus* species it is known that a variety of trapping approaches are efficient, however evaluation of which trap is best is much needed. The aim of this current research was to study the efficiency of two trap types in Slovenia: the green sticky prismatic trap and the green multi-funnel trap. Five green sticky prismatic traps and five green multi-funnel traps were established in a predominantly oak forest stand in Ljubljana. The traps were placed in the middle part of the canopy in a sunny or semi-shaded position. Sample collection was carried out every two weeks from 26. 5. till 31. 8. 2021. Catches were checked in the laboratory. In total eight different species of *Agrilus* were caught: *A. angustulus*, *A. biguttatus*, *A. convexicollis*, *A. laticornis*, *A. obscuricollis*, *A. olivicolor*, *A. sulcicollis* and *A. hastulifer*. The most abundant species was *A. laticornis*, which accounted for 43. 98% of all *Agrilus* specimens, followed by *A. olivicolor* with 28. 22% and *A. obscuricollis* with 12. 86%. The majority of *Agrilus* specimens caught were in green multi-funnel traps, approximately two and a half times more than *Agrilus* specimens caught in green sticky prismatic traps. There was also a difference in species diversity between the trap types. Furthermore, the multi-funnel traps had seven different species of *Agrilus*, and five in the green sticky prismatic traps.

Nauki in izkušnje simulacijske vaje »*Jesenov krasnik 2020*«

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Pripravljenost Slovenije na morebitne izbruhe novih in še posebej nevarnih tujerodnih organizmov, t.i. karantenskih škodljivih organizmov (KŠO), v slovenskih gozdovih sloni na terenski mreži gozdarjev in spremljanju zdravja gozdov, dostopni in odzivni diagnostični infrastrukturi, ozaveščanju in vključevanju širše javnosti ter uradnem nadzoru. V primeru pojava KŠO v slovenskih gozdovih pa bo nujen tudi hiter in usklajen odziv. Sanacija izbruha KŠO v gozdarstvu je lahko zahtevna, obsežna, dolgotrajna in vključuje ekstremne ter težko izvedljive postopke, ki se v gozdarski praksi ne uporabljajo rutinsko. Za učinkovito in korektno izvedbo ukrepov je nujna vključenost ustrezno usposobljenih in informiranih izvajalcev del. Za učinkovito opravljeno delo je nujna tudi vnaprej pripravljena baza ustreznih izvajalcev in seznami potrebne opreme in sredstev. V letu 2020 smo zato organizirali simulacijsko vajo, s katero smo simulirali korake sporočanja, hitrega odzivanja, ukrepanja na terenu in koordinacije z vsemi vpletenimi na hipotetičnem primeru najdbe KŠO v gozdnem sestoju v Sloveniji. Kot modelni organizem smo izbrali hrošča *Agrilus planipennis* (jesenov krasnik), ki je z evropsko zakonodajo na področju zdravja rastlin uvrščen tudi med prednostne škodljive organizme. Identificirali smo izzive in omejitve pri hitrem odzivanju ter podali nekatere rešitve za učinkovito izvajanje ukrepov izkoreninjenja v primeru pojava KŠO v slovenskih gozdovih.

ABSTRACT

Lessons learned at the simulation exercise "*Emerald ash borer 2020*"

Slovenia's readiness for possible outbreaks of new and especially dangerous alien pests and diseases, quarantine organisms, in Slovenian forests is based on the network of foresters and monitoring of forest health, accessible and responsive diagnostic infrastructure, raising awareness and involvement of the general public and official control. In the case of an outbreak of quarantine organism in Slovenian forests, a rapid and coordinated response will be necessary. Dealing with an outbreak of a quarantine organism in forestry is demanding, extensive, time-consuming and can involve extreme and difficult procedures that are not routinely used in forestry practice. The effective and correct implementation of measures requires the involvement of properly trained and informed contractors. A pre-prepared database of contractors and lists of necessary equipment and resources are also necessary for efficient work. In 2020, we therefore organized a simulation, where we simulated the steps of communication, rapid response, field action and coordination with all involved in the hypothetical case of finding quarantine organism in a forest stand in Slovenia. As a model organism a beetle *Agrilus planipennis* was chosen, which is also included in the list of EU-priority pests. Challenges and

limitations were identified, and some solutions were provided for the efficient implementation of measures to eradicate quarantine organism in Slovenian forests.

Vključevanje javnosti v zgodnje zaznavanje škodljivih tujerodnih organizmov – primer projekt LIFE ARTEMIS

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Škodljivi tujerodni organizmi v zadnjih desetletjih zaradi naraščajoče globalne trgovine in podnebnih sprememb predstavljajo vedno večji problem in grožnjo različnim ekosistemom, tudi gozdovom. Da bi lahko preprečili oz. zmanjšali potencialno škodo, ki jo te vrste lahko povzročijo, je zelo pomembno, da vrste zaznamo čim prej, ko pridejo na novo območje, in takoj ukrepamo. Le s hitrim odzivanjem je namreč mogoče učinkovito obvladovanje invazivnih tujerodnih vrst in z razmeroma majhnimi sredstvi. Kapacitete strokovnih služb v gozdarstvu za zgodnje odkrivanje nevarnih škodljivih organizmov so omejene. Vključevanje splošne javnosti v okviru t. i. ljubiteljske znanosti lahko pomembno prispeva k uspehu delovanja sistema zgodnjega odkrivanja škodljivih organizmov in hitrega odzivanja nanje. V sklopu projekta *LIFE ARTEMIS - Osveščanje, usposabljanje in ukrepanje za invazivne tujerodne vrste v gozdu* (2017 – 2020) smo razvili spletno in mobilno aplikacijo Invazivke (*www.invazivke.si*), ki je javno dostopna in omogoča enostavno sporočanje opažanj invazivnih tujerodnih vrst, nevarnih za naše gozdove. S pomočjo tako pridobljenih podatkov lahko spremljamo širjenje v Sloveniji že prisotnih vrst in zaznavamo nove vnose potencialno nevarnih škodljivih organizmov. Zbiranje podatkov v Invazivke je osredotočeno na invazivne tujerodne vrste, ki so bile na osnovi izbranih kriterijev in izkušenj v tujini uvrščene na opozorilni seznam invazivnih tujerodnih vrst v gozdovih v Sloveniji. Na ta seznam je uvrščenih 58 vrst rastlin, 7 vrst sesalcev, 14 vrst žuželk ter 14 vrst gliv in fitoftor; od tega je 5 vrst žuželk ter 7 vrst gliv in fitoftor v predpisih s področja zdravstvenega varstva rastlin opredeljenih kot karantenske vrste. V času trajanja projekta, med majem 2017 in koncem oktobra 2020, je bilo v sistemu Invazivke zabeleženih 17.628 podatkov oz. opažanj; od tega 79,1 % za rastline, 6,1 % za žuželke in 3,8 % za glive. Karantenskih škodljivih organizmov nismo zaznali. Skupno je podatke sporočilo 423 uporabnikov sistema. Ljubiteljska znanost je pomemben podporni element sistema zgodnjega obveščanja o novih tujerodnih škodljivcih in boleznih, ki bi lahko ogrozili naše gozdove. Za uspešno vključevanje javnosti pa je nujno redno osveščanje in usposabljanje prostovoljcev.

ABSTRACT

Citizen science and the early detection of invasive alien pests and diseases - example of LIFE ARTEMIS project

Harmful alien organisms are posing an increasing problem in recent decades due to growing global trade and climate change and are threatening various ecosystems, including forests. To prevent or reduce the potential damage of these plant pests, it is very important to detect the species as soon as it arrives in new area and take immediate

action. Only with rapid response it is possible to manage it effectively and with relatively small resources. The capacity of professional forestry services for the early detection of harmful pests and diseases is limited. Involvement of the public in the context of so-called citizen science can make an important contribution to the success of the early detection system for plant pests and rapid response. As part of the LIFE ARTEMIS project - Awareness, training and measures on invasive alien species in forests (2017 - 2020), we developed a web and mobile application “Invazivke” (*www.invazivke.si*), which is publicly available and allows easy reporting of observations of invasive alien species, dangerous to our forests. With the help of the data obtained, we can monitor the spread of species already present in Slovenia and detect new arrivals of potentially dangerous pests. Data collection is focused on invasive alien species, which were included in the warning list of invasive alien species for Slovenian forests on the basis of selected criteria and experience from abroad. This list includes 58 species of plants, 7 species of mammals, 14 species of insects and 14 species of fungi and phytophthora; of which 5 species of insects and 7 species of fungi and phytophthora are defined as quarantine species in plant health regulations. During the project, between May 2017 and the end of October 2020, 17,628 data were recorded in the “Invazivke” system; of which 79.1 % for plants, 6.1 % for insects and 3.8 % for fungi. No quarantine pests were detected. In total, 423 users of the system submitted the records. Citizen science is an important supporting element of the early warning system for new pests and diseases that could threaten our forests. However, regular public awareness and training of volunteers is essential for successful public involvement.

Varstvo vinske trte

Učinkovitost delovanja avtonomnega modularnega sistema pri izvajanju procesa nanašanja škropilne brozge v vinogradu

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Avtonomni modularni sistem nameščen na konvencionalnem prototipu pršilnika, ki deluje na principu pulzno širinskega krmiljenja elektromagnetnih ventilov predstavlja najsodobnejšo tehnologijo za izvajanje kontroliranega nanašanja škropilne brozge, brez spreminjanja operativnih parametrov pršilnika (npr. tlak pri škropljenju, velikost šobe). V skladu z načeli preciznega vinogradništva, predstavlja pulzno širinsko krmiljenje primarno tehnologijo, ki omogoča nanašanje potrebne količine škropilne brozge izključno na ciljne površine vinske trte brez spreminjanja spektra velikosti kapljic in omogoča enakomerno kakovost depozita ter zmanjšanje odnašanja kapljic škropilne brozge izven ciljnih površin (t.i. drift). V vinogradu smo skozi celotno sezono škropljenja v letu 2021 testirali avtonomni aksialni prototip pršilnika na katerega smo namestili avtonomni modularni sistem z omogočenim pulzno širinskim krmiljenjem škropilne brozge. Testirali smo dva načina delovanja prototipa pršilnika, in sicer avtonomnega (zvezno krmiljenje delovnega cikla (DC: od 0 do 100 %)) ter konvencionalnega (šoba popolnoma odprta ves čas), pri enakomerni delovni hitrosti pršilnika 6 kmh^{-1}. Primerjali smo porabljeno količino FFS (fitofarmacevtskih sredstev) izraženo v odstotkih med avtonomnim in konvencionalnim načinom delovanja pršilnika skozi individualne šobe na pršilniku. Ugotovili smo, da je znašal največji prihranek škropilne brozge 69,8 %, skozi individualno šobo ob razvojnem stadiju (5 listov) vinske trte. Pridobili smo tudi podatke glede vpliva avtonomnega nanosa na pojav bolezni (stopnjo napada na listju in grozdju izražena v odstotkih) in na višino in kakovost pridelka v dveh vinogradih s klasično gojitveno obliko.

ABSTRACT

Efficiency of operation of an autonomous modular system in carrying out the spray mixture process in vineyard

Autonomous modular system mounted on a conventional sprayer prototype operating on the principle of pulse-width modulation control of electromagnetic valves represents state-of-the-art technology for implementation controlled application of spray mixture without changing the operating parameters of the sprayer (eg spray pressure, nozzle size). In accordance with the principles of precision viticulture the pulse-width modulation control is the primary technology which allows the application of the required amount of spray mixture exclusively to the target areas of the vine without changing the droplet size spectrum and allows for even deposit quality and reducing the drift outside the target areas. In the vineyard, we tested an autonomous axial sprayer prototype throughout the entire spraying season in 2021 on which we have installed an autonomous modular system with enabled pulse-width control. We tested two modes of operation of the sprayer prototype, namely autonomous (continuous duty cycle control (DC: 0 to 100%)) and conventional (nozzle fully open at all time), at a steady spray speed of 6 kmh^{-1}. We compared the amount of PPP expressed as a percentage between autonomous and conventional mode of operation of the sprayer through individual nozzles on the sprayer. We found that the maximum saving of the spray mixture was 69.8%, through an individual nozzle at phenological stage (5 leaves) of the vine. We also obtained data on the

influence of autonomous application on the occurrence of the disease (rate of attack on leaves and grapes expressed as a percentage) and on the height and quality of the crop in the two vineyards with a classic cultivation form.

Novi načini obvladovanja esce ali kapi vinske trte

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Kap vinske trte ali esca postaja v vinogradih severovzhodne Slovenije velik problem. Odstotek okuženih trt v nekaterih vinogradih z občutljivimi sortami ('Sauvignon', 'Laški rizling', 'Šipon') presega 5 %. Priporočeni ukrepi za preprečevanje širjenja esce so: razkuževanje orodja pri rezi, ločeno obrezovanje obolelih trsov, ki smo jih predhodno označili, premazovanje večjih odprtih ran po rezi, pomlajevanje obolelih trsov (izrezovanje obolelega dela trsa), odstranjevanje obolelih trsov in ostankov obolelih trsov iz vinograda ter njihovo uničenje. Učinkovitega ukrepa za zatiranje ter uspešno preprečevanje pojava in širjenja te bolezni v starejših vinogradih pa še ne poznamo. Z namenom preučevanja novih metod za preprečevanje pojava in širjenja esce izvajamo večletni poskus v vinogradu STS Ivanjkovci na sorti 'Sauvignon', ki se je začel jeseni leta 2019 in se bo nadaljeval vsaj še v letu 2022. V poskusu se izvajajo različni načini izrezovanja okuženi delov trsov; dendrokirurgija (izrezovanje celotnega trhlega dela stebla) in penetracija (navpični rez v glavi trsa) brez premaza in s kombinacijo premaza antagonističnih gliv, ki zmanjšujejo in preprečujejo vdor, rast in razvoj lesnih gniloživk v živem lesu. Ker se bolezen pojavlja v kronični in akutni obliki, je pomembno večletno spremljanje in opazovanje poskusa. Septembra 2019 smo v vinogradu izmed 321 trsov z različnimi barvami označili in nato tretirali 54 trsov okuženih z esco. V naslednjem letu smo poskus prvič ocenili in ugotovili, da si je od 54 trsov skupno opomoglo 24 trsov, znake esce je imelo še 26 trsov in štirje trsi so popolnoma propadli. Prav tako smo pregledali neoznačene trse in odkrili 25 na novo okuženih. V letu 2021 smo ponovno ocenili 49 trsov in pregledali neoznačene trse. Od 49 trsov si je skupno opomoglo 22 trsov, znake esce je imelo še 24 trsov in trije trsi so popolnoma propadli. Odkrili smo tudi 73 na novo okuženih trsov.

ABSTRACT

New methods to control esca also called grapevine measles

Grapevine measles or esca is becoming a major problem in the vineyards of northeastern Slovenia. The percentage of vines infected in certain vineyards with susceptible varieties ("Sauvignon", "Italian riesling", "Furmint") exceeds 5 %. Recommended measures to prevent the spread of esca are: disinfection of tools, separate pruning of diseased cane that have previously been labelled, coating of large open wounds after pruning, rejuvenation of diseased cane (cutting out the diseased part of th e cane), removal of diseased cane and remnants of diseased cane from the vineyard and their destruction. However, we do not yet know an effective measure to suppress and successfully prevent the occurrence and spread of this disease in older vineyards. In order to study new

methods to prevent the occurrence and spread of esca, we are conducting a multi-year experiment in the vineyard STS Ivanjkovci on the variety "Sauvignon", which started in autumn 2019 and will continue at least in 2022. The experiment is carried out with various methods of cutting out infected parts of the cane - cutting out the entire necrotic part of the stem or vertical incision in the head of the cane. Both vine surgeries were without coating or combine with a coating of antagonistic fungi that reduce and prevent the intrusion, growth and development of wood rot in live wood. As the disease occurs in chronic and acute form, it is important to monitor and observe the experiment for several years. In September 2019, 54 esca-infected canes were marked with different colours and treated in the vineyard of 321 canes. Over the next year, we assessed the experiment for the first time and found out that of the 54 canes, 24 were recovered in total, 26 canes were infected and four canes completely collapsed. We also examined unmarked canes and discovered 25 newly infected. In 2021, we re-evaluated 49 canes and examined unmarked canes. Of the 49 cane, 22 were recovered in total, 24 canes were infected and three canes completely collapsed. We also discovered 73 newly infected canes.

Možnosti obvladovanja bolezni lesa vinske trte z uporabo vodikovega peroksida

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Bolezni lesa vinske trte so močno razširjene v vseh vinorodnih deželah po svetu. V starejših vinogradih se pojavljajo in predstavljajo resen problem tri glavni tipi glivičnih obolenj lesa: kap vinske trte (ESCA), Eutipoza (Eutypa dieback) in propadanje zaradi gliv iz rodu *Botryosphaeria* (Botryosphaeria dieback). V mladih vinogradih in trsnicah pa sta prisotni zlasti Petrijeva bolezen (Petri disease) in črna noga (Black foot disease). Zmanjšan pridelek in odmiranje okuženih trt se odražata v veliki gospodarski škodi, za preprečevanje katere še ne poznamo celostne in povsem učinkovite rešitve. V letih od 2018 do 2021 smo v vinogradu v Vipavski dolini, kjer smo v prejšnjih letih zaznali pojav bolezni lesa vinske trte, za namene njihovega obvladovanja analizirali učinkovitost inovativne metode vbrizgavanja vodikovega peroksida (H_2O_2). V zdrave dele debla obolelih trt smo izvrtali luknjo in vanjo vbrizgali raztopino vodikovega peroksida, da pride preko prevodnega sistema v stik s patogenimi glivami v delih okuženega lesa. Poskus je bil zastavljen na sortah barbera, refošk, rebula, zelen, pinela in malvazija. Vsako leto smo ocenili in evidentirali zdravstveno stanje trt v vinogradu in spremljali njihov odziv po opravljenem treniranju z vodikovim peroksidom. Delež obolelih trt je bil med sortami različen. V prispevku so predstavljeni rezultati poskusa in druge možne strategije omejevanja bolezni lesa vinske trte.

ABSTRACT

Control possibilities of grapevine trunk diseases with the use of hydrogen peroxide

Grapevine trunk diseases, which are widespread in the main grapevine growing regions of the world and pose a serious problem in adult vineyards, include three main types: esca decline, Eutypa dieback and Botryosphaeria dieback. Petri disease and Black foot disease are mostly detected in young vineyards and nurseries. No completely effective solution is

currently available to reduce severe economic damage these fungal pathogens cause due to reduced yields and shortened life span of the vines. Hydrogen peroxide (H_2O_2) trunk injections, an innovative technique to limit grapevine trunk diseases symptoms expression, was tested in the years 2008 to 2021 in affected vineyard of the Vipava Valley. The injection with hydrogen peroxide was applied into a drill hole in the trunk of infected grapevines with the aim to put it in contact with the phytopathogenic fungi, through the grapevine conductive system. The following varieties were included in the experiment: Barbera, Refošk, Rebula, Zelen, Pinela and Malvasia. During the period of the trial, we have estimated and registered the number of vines showing typical trunk diseases symptoms and we evaluated the efficacy of applied hydrogen peroxide. The rate of the disease varied according to the variety of the vines. The paper presents the results of the experiment and a range of other grapevine trunk diseases control strategies.

Izkušnje z zatiranjem križastega grozdnega sukača (*Lobesia botrana*) in pasastega grozdnega sukača (*Eupoecilia ambiguella*) z metodo zbeganja v letu 2021

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Križasti grozdni sukač *Lobesia botrana* (Denis & Schiffermüller, 1775) in pasasti grozdni sukač *Eupoecilia ambiguella* (Hübner, 1796) sta permanentna škodljivca vinske trte (*Vitis vinifera* L.). Še posebej križasti grozdni sukač lahko v deževnih poletjih v severovzhodni Sloveniji povzroči, zaradi nevarnosti širjenja okužbe s sivo grozdno plesnijo (*Botrytis cinerea* Pers.), veliko gospodarsko škodo. Prav zato se drugi rod grozdnih sukačev zatira preventivno, kar lahko poveča število škropljenj z insekticidi na vinski trti iz enega na tri. Kot alternativa kemičnemu zatiranju je mogoče uporabiti metodo zbeganja, ki je v Sloveniji že dalj časa poznana. Prva preizkušanja z različnimi vrstami dispenzorjev so bila v Sloveniji opravljena v letih 1991 in 1992, ter 1996 in 1997. Vendar se omenjeni biotehnični način zatiranja obeh vrst grozdnih sukačev ni razširil, saj vse do leta 2017 v Sloveniji ni bilo za ta namen registriranega pripravka. Ker so se klimatske razmere v zadnjih 20 letih spremenile, smo v letu 2021 ponovno ovrednotili učinkovitost metode zbeganja obeh vrst grozdnih sukačev z dispenzorji ISONET l Plus na dveh lokacijah v Sloveniji, in sicer v Ivanjkovcih (severovzhodna Slovenija) in Pradah (zahodna Slovenija). Na obeh lokacijah je bilo v poskusnih vinogradih nameščenih po 500 dispenzorjev na hektar. Populacijo grozdnih sukačev smo spremljali s pomočjo feromonskih vab. Po postavitvi dispenzorjev na lokaciji Ivanjkovci na feromonske vabe nismo več ujeli metuljčkov križastega ali pasastega sukača, kar dokazuje učinkovito delovanje dispenzorjev ISONET I Plus. Na lokaciji Prade pa smo v poskusnem vinogradu v celotnem obdobju spremljanja od maja do oktobra ujeli skupno 10 križastih grozdnih sukačev. Na isti lokaciji smo v izolacijskem pasu, izven delovanja metode zbeganja na feromonskih vabah, ki so bile postavljene v oddaljenosti 50 m, 100 m, 150 m in 200 m od poskusnega vinograda, ujeli skupno 750 križastih grozdnih sukačev in 4 pasaste grozdne sukače.

ABSTRACT

Control of the European grapevine moth (*Lobesia botrana*) and European grape berry moth *(Eupoecilia ambiguella)* by the mating disruption technique in 2021

Both the European grapevine moth *Lobesia botrana* (Denis & Schiffermüller, 1775) and the European grape berry moth *Eupoecilia ambiguela* (Hübner, 1796) are two permanent pests of the grapevine (*Vitis vinifera* L.). The European grapevine moth is in particular damaging if summers are rainy. The economic damage is especially significant in north-eastern Slovenia, due to the risk of transmission of *Botrytis cinerea* (Pers.). For this reason, it is advised to spray preventively the second generation of grape moths, which can increase the number of insecticide sprays on the grapevine from one to three. As an alternative to chemical control, it is possible to use the method of confusion or mating disruption technique, which has been known in Slovenia for a long time. The first tests with different types of pheromone dispensers were performed in Slovenia in 1991, 1992, 1996 and 1997. However, the mentioned biochemical method of control of both types of grape moth has not been in usage, as there were none registered dispensers in Slovenia for mating disruption. In 2021, due to the climatic changes in the last 20 years, we decided to re-evaluated the effectiveness of matin disruption technique for both grape moths with ISONET L PLUS dispensers at two locations in Slovenia, in Ivanjkovci (north-eastern Slovenia) and in Prade (western Slovenia). We installed 500 dispensers per hectare in the experimental vineyards at both locations. The population of grape moths was monitored with the pheromone baits. After the installation of the pheromone dispensers at the Ivanjkovci, we have not caught any moths on the pheromone baits in this vineyard, which proves the effectiveness of ISONET L PLUS dispensers. In the experimental vineyard in Prade, during the entire monitoring period from May to October, we caught a total of 10 European grapevine moths. Near the latter experimental vineyard, where we didn't use the mating disruption technique, we caught a total of 750 European grapevine moths and 4 European grape berry moths. The pheromone baits in this vineyard were placed at a distance of 50 m, 100 m, 150 m and 200 m from the experimental vineyard.

Izkušnje z zatiranjem ameriškega škržatka (*Scaphoideus titanus*) v letu 2021

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Učinkovito zatiranje ameriškega škržatka (*Scaphoideus titanus*) je eden od najpomembnejših tehnoloških ukrepov preprečevanja širjena fitoplazme Grapevine flavescence dorée (FD), ki je karantenska bolezen. Fitoplazma FD se je v letih 2020 in 2021 močno razširila v Ljutomersko-Ormoških Goricah ter v nekaterih vinogradih v Lendavskih Goricah. Od leta 2019 je v Evropi prepovedana uporaba insekticidov na osnovi neonikotinoidov kot je bila aktivna osnov tiametoksam, ki je imela dovoljenje za zatiranje ameriškega škržatka na vinski trti. Na razpolago tudi ni insekticidov na osnovi aktivne snovi klorpirifos-metil, katero so vinogradniki najpogosteje uporabljali za zatiranje

križastega in pasastega grozdnega sukača, s stranskim delovanjem tudi na ameriškega škratka. V letu 2021 smo na lokaciji Maribor (SV Slovenija) in Šmarju pri Jelšah (Šmarsko-Virštanjski vinorodni okoliš) izvedli poskus zatiranja ameriškega škržatka, kjer smo preizkusili učinkovitost standardnih insekticidov in nekaterih sredstev za krepitev rastlin. Preizkusili smo učinkovitost različnih sredstev oziroma programe škropljenj: Flora verde (naravni piretrin), CutiSan (kaolin) Wetcit (olje pomarančevca), Sivanto prime (flupiradifuron), Exirel (ciantraniliprol), Mospilan 20 SG (acetamiprid). Na vsaki lokaciji smo izvedli do 4 aplikacije. Na lokaciji Maribor je največjo učinkovitost dosegla kombinacija pripravkov Sivanto prime in CutiSan ter CutiSan (uporabljen 4-krat), medtem ko je bilo na lokaciji Šmarje pri Jelšah najmanjše ugotovljeno število škržatkov pri kombinaciji Sivanto prime in Exirel ter Sivanto prime in Cutisan. Samo z eno aplikacijo, tudi z uporabo sistemičnih insekticidov, ne dobimo zadovoljivega - dolgotrajnega učinka na ameriškega škržatka.

ABSTRACT

Experiences with the control of American grapevine leafhopper, *Scaphoideus titanus,* in 2021

Effective control of the American grapevine leafhopper, *Scaphoideus titanus*, is one of the most important technological measures to prevent the spreading of phytoplasma Grapevine Flavescence dorée (FD), which is a quarantine disease. In 2020 and 2021, FD phytoplasma was spread strongly in Ljutomersko-Ormoške Gorice and in some vineyards in Lendavske Gorice. In Europe, prohibited use of insecticides with neonicotinoids compound since 2019. Active substance thiamethoxam was use to control the American grapevine leafhopper in grape vine. Insecticides with chlorpyrifos-methyl, which growers used to control wine moths and European grapevine moths with side effects on the American grapevine leafhopper, were prohibited to use. In 2021 carried out trials at the location of Maribor (NE Slovenia) and Šmarje pri Jelšah (Šmarje-Virštanj wine-growing region) where tested efficacy standard insecticides and some plant biostimulants for reduction population of American grapevine leafhopper. We tested the effectiveness of different products: Flora verde (natural pyrethrin), CutiSan (caolin) Wetcit (orange oil), Sivanto prime (flupiradifuron), Exirel (cyanthraniliprol), Mospilan 20 SG (acetamiprid). On each trial, we carried out to four applications. At the Maribor location, the combination of two products, Sivanto prime and CutiSan and CutiSan (used 4-times) had the highest efficiency, at location Šmarje pri Jelšah were the most effective against American grapevine leafhopper with combination Sivanto prime and Exirel and Sivanto prime and Cutisan. With only one application, also with systemic insecticides used, we do not get a satisfactory - long-residual effect on the American grapevine leafhopper.

Ali lahko vrstno pestri posevki pozitivno vplivajo na koristne organizme v vinogradih?

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Raznolikost rastlin lahko ohranja in daje prednost koristnim organizmom in s tem pripomore k naravnemu uravnavanju populacije škodljivcev. S tem namenom smo preučevali vpliv vrstno pestrega posevka na koristne in škodljive členonožce. Poskus je potekal v letih 2019 in 2020 na območju zgornje Vipavske doline, v vinogradu z ekološko (Podraga) in integrirano pridelavo grozdja (Manče). V obeh vinogradih smo primerjali tradicionalen (zatravljeno v Podragi oz. gola tla v Mančah) in alternativen (prekrivni posevek) način upravljanja s tlemi v medvrstnem prostoru. Skozi rastno dobo smo spremljali vrstno pokrovnosti in pestrost posevka in vzorčili koristne in škodljive členonožce z rumenimi lepljivimi ploščami, rumenimi lovnimi posodami in feromonskimi vabami. Izpostavljali smo tudi jajčeca križastega grozdnega sukača (*Lobesia botrana* v letu 2019) in marmorirane smrdljivke (*Halyomorpha halys* v 2020), da bi ocenili posreden vpliv posevka na parazitiranje in plenjenje jajčec. V dveh letih smo skupno pregledali vzorce iz 432 talnih pasti, 48 rumenih vodnih pasti in 216 rumenih lepljivih plošč. Rezultati analize ulovljenih talnih členonožcev v vipavskih vinogradih so pokazali pogosto zastopanost hroščev *Brachinus crepitans, Carabus coriaceus*, *Carabus germarii, Harpalus dimidiatus, Harpalus rufipes, Harpalus distinguendus, Pterostichus melas, Anchomenus dorsalis, Calathus fuscipes, Ophonus azureus, Amara* sp.*, Stelidota geminata, Urophorus* sp.*, Glischrochilus quadrisignatus, Carpophilus* sp., *Dermestes* sp.*,* kratkokrilcev (Staphilinidae) in pajkovcev (Arachnida). V obravnavanju, kjer smo sejali posevek, smo v letu 2019 ugotovili značilno večje ulove koristnih členonožcev v vodnih pasteh, medtem ko je bilo plenjene jajčec škodljivcev neznačilno večje. Na rumene lepljive plošče se je ulovilo neznačilno večje število osebkov ameriškega (*Scaphoideus titanus*) in zelenega škržatka (*Empoasca vitis*) kot tudi koristnih členonožcev (Crysopidae, Coccinnelidae, Ichneumonidae, Panorpidae, Syrphidae) v obravnavanju, kjer smo sejali prekrivni posevek. Sklepamo, da prekrivni posevki povečajo biotsko raznovrstnost in številčnost členonožcev vendar ni nujno, da to vpliva na naravno zatiranje škodljivcev.

ABSTRACT

Can cover crops promote beneficials in vineyards?

Plant diversity can promote and conserve beneficials and thus positively contribute to the natural control of pests. The aim of our study was to evaluate the influence of a species-rich cover crop on beneficial and pest arthropods. A two-year field trial (2019-2020) was therefore conducted in the upper Vipava valley, in an organic (Podraga) as well as an IP-managed vineyard (Manče). Both vineyards were divided into a traditional (grass in Podraga or bare soil in Manče) and an innovative (cover crop) production system. Throughout the growing season, we monitored the development of cover crops and sampled for the presence of arthropods using pitfall traps, yellow sticky traps, water traps and pheromone traps. Sentinel eggs of *Lobesia botrana* (2019) and *H. halys* (2020) were exposed in order to assess how cover crop affects parasitism and predation. In the two-year experiment we checked a total of 432 pit fall traps, 48 yellow water traps and 216 yellow sticky traps. The ground arthropod assemblage in Vipava vineyards was dominated by *Brachinus crepitans, Carabus coriaceus*, *Carabus germarii, Harpalus dimidiatus, Harpalus rufipes, Harpalus distinguendus, Pterostichus melas, Anchomenus dorsalis, Calathus fuscipes, Ophonus azureus, Amara* sp.*, Stelidota geminata, Urophorus* sp.*, Glischrochilus quadrisignatus, Carpophilus* sp., *Dermestes* sp.*,* rove beetles (Staphilinidae) and spiders (Arachnida). In the innovative treatment, we found significantly higher catches of beneficial arthropods within yellow water traps in 2019, while egg predation was insignificantly higher. Yellow sticky traps indicate insignificantly higher captures of the two leafhoppers *Scaphoideus titanus* and *Empoasca vitis* as well as

beneficial arthropods (Crysopidae, Coccinnelidae, Ichneumonidae, Panorpidae, Syrphidae) in the innovative treatment. Cover crops therefore seem to favor arthropod biodiversity and abundance but without necessarily increasing natural pest suppression.

Zatiranje plodove vinske mušice (*Drosophila suzukii* Matsumura) na vinski trti z aplikacijo lojevca

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V enoletnem poljskem poskusu smo preverili možnost zatiranja plodove vinske mušice na grozdju vinske trte sorte Zweigelt, z aplikacijo lojevca. Pripravek Invelop (85% talk; magnezijev silikat hidroksid ($Mg_3Si_4O_{10}(OH)_2$) smo nanesli v cono grozdja dvakrat (14. 8., 15 kg/ha in 29. 8., 25 kg/ha). Analizirali smo stopnjo napada ličink na jagodah, količino pridelka in pojav bolezni (*Botrytis cynerea* in *Acetobacterium* sp.). Učinkovitost (% Abbot) dveh aplikacij za zmanjšanje napada je bila 60 %. Izguba pridelka povzročena od mušice, sive plesni (*B. cynerea*) in ocetnega cika (*Acetobacterium* sp.) je pri netretirani kontroli znašala 22 % in pri tretiranem obravnavanju 13,5 %. Glede na razliko v višini izgube je uporaba pripravka Invelop pri občutljivi sorti trte ekonomsko smiselna.

ABSTRACT

Controlling of spotted wing drosophila (*Drosophila suzukii* Matsumura) on grapevine with the application of talc

In a one-year field experiment, we analyzed the possibility of controlling the spotted wing drosophila on grapes of the Zweigelt variety with the application of talc clay mineral. Preparation Invelop (85% talc; magnesium silicate hydroxide ($Mg_3Si_4O_{10}(OH)_2$) was applied to the grape cluster zone twice (14. 8., 15 kg/ha and 29. 8., 25 kg/ha). The larval attack rate on berries was analyzed, grape yield, and disease incidence (*Botrytis cynerea* and *Acetobacterium* sp.) The efficiency (% Abbot) of the two applications to reduce the attack rate from larvae was 60%. In the untreated control, yield loss amounted to 22%, and in the treated grape plots, 13.5%. Given the difference in the amount of yield loss, the use of preparation Invelop in a susceptible vine variety certainly is economically feasible.

Primerjava učinkovitosti kemičnih in alternativnih metod zatiranja plevelov v vinogradu

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V vinogradu na lokaciji Polički vrh v okolici Jarenine je bila v okviru projektov EIP in CRP izvedena dvoletna demonstracija kemičnih in mehanskih metod zatiranja plevelov, v 0,5 m širokem pasu pod trtami. Analizirali smo učinkovitost zatiranja in vpliv uspešnosti zatiranja plevelov na pridelek vinske trte. Kemično zatiranje smo izvedli z uporabo herbicida glifosat (GL)(standard), pelargonske kisline (PK), ocetne kisline (OK) in eteričnega olja agrumov (EO). Mehanično zatiranje smo izvedli z uporabo priključnih orodij znamke Braun; rotirajoča motika (RM), spodrezovalnik (SP) in pletvenik (PL). Ocenjevali smo tudi obravnavanje, kjer smo plevele trikrat letno zatirali z ognjem (OG). V obeh sezonah so bila obravnavanja glede na višino pridelka grozdja dokaj enakovredna, razlike med njimi pa so bile v obsegu med 300 do 1000 kg/ha, večinoma statistično neznačilne. V sezoni 2020 so bili stroški izvedbe alternativnih metod pri PK 7,50x, pri OK 3,33x, pri EO 4,67x, pri OG 5,50x, pri RM 2,08x, pri SP 2,33x in pri PL 1,92x višji, kot stroški zatiranja z uporabo herbicida glifosat. V sezoni 2021 so bili stroški izvedbe alternativnih metod pri PK 6,93x, pri OK 4,51x, pri EO 4,01x, pri OG 3,14x, pri RM 1,53x, pri SP 1,72x in pri PL 1,81x višji, kot stroški zatiranja z uporabo herbicida glifosat. Z uporabo alternativnih metod ni možno doseči finančne učinkovitosti, kot jo lahko dosežemo pri uporabi herbicida glifosat dvakrat letno.

ABSTRACT

Comparison of the effectiveness of chemical and alternative methods of weed control in the vineyard

As part of the EIP and CRP project, a two-year demonstration of chemical and mechanical weed control methods in a 0.5 m wide strip under vines was carried out in a vineyard at the Polički vrh location, in the vicinity of Jarenina. We analyzed the effectiveness of control and the impact of weed control on the yield of vines. Chemical control was performed using the herbicides glyphosate (GL)(standard), pelargonic acid (PK), acetic acid (OK), and citrus essential oil (EO). Mechanical weeding was performed using Braun attachment tools; rotating hoe (RM), undercutter (SP), and flail weeder (PL). We also included a treatment, where weeds were controlled three times a year with fire (OG). In both seasons, the treatments were fairly equal in terms of grape yield; the differences between them ranged from 300 to 1000 kg/ha, mostly statistically insignificant. In the 2020 season, the costs of implementing alternative methods were for PK 7.50x, for OK 3.33x, for EO 4.67x, for OG 5.50x, for RM 2.08x, for SP2.33x and for PL 1.92x higher than the cost of control using the herbicide glyphosate. In the 2021 season, the costs of performing alternative methods for PK 6,93x, for OK 4.51x, for EO 4.01x, for OG 3.14x, for RM 1.53x, for SP 1.72x and for PL 1.81x higher than the cost of control using the herbicide glyphosate. By implementation of alternative methods, it is not possible to achieve financial efficiency comparable to one, accomplished with the use of the herbicide glyphosate twice a year.

Raznolikost fitoplazem skupine 16SrV v trtah, leskah in njihovih prenašalcih

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V vinogradih povzroča velik upad pridelka in krčenje vinogradov fitoplazma Grapevine flavescence dorée (FD) iz skupine 16SrV, povzročiteljica zlate trsne rumenice, ki je v EU uvrščena na seznam karantenskih škodljivih organizmov. V letošnjem letu so bila v Sloveniji odkrita številna nova žarišča okužbe s to fitoplazmo in v skladu s predpisi je bilo potrebno uničiti več vinogradov predvsem na območju Ljutomersko Ormoških goric. Trta je lahko okužena z različnimi izolati fitoplazem iz skupine 16SrV, od katerih so za nekatere dokazali, da lahko povzročijo epifitocije, saj jih med trtami zelo učinkovito raznaša ameriški škržatek (*Scaphoideus titanus*) (Martini in sod., 2002). Iz drugih gostiteljskih rastlin lahko na trto različne izolate fitoplazem iz skupine 16SrV, tudi tiste, ki jih ameriški škržatek ne prenaša in zato ne povzročijo epifitocij, zanesejo nekatere druge žuželke, ki sesajo rastlinski sok (Malembic-Maher in sod., 2020). Med najbolj skrb vzbujajočimi je vzhodnjaški škržatek (*Orientus ishidae*), ki je polifag in se je od prve najdbe leta 2004 razširil po celotni Sloveniji. Velike populacije vzhodnjaškega škržatka smo odkrili v nasadih lesk v SV in JZ Sloveniji in v njih potrdili prisotnost fitoplazem 16SrV skupine. Okuženost s fitoplazmami iz skupine 16SrV smo potrdili tudi na propadajočih leskah. Z molekularnimi analizami lahko ločujemo med izolati fitoplazem iz skupine 16SrV, ki na trti povzorčijo epifitocije in tistimi ki ne, na primer z analizami nukleotidnega zaporedja gena *map*, s katerimi lahko določimo genotip map-FD. V prispevku bomo predstavili zastopanost različnih genotipov fitoplazem iz skupine 16SrV odkritih v slovenskih vinogradih, nasadih lesk in prenašalcih ter predstavili možne poti širjenja odkritih genotipov. Znanje o podobnosti izolatov v trti in leskah nam bo v pomoč za nadaljnje pravilno načrtovanje ukrepov.

ABSTRACT

Diversity of 16SrV phytoplasma group in grapevine, hazelnut and its vectors

Grapevine Flavescence dorée phytoplasma (FD) from the 16SrV group is a quarantine pest in the EU and causes many problems in vineyards. This year many new cases of infection with this phytoplasma were detected in Slovenia and according to the regulations several vineyards had to be destroyed in Ljutomersko Ormoške gorice. Grapevine can be infected with different isolates of 16SrV phytoplasma, some of which have proven to be epidemic because they can be very efficiently spread among grapevines by the American leafhopper (*Scaphoideus titanus*) (Martini et al., 2002). Other isolates that can not be transmitted by American leafhopper and do not cause epidemics, can be transmitted from other hosts to grapevine by some other plant sap-sucking insects (Malembic-Maher in sod., 2020). One of most troublesome is mosaic leafhopper (*Orientus ishidae*), a polyphage which spread throughout Slovenia since its first discovery in 2004. We have detected large populations of mosaic leafhopper in hazelnut orchards in NE and SW Slovenia and confirmed the presence of the 16SrV group phytoplasmas in them. Infection with 16SrV group phytoplasmas was also confirmed on decaying hazelnuts. Molecular analyses can distinguish between epidemic and non-epidemic phytoplasma isolates of the 16SrV group, for example, by analysing the nucleotide sequence of the *map* gene, which can be used to determine the map-FD genotype. In this article, we present different genotypes of 16SrV phytoplasma detected in Slovenian vineyards, hazel orchards and vectors, and highlight possible transmission routes of the detected genotypes. Knowledge of the similarity of isolates in grapevines and hazelnuts will help us to properly plan further measures.

Posterji

Robigovirusi na češnji v Sloveniji

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Rod *Robigovirus* je nedavno opisan rod virusov v družini *Betaflexiviridae.* CNRMV (virus nekroze in rjaste lisavosti češnje, cherry necrtotic rusty mottle virus), CGRMV (virus zelene obročkavosti in lisavosti češnje, cherry green ring mottle virus), CRMaV (cherry rusty mottle-associated virus) in CTLaV (cherry twisted leaf-associated virus) so štirje predstavniki tega rodu, ki okužujejo češnje in v nekaterih primerih povzročajo razvoj bolezenskih znamenj. V obdobju od 2019 do 2021 smo zato na 18 lokacijah kolekcijskih in pridelovalnih nasadov ter vrtov zbrali 50 vzorcev. Vseh 50 vzorcev smo z molekularnimi metodami testirali na navzočnost robigovirusov, ki okužujejo češnje. Za detekcijo slednjih smo razvili RT-PCR metodo, s katero lahko detektiramo vse 4 viruse, identificiramo pa jih z analizo sekvenc in/ali z RT-PCR metodami za detekcijo posameznih virusov. Okužbo z robigovirusi smo potrdili na 12 drevesih s 4 lokacij in sicer so bila 3 drevesa okužena s CGRMV in 9 dreves s CNRMV. To so bile prve najdbe CGRMV in CNRMV na češnjah v Sloveniji.

ABSTRACT

Robigoviruses on cherries in Slovenia

Genus *Robigovirus* is a rather new genus of the family *Betaflexiviridae. Cherry necrotic rusty mottle virus (CNRMV), cherry green ring mottle virus (CGRMV), cherry rusty mottle associated virus (CRMaV) and cherry twisted leaf associated virus (CTLaV) are the* four viruses from this genus that infect cherries and can cause symptoms in this crop. 50 samples from 18 different locations were collected between 2019 and 2021. Samples were taken either from collection or commercial orchards and gardens. All 50 samples were analysed for the presence of robigoviruses infecting cherry trees. RT-PCR that can detect all four viruses was developed and identification of the individual virus was done with sequence analysis or/and RT-PCR for a single virus. Infections were found on 12 trees from 4 different location. CGRMV was confirmed on 3 trees and CNRMV on 9 trees. This was the first detection of CGRMV and CNRMV on cherry trees in Slovenia.

Preizkušanje učinkovitosti insekticidov za zatiranje plodove vinske mušice (*Drosophila suzukii* [Matsumura, 1931]) v češnjah

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Drosophila suzukii (Matsumura, 1931) - plodova vinska mušica (PVM) je postala gospodarsko najpomembnejši škodljivec sadnih vrst z mehkimi plodovi. Češnjo uvrščamo med najbolj občutljive in napadu PVM najbolj izpostavljene sadne vrste, saj v času zorenja češenj PVM nima veliko alternativnih gostiteljev. Strategija integriranega varstva PVM združuje različne preventivne metode varstva rastlin in agrotehnične ukrepe, s ciljem zmanjševanja številčnosti populacije škodljivca in s tem tveganja za nastanek škode. Uporaba insekticidov zoper PVM, ki je del te strategije, je v pridelavi češenj nujen ukrep, saj številčnosti PVM v obdobju zorenja češenj zaenkrat z drugimi metodami ne uspemo zmanjšati pod prag gospodarske škodljivosti. Leta 2019 in 2020 smo v nasadu češenj v Sadjarskem centru Bilje preizkušali učinkovitost insekticidov na sorti Regina, ki je zaradi poznega zorenja zelo izpostavljena napadu PVM. V poskusu smo proučevali škropilne programe z različnimi kombinacijami insekticidnih pripravkov iz skupine organofosfatov (fosmet), spinosinov (spinosad, spirotetramat), piretroidov (lambda-cihalotrin, deltametrin) in antranilnih diamidov (ciantraniliprol). Vsak program je vključeval tri zaporedne aplikacije insekticidov. Termine škropljenja smo določali na osnovi fenološkega razvoja češenj in dolžine delovanja uporabljenih aktivnih snovi, pri čemer smo skušali zagotavljati stalno pokritost plodov z insekticidi, od začetka zorenja (BBCH 81) do obiranja. Učinkovitost posameznega škropilnega programa je bila ocenjena na podlagi ugotavljanja povprečne črvivosti plodov oz. na podlagi povprečnega števila ličink *D. suzuki* na 50 plodov. Rezultati preizkušanj so pokazali, da pravočasna uporaba insekticidov pomembno zmanjšuje populacijo PVM v nasadih češenj ter preprečuje nastanek škode na pridelku češenj. Preizkušeni insekticidni programi so v letih 2019 in 2020 pokazali dokaj visoko stopnjo učinkovitosti zoper PVM. Povprečna črvivost plodov je bila v vseh obravnavanih programih nizka in se je statistično značilno razlikovala od neškropljene kontrole.

ABSTRACT

Field testing of insecticide efficacy against spotted wing drosophila (*Drosophila suzukii* [Matsumura, 1931]) on sweet cherry

Drosophila suzukii (Matsumura, 1931) - *Spotted wing drosophila (SWD)* has become the most serious economic pest of soft-skinned fruits. Sweet cherry is one of the most susceptible and most vulnerable crops by SWD, because it ripens when only few alternative host fruits are available. Integrated *strategies* for *management* of Spotted Wing Drosophila consist of preventive pest management techniques and different cultural control methods which aims to reduce the pest population and to minimize fruit infestation. Chemical *control of SWD* as a part of this strategy, remains an important management tool, especially during the cherry ripening period when other methods are not providing adequate control. In 2019 and 2020 the field trials were conducted in Bilje Fruit Growing Centre to evaluate the efficacy of various insecticides against SWD in sweet cherry cv. `Regina´, which is a late ripening variety and susceptible to SWD attacks. Different combinations of active substances from the chemical group of organophosphates (phosmet), spinosyns (spinosad, spinoteram), pyrethroids (lambda-cyhalothrin, deltamethrin) and anthranilic diamides (cyantraniliprole) have been tested in four spray programs. Each program consists of three consecutive insecticide applications. The timing of insecticide application was following the speed of sweet cherry phenological progress and the insecticide longevity, starting at the beginning of fruit colouring (BBCH 81) and ending just before the harvest. To evaluate the effectiveness of spraying programs, 50 fruits per treatment were randomly collected in the canopy and examined for infestation with *D. suzukii* larval stages. The results of the field experiments conducted in years 2019 and 2020 have shown that appropriate time of insecticide application can reduce SWD population and prevent crop loss in sweet cherries. Spraying programs with different

combinations of insecticides was effective in controlling the SWD adults. The mean percentages of damaged fruits in all insecticide programs were significantly lower regarding untreated control.

Ali lahko s prilagojenim načinom skladiščenja vplivamo na zmanjšanje poškodb plodov češenj in jagodičja zaradi plodove vinske mušice (*Drosophila suzukii*)?

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V pridelavi jagodičja in češenj se zadnja leta soočamo z vedno večjimi težavami, ki jih povzroča plodova vinska mušica (*Drosophila suzukii*, PVM). PVM napada povsem zdrave, nepoškodovane plodove zato se pogosto zgodi, da pridelovalci ob obiranju ne opazijo znakov poškodb ter jih kot take tudi skladiščijo. Za kakovostno skladiščenje jagodičja in češenj velja, da ga skladiščimo v kontrolirani atmosferi z povišano koncentracijo CO_2. Zanimalo nas je, kako različne koncentracije CO_2 vplivajo na razvoj PVM v skladiščenih plodovih češenj, malin in ameriških borovnic. Poskuse smo izvedli tako, da smo zdrave plodove v insektariju izpostavili gojeni populaciji PVM obeh spolov, da smo zagotovili zadostno napadenost plodov. Nato smo plodove skladiščili pri sobni temperaturi in skladiščni temperaturi 4 ^{0}C pri različnih koncentracijah CO_2 (naravna atmosfera, 10 % CO_2, 100 % CO_2) v različnih časovnih obdobjih (0, 24, 72 h) ter spremljali vpliv naštetih dejavnikov na razvoj PVM. Na podlagi rezultatov poskusov smo ugotovili, da imajo tako povečane koncentracije CO_2 kot ohlajanje vpliv na populacijo mušic in ličink. Pri malinah, češnjah in ameriških borovnicah sta na število PVM značilno vplivala dejavnika koncentracija CO_2 in čas ohlajanja, ter tudi interakcija obeh dejavnikov. Opazili smo tudi bistveno večjo občutljivost malin za napad PVM v primerjavi z ameriškimi borovnicami in češnjami. Vpliv 100% CO_2 je bil opazen že brez ohlajanja, saj je bil razvoj PVM zgolj s 24-h inkubacijo pri sobni temperaturi v borovnicah in češnjah popolnoma zaustavljen (do 1% preživelih ličink v primerjavi s kontrolo), pri malinah pa bistveno zmanjšan (do 25% preživelih ličink). Po 24-h ohlajanju je bil učinek dodanega CO_2 manjši. Pri 72-h ohlajanju smo vpliv na razvoj PVM opazili tudi pri nižjih koncentracijah CO_2 (naravna atmosfera in 10% CO_2), pri 100% CO_2 pa je bil razvoj PVM zaustavljen. Zaradi ugodnega delovanja 100% CO_2 že po 24-h, smo z nadaljnjimi poskusi s krajšimi intervali ugotovili, da je že 3-h izpostavljenost 100% CO_2 pri sobni temperaturi in naknadnem ohlajanju na 4°C dovolj, da se zaustavi razvoj PVM.

ABSTRACT

Can modified storage conditions reduce the damage caused by the spotted wing drosophila (D*rosophila suzukii*) on cherry and berry fruits?

The production of berries and cherries is facing major loses caused by the spotted wing drosophila (*Drosophila suzukii*, SWD). SWD infests healthy, undamaged fruits, so producers often harvest and store damaged fruits. Long term storage conditions of berries and cherries must be modified with atmosphere consisting higher CO_2 concentration. The

aim of present study was to investigate how different concentrations of CO_2 affect the development of SWD in stored fruits. The experiments were performed by first harvesting healthy fruits and exposing them to a laboratory-grown SWM male and female population in the insectarium to ensure infestation of the fruits. The fruits were then stored at room temperature and in cold storage at 4ºC with different CO_2 concentrations (air atmosphere, 10% CO_2, 100% CO_2) in different time periods (0, 24, 72-h). We monitored the influence of these factors on the development of SWM. Based on the results of the experiments, we observed that both increased CO_2 concentrations and cold storage have affected the population of adult flies and larvae. In the case of raspberries, cherries and blueberries, the number of SWDs was significantly influenced by CO_2 concentration and cooling time, and we also confirmed a significant interaction of these two factors. There was a significantly higher susceptibility of raspberries to SWM attack compared to blueberries and cherries. Significant effect of 100% CO_2 was observed in samples that were kept at room temperature after 24-h incubation. The development of SWM was totally suppressed at infested blueberries and cherries (up to 1% of surviving larvae compared to control) and significantly decreased in raspberries (up to 25% of surviving larvae). After 24-h of cold storage, the effect of added CO_2 was lower. After 72-h of cold storage we confirmed the influence on the development of SWM also at lower CO_2 concentrations (air atmosphere and 10% CO_2) as 100% CO_2 totally suppressed it. Due to the beneficial effect of 100% CO_2 after only 24-h at room temperature, we established further experiments. Results revelled a successful control agents SWM after 3-h of exposure to 100% CO_2 at room temperature and subsequent cooling at 4°C.

Presence of *Phytophthora fragariae* var. *rubi* in strawberry orchard in the Republic of Srpska

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Commercial production of soft fruit, specially strawberry (*Fragaria* L.) and raspberry (*Rubus idaeus* L.) has significant development in recent times in the Republic of Srpska territory. *Phytophthora fragariae* var *rubi* Wilcox and Duncan is the primary problem of drying raspberries in the area and it has been included in EPPO A2 quarantine list of damaging organisms. The presence of *Phytophthora fragariae* var. *rubi*, causal agent of root rot was first detected in raspberry producion in the Republic of Srpska in 2008. The fastest pathogen spread distribution is usage of the infected nursery plant material. Once a pathogen enters the production area, can survive in the soil for many years, even in the absence of host plants. In a survey to determine the presence of pathogen, nurseries, and comercial fruit production, as well as imported plant material, were inspected. Last two yeras, in total 208 samples were tested by nested-PCR and isolation followed by identification based on growth in culture and morphological features. Acording to our knowledge, in 2020 for the first time in this area, *Phytophthora fragariae* var. *rubi* was detected in one strawberry orchard production. Nevertheless, during 2021, no positive samples of strawberries were detected but only raspberries. During the last two years, *P. fragariae* var. *rubi* was not detected in any of soil samples tested by baiting method.

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IZVLEČEK

Prisotnost *Phytophthora fragariae* var. *rubi* v nasadu jagod v Republiki Srbski

Komercialna pridelava jagodičja, zlasti jagod (*Fragaria* L.) in malin (*Rubus idaeus* L.), se v zadnjem času močno razvija na ozemlju Republike Srbske. *Phytophthora fragariae* var. *rubi* Wilcox in Duncan je primarni problem sušenja malin na tem območju in je bil uvrščen na karantenski seznam EPPO A2 škodljivih organizmov. Glivo *Phytophthora fragariae* var. *rubi*, povzročitelja gnilobe korenin, smo prvič odkrili v pridelavi malin v Republiki Srbski leta 2008. Najhitrejša distribucija patogena je uporaba okuženega sadnega materiala. Ko patogen enkrat vstopi v proizvodno območje, lahko preživi v tleh več let, tudi če ni gostiteljskih rastlin. V raziskavi za ugotavljanje prisotnosti patogena, so bile pregledane drevesnice in komercialna pridelava sadja ter uvožen rastlinski material. Zadnji dve leti je bilo skupaj 208 vzorcev testiranih z nested-PCR in izolacijo, ki ji je sledila identifikacija na podlagi rasti v kulturi in morfoloških značilnosti. Po naših podatkih je bila gliva *Phytophthora fragariae* var. *rubi* na tem območju prvič ugotovljena leta 2020 v nasadu jagod. Kljub temu v letu 2021 niso zaznali pozitivnih vzorcev jagod, ampak le maline. V zadnjih dveh letih gliva *P. fragariae* var. *rubi* ni bila ugotovljena v nobenem talnem vzorcu, testiranem z metodo vabe.
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Brown marmorated stink bug (*Halyomorpha halys*): population trends in Friuli Venezia Giulia (northeastern Italy)

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In the summer of 2014, the first specimens of *Halyomorpha halys* were found in Friuli Venezia Giulia, North East of Italy, two years after the first report in Italy. In the following years the populations of the stink bug rapidly increased both in density and in the distribution, and since 2018 it is considered present throughout the region. Until 2019 the fruit sector suffered heavy damage to production, unsustainable by farmers. In 2019 the first signs of a decline in populations occurred in some areas. In the last two years, this trend has been confirmed by a clear decline in damages observed mainly by apple producers. In the summer of 2018, the allochthonous parasitoid *Trissolcus mitsukurii* was found in three locations and in the following years it rapidly spread throughout most of the region and numerous *H. halys* egg clusters have been found parasitized. In 2019 was conducted an intense research activity at national level, aimed in modifying the Italian legislation that effectively prohibited the introduction of alien organisms into the environment and providing a risk assessment for *Trissolcus japonicus* (a species similar to *T. mitsukurii* already widespread) that is considered the main parasitoid in the original

distribution area of *H. halys*. In 2020 the National control program against the brown marmorated stink bug by using *T. japonicus* as biological control agent, started. Thank to this program 100 females and 10 males of *T. japonicus* were released in each of 50 sites homogeneously distributed throughout the territory, twice during the summer. From the surveys carried out in 2020 in some of these releasing sites, *H. halys* egg clusters parasitized by *T. japonicus* (previously never found in Friuli Venezia Giulia) were found, while in 2021 *H. halys* population was very low and a reduced number of egg clusters have been found so no more *T. japonicus* findings were observed.

IZVLEČEK

Populacijski trendi marmorirane smrdljivke (*Halyomorpha halys*) v Furlaniji Julijski krajini (severovzhodna Italija)

Poleti leta 2014 so bili v Furlaniji Julijski krajini na severozahodu Italije najdeni prvi primerki marmorirane smrdljivke (*Halyomorpha halys*), le dve leti po njenem prvem odkritju v Italiji. Razširjenost vrste in gostota populacije sta se v naslednjih letih hitro povečevali. Leta 2018 je bila *H. halys* razširjena že v celotni regiji. Do leta 2019 je v pridelavi sadja povzročila izjemno veliko gospodarsko škodo, ki je postala za pridelovalce sadja nevzdržna. Prvi znaki upadanja populacije *H. halys* so bili na nekaterih lokacijah v regiji opaženi leta 2019. V zadnjih dveh letih se trendi upadanja populacije nadaljujejo, zmanjšuje se tudi škoda v pridelavi sadja, kar najbolj opažajo pridelovalci jabolk. V povezavi z upadom populacije *H. halys*, je bil leta 2018 na treh lokacijah v Furlaniji Julijski krajini najden tujeroden jajčni parazitoid *Trissolcus mitsukurii*. Hitro širjenje parazitoida na območju regije je bilo v naslednjih letih potrjeno s številnimi najdbami parazitiranih jajčnih legel marmorirane smrdljivke. S ciljem, da bi dosegli spremembe v italijanski nacionalni zakonodaji na področju biotičnega varstva, ki ni dovoljevala vnosa tujerodnih koristnih vrst za namene zatiranja škodljivih organizmov, so bile leta 2019 v Italiji izvedene številne raziskave jajčnih parazitoidov stenic. Izsledki raziskav so bili sestavni del ocene tveganja za vnos tujerodnega parazitoida *Trissolcus japonicus*, ki je v izvornem okolju glavni parazitoid marmorirane smrdljivke. Leta 2020 je Italija začela izvajati nacionalni program biotičnega varstva marmorirane smrdljivke s parazitoidom *T. japonicus*. Na območju Furlanije Julijske krajne je bil parazitoid izpuščen na 50-ih enakomerno razporejenih lokacijah. Na vsaki lokaciji sta bila v poletnem času opravljena dva izpusta, pri tem je bilo spuščenih po 100 samic in 10 samcev vrste *T. japonicus.* Na mestih izpusta parazitoida so bila v letu 2020 najdena parazitirana jajčna legla *H. halys*, v njih pa je bil navzoč *T. japonicus*, ki pred tem v Furlaniji Julijski krajini še ni bil najden. Leta 2021 so bile populacije *H. halys* v regiji zelo majhne. Ob zmanjšanem številu odkritih jajčnih legel parazitoid *T. japonicus* v letu 2021 ni bil najden.

Sezonska dinamika in gostitelji marmorirane smrdljivke (*Halyomorpha halys* [Stål], Hemiptera, Pentatomidae) v Ljubljani

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V letu 2021 smo v sklopu projekta Euphresco »Improved knowledge about epidemiology and distribution of priority invasive and (re)emerging arthropod pests in fruit crops and grapevines (e.g. *Aromia bungii*, *Popillia japonica*, *Halyomorpha halys*) (2020-A-340)« začeli s spremljanjem zastopanosti marmorirane smrdljivke (*Halyomorpha halys*) v urbanem okolju, in sicer na dveh lokacijah v Ljubljani. Na obeh lokacijah (Laboratorijsko polje Biotehniške fakultete – Rožna dolina in Rakovnik) smo postavili tri feromonske pasti z agregacijskimi feromoni. Marmorirana smrdljivka izvira iz vzhodne Azije, od koder je bila naključno vnesena v ZDA in Evropo, kjer je na nekaterih območjih postala invazivna. Škodljivec napada sadno drevje, jagodičje, vrtnine, koruzo, sojo in vinsko trto, na kjer predstavlja resno grožnjo v pridelavi. Spremljanje številčnosti marmorirane smrdljivke (mlajše ličinke, starejše ličinke, odrasle stenice) v pasteh je potekalo v tedenskih intervalih. V bližini feromonskih pasti smo popisali tudi rastlinske vrste. V juliju, avgustu in septembru smo na rastlinskih vrstah spremljali tudi zastopanost različnih stadijev marmorirane smrdljivke. V prispevku bomo predstavili številčnost marmorirane smrdljike v različnih časovnih intervalih od marca do novembra 2021. Poleg tega bomo predstavili tudi vpliv vremenskih dejavnikov na številčnost škodljivca.

ABSTRACT

Seasonal dynamics and host plants of brown marmorated stink bug (*Halyomorpha halys* [Stål], Hemiptera, Pentatomidae) in Ljubljana

In 2021, as part of the Euphresco project "Improved knowledge about epidemiology and distribution of priority invasive and (re) emerging arthropod pests in fruit crops and grapevines (eg *Aromia bungii*, *Popillia japonica*, *Halyomorpha halys*) (2020-A-340)", we have started to monitor the brown marmorated stink bug (*Halyomorpha halys*) in an urban environment at two locations in Ljubljana. At both locations (Laboratory Field of the Biotechnical Faculty - Rožna dolina and Rakovnik), we have set up three pheromone traps with aggregation pheromones. *H. halys* originates from East Asia but was accidently introduced to the USA and Europe, where it became invasive in some areas. It attacks fruit trees, berries, vegetables, corn, soybeans and vines and is a serious threat to agricultural production therefor. Monitoring of the abundance of brown marmorated stink bug (young larvae, old larvae, adults) in traps was done at weekly intervals. Plant species near the pheromone traps were identified and recorded. We also collected data on the occurrence of different developmental stages of the brown marmorated stink bug on several plant species in July, August and September. In this paper, we will present the abundance of brown marmorated stink bug at different time intervals from March to November 2021. In addition, we will also present the influence of weather parameters on the abundance of insect pest.

Preučevanje vpliva entomotoksičnih lektinov na marmorirano smrdljivko (*Halyomorpha halys*) s prehranskimi testi

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V zadnjih 15 letih so v gobah našli številne entomotoksične lektine. Lektini so raznolika skupina proteinov, ki specifično in reverzibilno vežejo glikane, ne da bi jih pri tem spreminjali. Njihove entomotoksične lastnosti so posledica vezave specifičnih glikanov v tarčnih žuželkah. Toksičnost izbranih lektinov smo testirali na invazivni vrsti kmetijskega škodljivca, marmorirani smrdljivki (*Halyomorpha halys*). Izbrali smo lektine z različno specifičnostjo vezave za glikane in različnimi zvitji, in sicer galektina CGL2 in CGL3 iz gobe *Coprinopsis cinerea*, ki specifično vežeta Gal-β1,4-GlcNAc oziroma GalNAcβ1-4GlcNAc, ter beta-trilistni lektin CCL2 iz iste gobe in beta-propelerski lektin AAL iz gobe *Aleuria aurantia*, ki veže fukozo v različnih glikokonjugatih. Lektine smo pripravili z izražanjem v bakterijskem ekspresijskem sistemu in jih očistili z afinitetno in gelsko kromatografijo. V laboratorijskih poskusih smo za testiranje toksičnosti lektinov na nimfe *H. halys* uporabili umetno gojišče. Tri ml še ne strjenega gojišča (približno 50 °C) smo odpipetirali v 3 ml odmrznjenega lektina (1-4 °C), da smo dobili končno koncentracijo lektina 500 µg/ml. Kot negativno kontrolo smo uporabili pufer PBS, 0,1% raztopina insekticida Mospilan 20 SG (a.s. acetamiprid) je služila kot pozitivna kontrola. Za poskus smo uporabili 250 mm plastične posode, v katere smo prenesli po 6 nimf druge razvojne stopnje. Poskus smo izvedli v treh ponovitvah (n = 18) in ponovili trikrat. Preživelost nimf smo ocenjevali dnevno do 14 dni. Na začetku in koncu vsakega poskusa smo stehtali vse žive nimfe. Pufer PBS ni bil toksičen za preučevane žuželke. Nobeden od testiranih lektinov ni značilno povečal smrtnosti nimf, le pozitivna kontrola (acetamiprid). Preučevani lektini prav tako niso povzročili subletalnih učinkov, ocenjeno po spremembi telesne mase nimf. Poročamo o uspešnem razvoju protokola, s katerim bomo v prihodnje preučili še druge potencialno entomotoksične proteine s ciljem, da bi našli alternative običajnim kemičnim insekticidom.

ABSTRACT

Test of entomotoxic lectins on brown marmorated stink bug (*Halyomorpha halys*) in diet bioassays

In the last 15 years, several entomotoxic lectins have been described in mushrooms. Lectins are a diverse group of proteins that specifically and reversibly bind carbohydrates without altering them and their entomotoxic properties are due to the binding of specific glycans in the target insects. Therefore, we decided to test their toxicity against an invasive agricultural pest, the brown marmorated stink bug (*Halyomorpha halys*). We selected lectins with different specificities for glycans and different folds, namely the galectins CGL2 and CGL3 from *Coprinopsis cinerea*, which specifically bind Gal-β1,4-GlcNAc and GalNAcβ1-4GlcNAc, respectively, and the beta-trefoil lectin CCL2 from the same species, and the beta-propeller lectin AAL from *Aleuria aurantia*, which bind fucose. The lectins were produced in a bacterial expression system and purified by affinity and gel chromatography. To test the toxicity of the lectins to *H. halys* nymphs in laboratory bioassays, artificial diet was used. Three ml of not yet solidified artificial diet (cca. 50 °C) was pipetted into 3 ml of thawed lectin (1-4 °C), to obtain a final lectin concentration of 500 µg/ml. PBS buffer was used as a negative control, 0.1% tap water dilution of the insecticide Mospilan 20 SG (a.s. acetamiprid) served as a positive control. The experiment was conducted in 250 ml plastic containers containing 6 *H. halys* 2nd nymph stages. Experiment was performed in three replicates (n = 18 per treatment) and repeated thrice. Mortality was assessed each day for up to 14 days. At the beginning and end of

each experiment, all live nymphs were weighed. The protein storage buffer (PBS) was non-toxic. None of the lectins tested caused a significant increase in mortality, only the positive control did. The lectins also did not cause sublethal effects, as assessed by the change in body mass of the nymphs. We report the successful development of a testing protocol that we will use in the future to test other proteins for their potential entomotoxicity in order to find alternatives to conventional chemical insecticides.

Odziv marmorirane smrdljivke (*Halyomorpha halys* [Stål], Hemiptera, Pentatomidae) na izbrane kemične snovi

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Marmorirana smrdljivka je predstavnik družine ščitastih stenic. Gre za invazivno, tujerodno in polifagno vrsto, ki izvira iz Vzhodne Azije. Sredi 90-ih je bila vnesena v ZDA ter leta 2004 v Evropo. V Sloveniji smo stenico prvič našli leta 2017 v Šempetru pri Gorici. V slabih dveh letih se je razširila po celotni Sloveniji ter začela povzročati škodo v kmetijski pridelavi. V laboratorijskem poskusu smo preučevali vpliv izbranih kemičnih snovi (citronelal, heksanal, ß-kariofilen, α-kariofilen, linalol, terpinolen, nonanal, dimetil sulfid, etanol, nerolidol, nonanal, ocimen) na gibanje marmorirane smrdljivke. Rezultati so pokazali, da snovi nerolidol, ocimen in terpinolen na gibanje marmorirane smrdljivke delujejo odvračalno. Omenjene snovi imajo potencial v varstvu rastlin. V praksi bi se omenjene snovi lahko namestilo v bližino gojenih rastlin. Ker snovi delujejo kot repelenti bi s tem lahko vplivali na manjši delež poškodb na gojenih rastlinah. V prihodnje bo potrebno izvesti poskuse da lahko potrdimo naše hipoteze.

ABSTRACT

Response of marmorated stink bug (*Halyomorpha halys* [Stål], Hemiptera, Pentatomidae) to selected chemicals

The marmorated stink bug is a representative of the family Pentatomidae. It is an invasive, alien and polyphagous species native to East Asia. It was introduced to the United States in the mid-1990s and to Europe in 2004. In Slovenia, this stink bug was first found in 2017 in Šempeter pri Gorici. In less than two years, it spread throughout Slovenia and began to cause damage in agricultural production. In a laboratory experiment, we studied the influence of selected chemicals (citronellal, hexanal, ß-caryophyllene, α-caryophyllene, linalool, terpinolene, nonanal, dimethyl sulfide, ethanol, nerolidol, nonanal, ocimene) on the movement of the marmorated stink bug. The results showed that the substances nerolidol, ocimene and terpinolene have a repellent effect on the movement of the marmorated stink bug. These substances have potential in plant protection. In practice, these substances could be placed near cultivated plants. Because the substances act as repellents, this could affect a lower proportion of damage to cultivated plants. In the future, experiments will need to be conducted so that we can confirm our hypotheses.

First records of new insect pests in Croatia between two Slovenian conferences on plant protection (2019-2022)

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Three new insect pests were found for the first time in Croatia since the last Slovenian Conference on Plant Protection held in Maribor in 2019. Two of them are invasive, having Eastern Palearctic and Oriental origin, respectively, and one is a Palearctic species widely spread in Europe. Rose flea beetle *[Luperomorpha xanthodera* (Fairmaire, 1888)*]* is an alien species originating from China. In Europe, it was detected for the first time out of its natural habitat in Britain in 2003. Subsequently, the pest has spread rapidly across Europe. Adults are polyphagous, mainly anthophagous, causing damage on plants belonging to 23 genera from 19 botanical families. In Croatia, *L. xanthodera* was found for the first time in August 2019 on flowers of lemon seedlings in nursery in Rovinj. Later during the same year the species was found in additional 14 continental and coastal localities, on nine ornamental plant species from six different families. The ficus whitefly *[Singhiella simplex* (Singh, 1931)*]* is one of the most important pests of various ornamental *Ficus* species worldwide. It is an alien species originating from India. In Europe, the pest was first recorded in Cyprus in 2014. *S. simplex* was intercepted in Croatia in 2019 on potted plants of *Ficus benjamina* L. and *Ficus microcarpa* L.f., originating from the Netherlands. Privet thrips *[Dendrothrips ornatus* (Jablonowski, 1894)*]* is a polyphagous pest, living and breeding on leaves of privet, syringa, ash, alder, hazel and lime. It was found in Croatia in privet hedge *(Ligustrum vulgare* L.) in Čazma, in June 2020. Specimens of all newly recorded species were identified in the Laboratory for zoology to the species level on the basis of morphological characters, using classical identification methods according to relevant morphological keys.

Alien psyllid species (Hemiptera: Psylloidea) recorded in Croatia

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Alien species are recognised as a great threat to biodiversity. Alien terrestrial invertebrates represent one of the most numerous groups of organisms introduced into Europe, with arthropods, mostly insects, being most dominant and representing for nearly 94% of all species within the group. At the order level, Hemipterans are second most represented, accounting for 26% of all alien insects. Most alien insect species spread unintentionally through human activities, mainly by abundant international trade of their host plants. In combination with global warming, many insect species from subtropical and tropical areas

domesticate easily in Europe, particularly in southern regions. Due to their small size, which makes them difficult to detect, Hemipteran species, including psyllids, seem particularly prone to such spread. Psyllids (Hemiptera: Sternorrhyncha: Psylloidea) are a relatively small group of phytophagous insects, with about 4000 described species worldwide. They are highly host specific and feed mostly on perennial Dicotyledonous plants. They are present in all major zoogeographical regions, but show greatest diversity in tropical and south temperate areas. They cause direct damages to their host plants by sucking on the plant sap. Indirect damages are a result of transmission of harmful phytoplasma diseases and abundant excretion of honeydew. So far seven alien species from superfamily Psylloidea have been recorded in Croatia. All species feed on woody ornamentals commonly found in the Croatian coastal region. Their status and distribution will be presented.

A new record in Friuli Venezia Giulia region (northeastern Italy): the black fig weevil (*Aclees taiwanensis* Kôno)

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The black fig weevil *Aclees taiwanensis* Kôno is a beetle harmful to plants of genus *Ficus,* whose xylophagous larvae are capable of causing rapid decay and death of infested plants. This Asian species, after its first findings in 2005, has been causing damage for several years in France and central Italy, but is not currently considered a quarantine pest, so no emergency measures for its containment and / or eradication have been applied. In 2021 *Aclees taiwanensis* was also found in Friuli Venezia Giulia (north-eastern Italy) where the fig is a plant grown mainly in private gardens and where it caused the death of infested trees. In addition to the common fig (*Ficus carica* L.), this species can also infest ornamental plants such as *F. benjamina*, *F. microcarpa*, *F. pandurata*. The black fig weevil can be active throughout the year, with adults overwintering in the ground or in the cracks of the trunks. In the central regions of Italy females can lay more than 180 eggs during the growing season but more in late spring and early summer; in Friuli Venezia Giulia the biological cycle may not match due to different climatic conditions of northern Italy. There is no registered pesticide available to control this pest also due to the difficulty of identifying suitable ones, since the larvae development takes place inside the trunk. In this phase of pest's expansion of the distribution range it is important to be able to identify the symptoms of *Aclees* presence by early detection, the main ones are listed below:

- Presence of adults feeding on fig leaves or on small fruits
- Presence of light brown sawdust at the base of the trunk
- Presence of adult holes in the basal part of the trunk or on the branches
- Progressive decay of the plant or its parts

IZVLEČEK

Figov rilčkar (*Aclees taiwanensis* Kôno): nova najdba v deželi Furlanija Julijska krajina (severovzhodna Italija)

Figov rilčkar *Aclees taiwanensis* Kôno je škodljiv za rastline iz rodu Ficus. Njegove ksilofagne ličinke so sposobne povzročiti hitro sušenje in propad napadenih rastlin. Ta azijska vrsta je v Evropi prisotna od leta 2005. Čeprav že nekaj let povzroča škodo na figah v Franciji in osrednji Italiji, ni uvrščena med karantenske škodljivce, zato tudi niso bili uvedeni nujni ukrepi za njeno zajezitev ali izkoreninjenje. Leta 2021 je bil *A. taiwanensis* prvič najden v Furlaniji Julijski krajini (severovzhodna Italija), kjer je bilo opaženo propadanje fig v zasebnih vrtovih. Poleg fig (*Ficus carica* L.), lahko napada tudi okrasne rastline iz rodu Ficus, kot so *F. benjamina*, *F. microcarpa* in *F. pandurata*. Figov rilčkar je lahko aktiven skozi vse leto. Odrasli hrošči prezimujejo v tleh ali v razpokah figovih dreves. Na območju osrednje Italije lahko samice med rastno dobo odložijo več kot 180 jajčec, večino pozno spomladi in zgodaj poleti. V Furlaniji Julijski krajini, ki leži severneje, se zaradi različnih podnebnih razmer biološki cikel *A. taiwanensis* morda ne ujema povsem s tem, ki je bil ugotovljen v osrednji Italiji. Trenutno ni registriranih fitofarmacevtskih sredstev za zatiranje figovega rilčkarja, kot tudi ni izbora primernih substanc, ki bi učinkovito delovale na ličinke, katerih razvoj poteka v lesu figovih dreves. V fazi širitve škodljivca, je za zgodnje odkrivanje na novem območju pomembno poznavanje znakov napada *A. taiwanensis* kot so: prisotnost odraslih rilčkarjev, ki se hranijo na listih in plodovih fig, prisotnost žagovine v spodnjem delu debla, prisotnost izvrtin, ki jih vrtajo odrasli rilčkarji v spodnjem delu debla in spodnjih vejah ter naglo propadanje dreves ali delov krošnje

High diversity of *Diaporthe* spp. in leaves and twigs of *Diospyros kaki*

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Persimmon has been produced in Slovenia for many years without that plant protection products had to be applied. This changed in recent years after the emergence of *Plurivorosphaerella nawae*, the causal agent of the circular leaf spot and premature fruit drop, identified at the Agricultural Institute of Slovenia in 2019. To further explore occurrence of potentially pathogenic fungi, twigs and leaves showing any kind of symptoms were collected in Slovenian Istria, Goriška Brda, Vipava valley (in 2020 and 2021) and Southeast Slovenia (2020). Fungi retrieved from wood samples or surface disinfected leaves were identified according to morphological characters and barcode sequencing of phylogenetic marker genes. A total of eight different *Diaporthe* species could be identified and even different *Diaporthe* species were sometimes retrieved from the same sample. They included *D. foeniculina*, *D. eres* (known as pathogens of kaki trees), *D.* cf. *amygdali*, *D. mediterranea*, and *D. rudis*, all known to occur in various plant species as endophytes or pathogens. Sporadically, also *D. phaseolorum*, *D. oncostoma* (mainly known from *Robinia* sp.), and *D. pulla* (so far only known from *Hedera* sp.) was isolated. In general, *Diaporthe* causes diverse disease symptoms including twig cankers, wilting and dieback, leaf spots and root and fruit rots. So far, the identified *Diaporthe* species were not found to consistently associate disease phenotypes on kaki. However, the high prevalence of different species of *Diaporthe* on persimmons could become more

problematic when plants are exposed to stress including frost and drought or other consequences that relate to climate change.

IZVLEČEK

Velika raznolikost *Diaporthe* spp. v listih in vejicah kakija *Diospyros kaki*

Kaki se je v Sloveniji že vrsto let prideloval brez uporabe fitofarmacevtskih sredstev. To se je nedavno spremenilo zaradi pojava glive *Plurivorosphaerella nawae*, povzročiteljice listne pegavosti ter prezgodnjega odpadanja listja in plodov, ki smo jo na Kmetijskem inštitutu Slovenije identificirali leta 2019. Za nadaljnje raziskovanje pojavljanja potencialno patogenih gliv smo v Slovenski Istri, Goriških Brdih, Vipavski dolini (v letih 2020 in 2021) in jugovzhodni Sloveniji (2020) vzorčili vejice in liste, ki kažejo kakršne koli simptome bolezni. Glive osamljene iz lesa vej ali površinsko dezinficiranih listov, smo identificirali glede na morfološke lastnosti in zaporedje črtnih kod filogenetskih genskih označevalcev. Skupno smo identificirali osem različnih vrst Diaporthe, kot so *D. foeniculina*, *D. eres* (znani kot povzročiteljici bolezni kakijevih dreves), *D. cf. amygdali, D. mediterranea* in *D. rudis*, za katere je znano, da se pojavljajo v različnih rastlinskih vrstah kot endofiti ali patogeni. Sporadično so bili izolirani tudi *D. phaseolorum, D. oncostoma* (predvsem poznana iz *Robinia* sp.) in *D. pulla* (doslej poznana le iz *Hedera* sp.). Večkrat smo iz istega vzorca pridobili celo različne vrste *Diaporthe*. Na splošno glive rodu *Diaporthe* povzročajo različne simptome bolezni, vključno z razjedami, venenje in odmiranjem vej, pegavosti listov ter gnilobo korenin in plodov. Doslej še nismo potrdili, da bi lahko identificirane vrste *Diaporthe* dosledno povezovali s fenotipom bolezni na kakiju. Vendar pa lahko visoka razširjenost različnih vrst *Diaporthe* na kakiju postane problematična, kadar so rastline izpostavljene stresu, vključno z zmrzaljo, sušo ali drugimi posledicami, ki so povezane s podnebnimi spremembami.

Izbor presejalnih testov za določanje karantenskih bakterij rodu *Xanthomonas* na agrumih

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Zgodnja diagnostika je ključna za zmanjšanje tveganja vnosa in širjenja rastlinskih škodljivcev. Z validacijami in različnimi medlaboratorijskimi primerjavami pridobivamo podatke o zanesljivosti testov, ki se uporabljajo v diagnostiki. Nacionalni inštitut za biologijo je v okviru raziskovalnega projekta VALITEST (Horizon 2020 GA 773139) sodeloval v medlaboratorijski primerjalni študiji laboratorijskih testov za odkrivanje karantenskih bakterij *Xanthomonas citri* pv. *citri* in *Xanthomonas citri* pv. *aurantifoliae*. Te bakterije povzročajo pomembne bolezni pri pridelavi agrumov. V seriji slepih vzorcev, ki jih je pripravil organizator študije, Laboratorij za zdravje rastlin ANSES, Enota za tropske škodljivce in bolezni, smo testirali različne teste na podlagi LAMP, PCR, PCR v realnem času in direktnih molekularnih testov, kateri so bili izvedeni na načinu, ki so primerni tudi za izvedbo na terenu, torej brez izolacije DNK. Na podlagi rezultatov smo

zasnovali optimalno kombinacijo testov za določanje bakterij iz rodu *Xanthomonas* na agrumih, ki zagotavljajo ustrezno občutljivost in specifičnost presejalnega testiranja.

ABSTRACT

Selection of screening tests for detection of quarantine bacteria of the genus *Xanthomonas* in *Citrus spp.*

Early diagnosis is key to reducing the risk of introduction and spread of plant pests. Through validations and various interlaboratory comparisons, we obtain data on the reliability of tests used in diagnostics. As part of the VALITEST research project (Horizon 2020 GA 773139), the National Institute of Biology participated in an interlaboratory comparison study of laboratory tests for the detection of quarantine bacteria *Xanthomonas citri pv. citri* and *Xanthomonas citri pv. aurantifoliae*. These bacteria cause important diseases in citrus production. In a series of blank samples prepared by the study organizer, ANSES Plant Health Laboratory, Unit for Tropical Pests and Diseases, we tested various tests based on LAMP, PCR, real-time PCR methods and direct molecular tests, which were done with on-site compatible approach without DNA isolation. Based on the results, we designed an optimal combination of tests to determine bacteria of the genus *Xanthomonas* on citrus fruits that provide fit-for-purpose sensitivity and specificity of screening testing.

Ambrozijski podlubnik (*Xylosandrus germanus* [Blandford, 1894]) na vinski trti (*Vitis vinifera* L.)

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Ambrozijski podlubnik je polifagna invazivna tujerodna vrsta, ki je bil zabeležen na preko 200 lesnatih rastlinah. V Sloveniji je bil prvič ugotovljen v letu 2000. Za kmetijsko pridelavo je bil do sedaj nevaren zaradi nagnjenosti do sadnih vrst. V letu 2019 smo v Službi za varstvo rastlin na KGZS – Zavodu Novo mesto prvič zabeležili tudi lokaliziran napad na vinski trti. Vzorec iz vinograda na Trški gori pri Novem mestu je bil potrjen na Gozdarskem inštitutu Slovenije. Druga lokacija napada je bila v večjem obsegu v 2020 zabeležena na vinorodnih legah pri Šentrupertu. Pri trtah so znamenja napada slabo opazna, saj lubje zelo zastira črvino. Poškodovano tkivo se v večini primerov hitro prerašča in trs uspešno prenese gostoto podlubnikov, ki bi sicer rastlino pokončala. Odmirati začne šele, ko ga hkrati naseli več deset osebkov podlubnikov. Skrbi nas prihodnja dinamika širjenja in naraščanje škode na vinski trti.

ABSTRACT

Black timber bark beetle (*Xylosandrus germanus* [Blandford, 1894]) on grapevine (*Vitis vinifera* L.)

Black timber bark beetle is a polyphagous, invasive species that has been recorded on over 200 woody plants. In Slovenia it was first identified in 2000. Until now it has been dangerous for agricultural production due to its tendency towards fruit tree species. In 2019, the Plant Protection Service at KGZS - Novo mesto Institute for the first time recorded also localized attack on grapevine. The sample from the vineyard on Trška gora near Novo mesto was confirmed at The Slovenian Forestry Institute. The second location of the attack was recorded on a larger scale in 2020 at the wine-growing sites near Šentrupert. On vines, the signs of attack are poorly visible, as the bark greatly conceals the holes. In most cases, the damaged tissue grows quickly and the cane successfully tolerates the density of beetles that would otherwise kill the tree species. It begins to die only when it is inhabited by dozens of beetles at the same time. We are concerned in the future dynamics of spreading and increasing damage to the grapevine.

Zatiranje ameriškega škržatka (*Scaphoideus titanus* Ball, Hemiptera, Cicadellidae) na vinski trti (*Vitis vinifera* L.) z nahrbtnimi napravami za nanos fitofarmacevtskih sredstev

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V vinogradu v Mirni Peči je bil v letu 2020 postavljen poskus v katerega so bile vključene tri nahrbtne naprave za škropljenje manjših vinogradov. Prva naprava je bila ročna škropilnica Solo 425, druga je bila baterijska škropilnica Solo Accu in tretji motorni pršilnik Solo 444. Zaradi močnega pojava ameriškega škržatka (*Scaphoideus titanus*) na tem območju v zadnjih letih, je bila primerjana kakovost nanosa dveh kontaktnih insekticidov proti temu škodljivcu z omenjenimi napravami. V poskusu je bilo ugotovljeno, da je bil odstotek pokritosti pri vseh treh napravah za škropljenje podoben in je znašal več kot 35 %. Pri motornem nahrbtnem pršilniku je bilo ugotovljeno večje število odtisov kapljic na cm^2. Na zunanjem delu vinske vrte, tako zgoraj kot tudi spodaj, je bil večji odstotek pokritosti z insekticidom kot zgoraj in spodaj v notranjem delu vinske trte. Tudi število odtisov kapljic na cm^2 je bilo na zunanjem delu vinske trte večje kot v notranjosti. Po prvem škropljenju z insekticidom Exirel se število ličink ni bistveno zmanjšalo, medtem ko se je po drugem škropljenju z insekticidom Decis 2,5 EC zmanjšalo na minimum. Rezultati poskusa so pokazali, da se lahko tudi s kakovostnimi ročnimi in baterijskimi škropilnicami doseže primerljiv nanos in delovanje insekticidov za zatiranje ameriškega škržatka kot z motornimi nahrbtnimi pršilniki, ki so trenutno največ v uporabi pri škropljenju manjših vinogradov.

ABSTRACT

Control of leafhopper (*Scaphoideus titanus* Ball Hemiptera, Cicadellidae) on grapevine (*Vitis vinifera* L.) with knapsack sprayers to dispense plant protection products

In the vineyard near Mirna Peč a trial was performed in 2020, containing three backpack sprayers for spraying small vineyards. The first was hand knapsack sprayer Solo 425, the second was battery knapsack sprayer Solo Accu and the last motorized knapsack

mistblower Solo 444. Due to the large abundance of leafhopper (*Scaphoideus titanus*) in this area in the last few years, the quality of spray deposit after spraying with three backpack spraying devices and two contact insecticides to control this pest was compared. In a trial it was established that the spray coverage of all three knapsack spraying devices was similar and amounted over 35 %. When using motorized mistblower the larger number of spray impacts per cm^2 was determined. On the outer part of the grapevine, both on the top and at the bottom, the higher insecticide coverage was established compared to inner part of the grapevine, both at the top and at the bottom. Also the number of spray impacts per cm^2 was larger on the outer part of the vine compared to inner part. After first insecticide spraying using Exirel the number of nymphal instars did not decrease greatly, while after second insecticide spraying with Decis 2,5 EC their number decreased to a minimum. Results gained in a trial showed that comparable spray deposit and insecticide effect on leafhopper can be achieved also with hand knapsack sprayers and battery knapsack sprayers compared to motorized mistblowers, which are generally more frequently used for spraying small vineyards.

Virological examination of a Hungarian vineyard

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Winegrowing and winemaking have been known to mankind for thousands of years. From antiquity to the present day, they have evolved with civilization, social customs, and traditions. The emergence and disappearance of human interventions, natural environmental changes and pathogens have remarkable effects on the development of viticulture. Many viruses may cause significant diseases to the grapes. Plant viruses belong to pathogens that draw attention to their presence in everyday cultivation only when the infected plants show clear symptoms of a disease. The control of viruses is very difficult since the infected plants cannot be cured according to our current knowledge. In the control of viruses, there are difficulties in diagnostics that lead to the need to focus on the use of pathogen-free plant propagating material and to the prevention of the infection. The degree of infection can be determined most reliably by molecular biological methods. The aim of our research was to assess the infection of Grapevine leafroll-associated virus (Grapevine fleck virus) in grapevine from the Northern Transdanubia region using an enzyme-linked immunosorbent assay (ELISA) test. This study also covers the evaluation of the relative dominance of Grapevine leafroll-associated virus 1, Grapevine leafroll-associated virus 2, Grapevine leafroll-associated virus 3, Grapevine leafroll-associated virus 6, Grapevine leafroll-associated virus 7. In 25 of the 60 samples, Grapevine leafroll-associated virus and Grapevine fleck virus were detected. GlRaV1, GLRaV2 variants and GFkV (Grapevine fleck virus) virus were the most common viruses with serologically positive results. This confirms the results of previous studies showing GLRaV1-2 and GFkV as the dominant pathogens among grape viruses in Hungary and in the Northern Transdanubia.

Vpliv medvrstnega posevka na zastopanost plevelov v vinogradu

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Obvladovanje plevelov je pomemben ukrep varstva rastlin v vinogradništvu, sploh v prvih letih po sajenju trt. Ker imajo plevelne rastline veliko tekmovalno sposobnost za hranila in vodo, lahko njihova prisotnost negativno vpliva na rast vinske trte ter posledično na kakovost in količino pridelka. Setev rastlin v medvrstni prostor vinograda ima lahko več pozitivnih učinkov. Poleg povečanja števila koristnih organizmov, zmanjšanja erozije in povečanja vsebnosti organske snovi v tleh je uporaba posevkov priporočljiva tudi z vidika obvladovanja plevelov. V vrstno pestrih posevkih so zastopane rastline z različnim obdobjem in dinamiko rasti, zato so tla v medvrstnem prostoru dalj časa prekrita, kar potencialno zavira rast plevelov. V raziskavi, ki smo jo v letih 2019 in 2020 opravili v vinogradu z integrirano pridelavo grozdja na območju zgornje Vipavske doline (Manče), smo preučevali vpliv posevka na sestavo vegetacije v medvrstnem prostoru v primerjavi z mehansko obdelanimi tlemi. V delu medvrstnega prostora je bil posejan posevek z različnimi vrstami rastlin, primarno namenjenimi privabljanju koristnih organizmov, drugi del pa je po obdelavi ostal gol. V raziskavi smo skozi rastno dobo posevka v medvrstnem prostoru periodično spremljali vznik posameznih vrst posevka, poleg tega pa tudi vznik in rast ostalih rastlinskih vrst. Vznik plevelnih vrst je bil manjši pri rastlinah, težavnih za obvladovanje, kot so trajni pleveli topolistna kislica (*Rumex obtusifolius*), ozkolistni trpotec (*Plantago lanceolata*) in njivski slak (*Convolvulus arvensis*). Zabeležena je bila manjša pokrovnost travnega plevela *Setaria pumila*. Rezultati nakazujejo, da prekrivni posevki – poleg direktnega in indirektnega vpliva na členonožce – hkrati tudi zmanjšujejo tekmovalno sposobnost plevelov v vinogradu.

ABSTRACT

Effect of cover crop on weed presence in vineyard

Weed management is an important part of plant protection in vineyards especially in the first years after sowing. Because of weed competition for water and nutrients their presence can affect vine growth and consequently lower yield quality and quantity. Species-rich cover crops grown between vine rows can have multiple positive effects. Apart from positive effects on beneficial arthropods, soil erosion prevention, organic matter increase, cover crops can also be an effective weed management technique. Because of a mix of plants with different growing periods are sown in a species-rich cover crop, soil is covered for a long period of time and therefore weed emergence and growth is slowed down. A field trial testing the effect of a cover crop on weed population was conducted in 2019 and 2020 in the upper Vipava valley (Manče) in a vineyard under integrated management with inter-row cultivation. One part of the vineyard was sown with a cover crop and the other left as it was (bare soil). During the growing season monitoring of cover crop species as well as other vegetation growth was monitored in the inter-rows of the vineyard. Results show a reduction in weed competition in treatment with cover crop compared to the cultivated treatment. Emergence of weeds difficult to control, such as *Rumex obtusifolius*, *Plantago lanceolata* and *Convolvolus arvensis*, was lower when a cover crop was present. Also a lower land cover of a grass species *Setaria pumila* was recorded in the part with the cover crop. Thus the results indicate that – in addition to

direct and indirect effects on arthropods – cover crops also show a potential to suppress weeds.

Testiranje oljk na navzočnost virusov v Sloveniji

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Oljka je druga najpomembnejša sadna vrsta v Sloveniji. Dovzetna je za okužbe z več virusi, med katerimi jih večina povzroča latentne okužbe. V letu 2016 smo prvič uporabili molekularne metode za preverjanje prisotnosti virusov na oljkah v Sloveniji. Za detekcijo ArMV (virus mozaika repnjaka, arabis mosaic virus), CLRV (virus zvijanja listov češnje, cherry leaf roll virus), CMV (virus mozaika kumare, cucumber mosaic virus), OLYaV (z rumenenjem listov oljke povezani virus, olive leaf yellowing-associated virus) in SLRSV (latentni virus obročkaste pegavosti vrtnega rdečega jagodnjaka, strawberry latent ringspot virus) smo vpeljali enostopenjsko metodo verižne reakcije s polimerazo z reverzno transkripcijo. Začetni oligonukleotidi uporabljeni pri analizi so bili preverjeni v medlaboratorijskem testiranju v Italiji. Od leta 2016 do 2021 smo z dreves v matičnih, kolekcijskih in pridelovalnih nasadih odvzeli 95 vzorcev. Nekatere drevesa so bila v tem času vzorčena večkrat, nobeno pa ni kazalo znamenj okužb z virusi. Do sedaj smo na oljkah v Sloveniji potrdili dva virusa in sicer CMV in OLYaV. Detekcija virusov pri drevesih brez izraženih bolezenskih znamenj se je izkazala za težavno, saj smo pri vzorcih iz istih dreves dobili različne rezultate. Sklepamo, da so posamezni virusi pri določenih sortah neenakomerno porazdeljeni in/ali navzoči v nizki koncentraciji.

ABSTRACT

Testing of olives for the presence of viruses in Slovenia

Olives are the second most important fruit crop in Slovenia. They can be infected by several viruses, although most of infections are latent. Testing olives for virus infections in Slovenia using molecular methods started in 2016. One step RT-PCRs for detection of ArMV (arabis mosaic virus), CLRV (cherry leaf roll virus), CMV (cucumber mosaic virus), OLYaV (olive leaf yellowing-associated virus) and SLRSV (strawberry latent ringspot virus) were introduced. Primers validated in the inter-laboratory testing performed in several Italian laboratories were used. Altogether 95 samples were taken in mother, collection and production orchards. Some tree samples were sampled more than once. None of the trees showed symptoms of viral infection. For now only CMV and OLYaV were found to be present in olive orchards in Slovenia. Detection of viruses in symptomless olives proved to be difficult since viruses could be detected only in some samples collected from the same tree. This indicates that at least some olive infecting viruses are distributed unevenly and/or in low concentrations through the canopy in some varieties.

Problematika zatiranja krvave uši (*Eriosoma lanigerum* [Hausmann, 1802]) v nasadu jablane na območju JV Slovenije

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Krvava uš (*Eriosoma lanigerum*) je za obvladovanje v jablanovih nasadih izrazito zahtevna škodljiva vrsta. Pri njenem zatiranju se srečujemo s problemi učinkovitosti pripravkov in negativnimi vplivi na okolje. Z namenom priprave primerne in učinkovite strategije varstva smo leta 2021 zasnovali poskus v nasadu jablan v okolici Brežic. Poskus je zajemal standardni, integrirani in ekološki pristop varstva. Preverjali smo, kako različni škropilni programi vplivajo na populacijo uši in njihove naravne sovražnike. Pridobljeni rezultati nakazujejo možnost uspešnega zatiranja populacije krvave uši z integriranim in ekološkim pristopom varstva, predvsem v nasadih z manjšo stopnjo napadenosti.

ABSTRACT

Issues of woolly aphid (*Eriosoma lanigerum* [Hausmann, 1802]) control in apple orchards of south-east Slovenia

Woolly aphid (*Eriosoma lanigerum*) in apple orchards is very difficult pest to control. We have problems with the effectiveness of insecticides and negative effects to the environment, especially on beneficial organisms. In 2021 we designed an experiment in apple orchard vicinity Brežice in order to prepare an appropriate and effective protection strategy. The field experiment includes a standard, integrated and ecological plant protection approach. We want to test how different spraying programs effect on the aphid population and their natural enemies. The obtained results show the successful control of woolly aphid populations with an integrated and ecological plant protection approach, especially in orchards with lower infestation levels.

Laboratorijsko preizkušanje mutanta egerolizinskega proteina ostreolizina A kot potencialnega bioinsekticida za zatiranje koloradskega hrošča

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Nedavno so odkrili, da se glivni egerolizinski proteini iz rodu *Pleurotus* vežejo z membranskim sfingolipidom, ceramid fosfoetanolaminom, ki je specifičen za membrane nevretenčarjev. Točkovna mutacija enega teh egerolizinov, ostreolizina A6 (OlyA6) poveča to interakcijo za faktor 1000. V genomu gliv rodu *Pleurotus* se nahajajo tudi nukleotidne sekvence, ki kodirajo proteine z domeno proteinskega kompleksa, ki napadajo membrano (ang. *membrane attack complex/perforin*; MACPF). Proteini z domeno MACPF

lahko v kombinaciji z egerolizini tvorijo transmembranske pore v umetnih in bioloških membranah, ki vsebujejo za egerolizin specifičen lipidni receptor, in posledično delujejo kot selektivni bioinsekticidi za zatiranje koloradskega in koruznega hrošča. Cilj naše raziskave je bil preučiti, če ima zgoraj omenjeni mutant ostreolizina A6 (OlyA6 E69A), ki se na lipidne membrane veže bistveno močneje od divjega tipa, v kombinaciji s partnerskim proteinom z domeno MACPF, pleurotolizinom B (PlyB) tudi višjo insekticidno aktivnost. Insekticidne učinke egerolizinov OlyA6 in OlyA6 E69A v kombinaciji s PlyB smo preučevali na laboratorijski populaciji koloradskega hrošča (*Leptinotarsa decemlineata*). V seriji laboratorijskih poskusov sta oba preučevana egerolizinska kompleksa pokazala toksični vpliv na ličinke koloradskega hrošča. Prehranjevanje ličink z listnimi diski tretiranimi s proteinsko mešanico je značilno povečalo smrtnost ličink in zmanjšalo njihovo prehranjevanje v 5-dnevnem poskusu. Izpostavitev ličink OlyA6 in OlyA6 E69A je imela značilen vpliv na manjši prirast ličink, kar se je odražalo v manjši spremembi njihove mase. Insekticidna učinkovitost obeh preučevanih egerolizinskih kompleksov je bila primerljiva; mutant ostreolizina A6 (OlyA6 E69A) v primerjavi z ostreolizinom A6 (OlyA6) in ni izkazoval večjega učinka na smrtnost in zmanjšanje prehranjevanja ličink.

ABSTRACT

Laboratory evaluation of aegerolysin A6 protein mutant as potential bioinsecticide for Colorado potato beetle control

Recently, aegerolysin proteins from the fungal genus *Pleurotus* were found to interact with ceramide phosphoethanolamine (CPE), a membrane sphingolipid specific for invertebrates. Moreover, a point-specific mutation of the aegerolysin proteins increases this interaction 1000-fold. Moreover, the genomes of these fungi contain nucleotide sequences encoding proteins with a membrane attack complex/perforin domain (MACPF). In combination, aegerolysins and MACPF proteins can perforate artificial and biological membranes containing the specific lipid receptor by forming transmembrane pore complexes with specific pesticide efficacy against Colorado potato beetle and Western Corn Rootworm. Therefore, our aim was to investigate whether the above-mentioned mutant of ostreolysin A6 (OlyA6 E69A), which binds to lipid membranes significantly more strongly than wild type, in combination with a partner protein with MACPF domain, pleurotolysin B (PlyB) also has higher insecticidal activity. The insecticidal properties of both aegerolysins in combination with PlyB, were examined in laboratory-reared larvae of the Colorado potato beetle (CPB; *Leptinotarsa decemlineata*). In serial of laboratory experiments, selected aegerolysin-protein complexes have shown a selective toxic effect to CPB. Exposure of CPB to leaf disks treated with protein mixtures significantly increased larval mortality and decreased their feeding during the 5–day experiment. Exposure of CPB larvae to leaf discs containing OlyA6/ PlyB and OlyA6 E69A/ PlyB significantly affected growth increment of tested larvae, which is reflected in a smaller change in biomass. The insecticidal efficacy of studied egerolysin complexes was comparable, as mutant of ostreolysin A6 (OlyA6 E69A) did not show higher mortality and reduction in larval feeding compared to ostreolysin A6 (OlyA6).

Uporaba šobe z variabilnim pretokom pri zatiranju rdečega žitnega strgača (*Oulema melanopus* L.)

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V poljskem poskusu smo uporabili injektorske šobe z variabilnim pretokom Turbo Drop VR 1,5 HighSpeed. Posebnost te šobe je dodatni ventil na šobi, ki omogoča širše razmerje pretoka (1:3) v območju 2 do 8 bar. Poljski poskus smo izvedli v letu 2020 na Laboratorijskem polju Biotehniške fakultete na treh sortah ozimne pšenice Falago, Gorolka in Illico. Tlaki pri škropljenju z omenjenimi šobami so bili 2, 4 in 6 bar. Za zatiranje rdečega žitnega strgača (*Oulema melanopus* L.**)** smo uporabili kontaktni insekticid na osnovi aktivne snovi deltametrin. Pri škropljenju smo ugotavljali kakovost nanosa z na vodo občutljivimi lističi in kasneje še poškodbe listne površine na zgornjih dveh listih ozimne pšenice. Poskusne parcele smo poželi s parcelnim kombajnom Wintersteiger in na koncu izračunali parametre pridelka po obravnavanjih. V prispevku bo prikazani rezultati kakovosti nanosa insekticida, odstotek poškodb listne površine zaradi rdečega žitnega strgača in parametri pridelka pri 3 tlakih škropljenja s šobo Turbo Drop VR 1,5 HighSpeed.

ABSTRACT

The use of variable rate nozzle for the chemical control of cereal leaf beetle

In the field trial injector nozzles with variable flow rate Turbo Drop VR 1,5 HighSpeed were used. A special feature of this nozzle is the additional valve on the nozzle, which allows a wider flow ratio (1: 3) in the range of 2 to 8 bar. In 2020 field trial was executed on the Laboratory field of Bioetchnical faculty with three winter wheat varieties Falago, Gorolka and Illico. Spraying pressures with the above mentioned nozzles were 2, 4 and 6 bar. For the chemical control of cereal leaf beetle (*Oulema melanopus* L.) contact insecticide based on active ingredient deltamethrine was used. At spraying we analyzed the deposit quality using water sensitive papers and later on the leaf damage on upper two leaves of winter wheat. The field plots were harvested by the plot harvester Wintersteiger and at the end grain yield parameters were calculated according to treatments. In the paper results of deposit quality, percentage of damaged leaf area due to cereal leaf beetle and yield parameters at three spraying pressures using Turbo Drop Vr 1,5 Hidg Speed nozzle will be presented.

Nove najdbe jajčnega parazitoida *Trichogramma brassicae* Bezdenko (Hymenoptera, Trichogrammatidae) v Sloveniji

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V avgustu in septembru 2021 smo na njivah s koruzo na različnih območjih Slovenije vzorčili jajčna legla koruzne vešče (*Ostrinia nubilalis* [Hübner]) z namenom preučitve zastopanosti jajčnih parazitoidov iz rodu *Trichogramma*. Pri nabiranju vzorcev so sodelovale tri inštitucije, in sicer Biotehniška fakulteta v Ljubljani, Inštitut za hmeljarstvo in pivovarstvo Slovenije iz Žalca ter KGZS - Kmetijsko gozdarski zavod Maribor. Pregledali smo 46 njiv s koruzo, na 31 lokacijah (njivah) oz. 67 % pregledanih lokacij pa smo našli jajčna legla koruzne vešče. Na območju osrednje Slovenije smo nabrali 14 vzorcev, na območju JV Slovenije 15 vzorcev, Štajerske in Koroške 10 vzorcev in na območju SV Slovenije 7 vzorcev. Po 14-21 dneh od datuma nabiranja oz. njihovega hranjenja v Laboratoriju za fitomedicino na Biotehniški fakulteti, smo vzorce pregledali z namenom ugotovitve parazitiranosti jajčnih legel. V petih vzorcih (jajčnih leglih), na 11 % pregledanih lokacij oz. na 16 % lokacij, na katerih smo našli jajčna legla, smo potrdili parazitiranost. Parazitoide iz rodu *Trichogramma* smo shranili v 95 % etanol in jih poslali v molekulsko identifikacijo v Kalifornijo (ZDA, University of California, Department of Entomology, Riverside). Dr. Paul Rugman-Jones je vseh pet vzorcev, enega iz JV Slovenije, dva s Štajerske in Koroške in dva iz SV Slovenije določil kot vrsto *Trichogramma brassicae* Bezdenko, ki spada med najbolj prepoznavne naravne sovražnike koruzne vešče (*Ostrinia nubilalis* [Hübner]) na JV Evrope. V prispevku bodo podrobneje predstavljene lokacije najdb tega pomembnega jajčnega parazitoida, katerega potrditev zastopanosti v Sloveniji ima veliko uporabno vrednost za biotično varstvo rastlin.

ABSTRACT

New records of egg parasitoid *Trichogramma brassicae* Bezdenko (Hymenoptera, Trichogrammatidae) in Slovenia

In August and September 2021, we have sampled egg clusters of European corn borer (*Ostrinia nubilalis* [Hübner]) in corn fields in different parts of Slovenia in order to study the presence of egg parasitoids from the genus *Trichogramma*. Three institutions participated in the collection of samples, namely the Biotechnical Faculty in Ljubljana, the Institute of Hop Growing and Brewing of Slovenia from Žalec and KGZS – Institute of Agriculture and Forestry Maribor. We have inspected 46 fields with corn, while at 31 locations (fields) or at 67 % of the inspected locations were found egg clusters of corn borer. We have collected 14 samples in the area of central Slovenia, 15 samples in the area of SE Slovenia, 10 samples in Štajerska and Koroška area and 7 samples in the area of NE Slovenia. After 14-21 days from the date of collection (their storage in the Laboratory of Phytomedicine at the Biotechnical Faculty), we have examined the samples in order to determine the parasitism of egg clusters. In five samples (egg clusters), at 11 % of inspected locations or at 16 % of the locations where eggs were found, their parasitism was confirmed. Parasitoids of the genus *Trichogramma* were stored in 95% ethanol and sent for molecular identification to California (USA, University of California, Department of Entomology, Riverside). Dr. Paul Rugman-Jones identified all five samples, one from SE Slovenia, two from Štajerska and Koroška and two from NE Slovenia, as *Trichogramma brassicae* Bezdenko, one of the most recognizable natural enemies of *Ostrinia nubilalis* [Hübner] in SE Europe. In the paper we will present more extensively the locations of

findings of this significant egg parasitoid, which confirmation in Slovenia is of a great importance for biological control.

Laboratorijsko preučevanje insekticidnega delovanja prahov invazivnih tujerodnih rastlinskih vrst v samostojni uporabi in kombinacijah z lesnim pepelom in diatomejsko zemljo na riževega žužka (*Sitophilus oryzae*, Coleoptera, Curculionidae)

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V laboratorijskih razmerah smo preučevali insekticidno delovanje prahov štirih invazivnih tujerodnih rastlinskih vrst (navadne amorfe [*Amorpha fruticosa*], velikega pajesena [*Ailanthus altissima*], kanadske zlate rozge [*Solidago canadensis*] in octovca [*Rhus typhina*]) v samostojni uporabi in v kombinacijah z lesnim pepelom in diatomejsko zemljo. Cilj naloge je bil preučiti učinkovitost navedenih prahov za zatiranje riževega žužka (*Sitophilus oryzae*) pri različnih temperaturah in različnih vrednostih relativne zračne vlage. Insekticidno delovanje prahov smo preučevali pri dveh različnih temperaturah (20 in 25 °C) in pri dveh vrednostih relativne zračne vlage (Rh) (55 in 75 %). Pšenico smo mešali z različnimi kombinacijami prahov v večjih erlenmajericah. Ugotovili smo nizko smrtnost pri samostojni uporabi rastlinskih prahov. Diatomejska zemlja je pokazala visoko učinkovitost pri samostojni uporabi, pri manjši koncentraciji v kombinacijah z rastlinskimi prahovi pa je njihova učinkovitost značilno padla. To pomeni, da ne obstaja dovolj sinergije med rastlinskimi prahovi in diatomejsko zemljo, medtem ko smo pri uporabi lesnega pepela ugotovili zadovoljivo učinkovitost, tako pri samostojni uporabi kot v kombinacijah z rastlinskimi prahovi.

ABSTRACT

Investigation on insecticidal efficacy of invasive alien plants powders in individual use and combinations with wood ash and diatomaceous earth against rice weevil (*Sitophilus oryzae*, Coleoptera, Curculionidae) under laboratory conditions

In this study, we studied the insecticidal activity of powders of four different invasive alien plant species under laboratory conditions, namely: 1) false indigo (*Amorpha fructicosa),* 2) tree of heaven (*Ailanthus altissima*), 3) Canada goldenrod *(Solidago Canadensis*) and 4) staghorn sumac (*Rhus typhina*), used alone and in combination with wood ash and diatomaceous earth. The goal of the task was to study the effectiveness of powders of four invasive alien plant species and combinations with wood ash and diatomaceous earth for the control of rice weevil (*Sitophilus oryzae*) at different temperatures and different air humidity values. The insecticidal action of the selected powder formulations and the effect of the prepared formulations were studied at two different temperatures (20 and 25 °C) and at two values of relative air humidity (Rh) (55 and 75 %). Wheat was mixed in various combinations in larger erlenmeyer flasks. We found low mortality in the independent use of plant powders. Diatomaceous earth showed high efficacy when used alone, but when we reduced the concentration in the combinations with plant powders, the efficacy dropped. This means that there is not enough synergy between plant dusts and diatomaceous earth. On the other hand, we found satisfactory efficiency in the use of wood ash, both in single use and in combinations, against rive weevil.

Inovativne metode zatiranja strun (Coleoptera: Elateridae) v krompirju

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Strune (Coleoptera: Elateridae) so pomembni škodljivci krompirja, saj s prehranjevanjem povzročijo majhne luknje na površini gomolja, lahko pa se zavrtajo tudi globoko v gomolje in tako omogočijo vstop rastlinskim patogenom. Z namenom vrednotenja učinkovitosti nekaterih inovativnih strategij za zatiranje strun smo v okviru EU projekta ECOBREED izvedli dva poljska poskusa v letu 2020 in dva v letu 2021. Preizkusili smo različne pripravke na osnovi entomopatogenih gliv iz rodu *Metarhizium*, in sicer bioinsekticid Attracap (Biocare GmbH; priporočena doza in polovična doza), šest najvirulentnejših KIS glivnih izolatov formuliranih na rižu (krompir + riž), namakanje gomoljev semenskega krompirja v glivni suspenziji šestih KIS najvirulentnejših izolatov (krompir + gliva) ter njuno kombinacijo (krompir + gliva + riž). Kemični insekticid Force (Syngenta, aktivna snov teflutrin, 15 g/kg) smo uporabili kot pozitivno kontrolo. Učinkovitost pripravkov smo ovrednotili na podlagi povprečnega števila lukenj na posamezen gomolj, deleža poškodovanih gomoljev in količine pridelka gomoljev. V primerjavi s kontrolo (krompir) je bilo v obeh letih število lukenj na posamezen gomolj in delež poškodovanih gomoljev manjši v vseh obravnavanjih, vendar nobeno od teh ni doseglo primerljive učinkovitosti s pozitivno kontrolo (Force). Pri bioinsekticidih se je v letu 2020 kot najučinkovitejša izkazala uporaba polovične doze bioinsekticida Attracap, saj je zmanjšala število lukenj na gomolj za 28.6 % in delež poškodovanih gomoljev za 12.8 %. V letu 2021 je bil najučinkovitejši bioinsekticid krompir + riž, saj je bilo v primerjavi s kontrolo število lukenj na gomolj manjše za 39.5 % in delež poškodovanih gomoljev manjši za 41.7 %. Vpliv obravnavanj na količino pridelka gomoljev je bil med sezonama nekonsistenten, saj sta se Attracap (polna doza) in krompir + gliva + riž kot najmanj uspešni v letu 2020, v letu 2021 izkazali za obravnavanji z največjim pridelkom. Bioinsekticidi na osnovi entomopatogenih gliv so se torej izkazali kot potencialna alternativa kemičnim insekticidom, posebno formulacija gliv na rižu, ki izkazuje višjo učinkovitost od komercialnih bioloških pripravkov in učinkovitost, primerljivo s kemičnim insekticidom.

ABSTRACT

Inovative wireworm (Coleoptera: Elateridae) control strategies in potato

Wireworms (Coleoptera: Elateridae) are important pests of potatoes, as they cause small holes in the surface of the tuber when feeding. However, they can also tunnel deep into the tubers, allowing entry of plant pathogens. In order to evaluate several innovative strategies for wireworm control in potato fields within EU project ECOBREED, we set up two field experiments in year 2020 and two in 2021. Various preparations based on entomopathogenic fungi of the genus *Metarhizium* were tested, namely the bioinsecticide Attracap (Biocare GmbH; full dose and half dose), six most virulent KIS fungal isolates

formulated on rice (potato + rice), potato tubers soaked in fungal suspension of the six KIS most virulent isolates (potato + fungi), and a combination of the latter two (potato + fungi + rice). The chemical insecticide Force (Syngenta, active ingredient Tefluthrin, 15 g/kg) was used as a positive control. The effectiveness of the treatments was evaluated by the number of holes per tuber, percentage of damaged tubers and tuber yield. Compared to the control (potato), the number of holes per tuber and the percentage of damaged tubers were lower for all treatments in both years, but none of them reached the success level of the positive control (Force). Compared to the control, the most effective bioinsecticide in 2020 was half dose of bioinsecticide Attracap, as it reduced the number of holes per tuber by 28.6 % and the percentage of damaged tubers by 12.8 %. In 2021, the most successful bioinsecticide was potato + rice as it reduced the number of holes per tuber by 39.5 % and the percentage of damaged tubers by 41.7 %. Tuber yield results were inconsistent between seasons as Attracap (full dose) and potato + fungus + rice, which were least successful in 2020, proved to be the treatments with the highest yield in 2021. Biopesticides containing entomopathogenic fungi can be considered as potential alternatives to chemical insecticides, particularly fungi formulated on rice, as they show higher efficacy than commercial bioinsecticides and similar efficacy to chemical insecticides.

Predstavitev raziskovalnega projekta: pomen hlapnih izločkov korenin gojenih rastlin pri posredni obrambi pred talnimi škodljivimi žuželkami (J4-3090)

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Ob napadu žuželk, številne rastlinske vrste začno sproščati hlapljive snovi, ki privabljajo njihove naravne sovražnike. Hlapljive snovi imajo pomembno vlogo v multitrofičnem sistemu, ki ga sestavljajo rastlina, herbivor in njegov naravni sovražnik. Delujejo kot neke vrste kemični signali, ki neposredno vplivajo tako na herbivora kot tudi na njegovega naravnega sovražnika. Nekatere od teh snovi nastanejo v poškodovanih kot tudi v nepoškodovanih rastlinah. Hlapljive snovi, ki jih izločajo rastline lahko na koristne organizme delujejo tako privabilno (atraktanti) kot tudi odvračalno (repelenti). V projektu J4-3090 (Pomen hlapnih izločkov korenin gojenih rastlin pri posredni obrambi pred talnimi škodljivimi žuželkami) raziskovalci iz treh institucij (UL - Biotehniška fakulteta, UM – Fakulteta za kmetijstvo in biosistemske vede in Kemijski inštitut Slovenije) preučujejo kemotropizem entomopatogenih ogorčic (EPO) s poškodovanimi in nepoškodovanimi koreninami rastlin paprike (*Capsicum annum*), solate (*Lactuca sativa*) in navadnega hrena (*Armoracia rusticana*). Poškodbe korenin bodo povzročili talni škodljivci, in sicer strune (*Agriotes lineatus*, Elateridae). Cilji projekta: (1) z našo raziskavo želimo obogatiti obstoječe znanje iz področja multitrofičnega komuniciranja med organizmi; (2) glavni namen raziskave je predvsem ugotoviti kdo je glavni komunikator z EPO – rastlina ali herbivor; (3) v primeru potrditve teze, da rastlina oz. herbivor proizvajata semiokemikalije, ki delujejo privabilno na EPO bo mogoče v prihodnje razviti feromonske kapsule na podlagi glavne aktivne snovi, ki bi privabile EPO h koreninam rastlin v večjem številu in s tem bi poskrbeli za njihovo večjo zaščito; (4) optimizacija načinov biotičnega varstva

rastlin pred škodljivimi organizmi in njihova implementacija v pridelavo živeža; (5) razvoj optimiziranih postopkov za vzorčenje in analizo semiokemikalij na izbranih organizmih. Poznavanje komunikacije med rastlinami, herbivori in njihovimi naravnimi sovražniki je ključnega pomena pri učinkovitejši implementaciji in optimizaciji biotičnega varstva v sisteme pridelave živeža.

ABSTRACT

Presentation of the research project: significance of volatile compounds released by roots of cultivated plants for indirect defence against soil pests (J4-3090)

When attacked by harmful organisms, many plant species release volatile compounds (VOCs) which attract natural enemies of herbivores. VOCs have an important role in a multitrophic system, which consists of a plant, a herbivore and its natural enemy. Their function is a chemical signal which directly influence both herbivore and its natural enemy. Certain compounds are produced both by damaged and undamaged plants. VOCs released by plants affect organisms in rhizosphere at different trophic levels either as attractants or as repellents. In project J4-3090 (Significance of volatile compounds released by roots of cultivated plants for indirect defence against soil pests) researchers from three institutions (UL - Biotechnical Faculty, UM - Faculty of Agriculture and Life Sciences and National institute of chemistry) study chemotropism of entomopathogenic nematodes (EPNs) with damaged and undamaged roots of the red pepper (*Capsicum annum*), lettuce (*Lactuca sativa*) and horseradish (*Armoracia rusticana*). The roots will be exposed for damage to soil pests, namely wireworms (*Agriotes lineatus*, Elateridae). Goals of the study are (1) to enrich the existing knowledge about multitrophic communications in rhizosphere; (2) to detect the principal communicators with EPNs– a constitutive or herbivore induced plant metabolites; (3) to evaluate the potential of biologically active VOCs as agents in plant protection against soil pests; (4) to develop optimised procedures for sampling and analysis of semiochemicals on the selected organisms. The hypothesis is that a plant produces semiochemicals which trigger activity of EPNs as attractants. If confirmed, the results and gained knowledge can be exploited to develop pheromone capsules based on the main active compounds which would attract EPNs to the roots of plants in larger numbers and would thus ensure their better protecion. Knowledge about the communication between plants, herbivores, and their natural enemies is crucial for more efficient implementation and optimisation of biological control in food production systems.

Natural decline of population of *Globodera pallida* in Rogatica, Bosnia and Herzegovina

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White potato cyst nematode (*Globodera pallida*) has been found for the first time in Bosnia and Herzegovina in 2012 in a potato field in municipality Rogatica, Republic of

Srpska. The distribution of the cysts within the field was assessed by dividing it on 46 plots 20X10 m. Each plot was sampled and number of cysts and their content was determined. The highest density was 177 cysts per 200 ml of soil. Average number of eggs per cyst was 54. The field was under official measures of ban of growth of potato and other hosts of potato cysts nematodes. The population decline was monitored every two years. After two years, decline of eggs per cyst of 81.7% was recorded, but after the next two years, there was no further decline of the nematode population. Sixt and eight years after the first finding there was no live content in the cysts. Eight years after first finding offical ban on potato growth was lifted. The official measure of ban of potato growth on the field infested with *G. pallida,* allowed the natural decline of nematode populations that resulted in the absence of vital eggs from the soil.

ABSTRACT

Naravni upad populacije *Globodera pallida* v Rogatici, Bosna in Hercegovina

Bela krompirjeva ogorčica (*Globodera pallida*) je bila prvič najdena v Bosni in Hercegovini leta 2012 na njivi s krompirjem v občini Rogatica, Republika Srbska. Razporeditev cist na njivi smo ocenili tako, da smo njivo razdelili na 46 ploskev 20x10 m. Vsako ploskev smo vzorčili ter določili število cist in njihovo vsebino. Največja gostota je bila 177 cist na 200 ml tal. Povprečno število jajčec na cisto je bilo 54. Njiva je bila pod uradnim ukrepom prepovedi pridelave krompirja in drugih gostiteljev krompirjevih ogorčic. Upadanje populacije ogorčic smo spremljali vsaki dve leti. Po dveh letih smo zabeležili upad jajčec na cisto za 81,7 %, po naslednjih dveh letih pa ni bilo nadaljnjega upadanja populacije ogorčic. Šest in osem let po prvi najdbi v cistah ni bilo žive vsebine. Osem let po prvi ugotovitvi ogorčic je bila uradna prepoved pridelave krompirja odpravljena. Uradni ukrep prepovedi rasti krompirja na njivi, okuženi z *G. pallida*, je omogočil naravni upad populacij ogorčic, kar je povzročilo odsotnost vitalnih jajčec iz tal.

Primerjava metod za zmanjševanje dimenzij hiperspektralnih podpisov na zgledu krompirja napadenega z ogorčicami koreninskih šišk

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Hiperspektralno slikanje predstavlja sodobno tehnologijo za zaznavanje bolezni rastlin na ne-invaziven način. Zajete slike vsebujejo večje število spektralnih kanalov (navadno več kot 100), na podlagi katerih se izvaja analiza. Njihova relevantnost je specifična za posamezni primer in je odvisna od objektov zaznavanja. Visoko število spektralnih kanalov pomeni, da so podatki visoko dimenzionalni in klasične statistične metode analize podatkov niso primerne. Metode za zmanjševanje dimenzij omogočajo izločevanje nepomembnih kanalov s pretvorbo celotnega nabora kanalov in izdelavo novih spremenljivk ali z izborom kanalov z največjim vplivom na razlike med razredi oziroma predmeti. V tej raziskavi smo analizirali hiperspektralne posnetke gomoljev krompirja (*Solanum tuberosum*) cv. Desiree napadene z ogorčicami koreninskih šišk vrste *Meloidogyne luci* in kontrolne zdrave gomolje. Dimenzionalnost podatkov smo zmanjšali do samo ene nove spremenljivke oziroma omejenega števila izbranih kanalov. Primerjali

smo šest pogosto uporabljenih algoritmov (metoda delnih najmanjših kvadratov, linearno diskriminantno analizo, analizo glavnih komponent, naključne gozdove, metodo ReliefF in ekstremno gradientno spodbujevanje), ki smo jih preizkusili na spektralnih podpisih gomoljev krompirja. Slednje smo razdelili na dve skupini: (1) zdravi gomolji, in (2) napadeni gomolji z jasno vidnimi znaki napada ogorčic. Učinkovitost posamezne metode smo ovrednotili s klasifikatorjem podpornih vektorjev in njegovo sposobnostjo razločevanja posameznih razredov. Najboljši rezultat smo dobili z uporabo linearne diskriminantne analize, s katero smo dosegli 100% natančnost klasifikacije. Ostali algoritmi so bili prav tako uspešni, vsi so dosegli zanesljivost klasifikacij najmanj 0,6. Rezultati te raziskave kažejo, da lahko tudi skrajno reducirani hiperspektralni podatki, s samo eno pretvorjeno spremenljivko, dosežejo visoko zanesljivost klasifikacij.
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ABSTRACT

Comparison of dimensionality reduction methods of hyperspectral signatures of potato tubers infested by root-knot nematodes

Hyperspectral imaging represents a modern technology for non-invasive detection of plant diseases. Captured images contain a large number of spectral channels (usually more than 100), which are used for analysis. Relevancy of these channels is case specific and consequently depends on observed objects. A high number of spectral channels means that data are highly dimensional and classical statistical methods of data analysis are not appropriate. Methods for reducing dimensions allow the elimination of irrelevant channels by converting the entire set of channels and creating new variables or by selecting channels with the greatest impact on differences between classes or objects. In this study, we analysed hypespectral images of potato tubers (*Solanum tuberosum*) cv. Desiree infested with root-knot nematode *Meloidogyne luci,* and healthy control tubers. We reduced the dimensionality of the data to only one new variable or a limited number of selected channels. We compared six commonly used algorithms (Partial least squares, Linear discriminant analysis, Principal component analysis, RandomForest, ReliefF, and Extreme gradient boosting), which we tested on spectral signatures of potato tubers. The latter were divided into two groups: (1) healthy tubers, and (2) infested tubers with clearly visible signs of nematode infestation. The efficacy of each dimensionality reduction method was evaluated with support vector machine classifier and its discriminatory ability of individual classes. The best result was obtained using linear discriminant analysis, which achieved 100% accuracy. The other algorithms were also relatively successful, all achieving a reliability of at least 0.6. The results of this study indicate, that even a severely reduced hyperspectral dataset, with just one extracted feature, can still enable high classification success.

Neinvazivno določanje zastopanosti talnih škodljivcev in suše pri koruzi z uporabo hiperspektralnega slikanja

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Koruza zahteva zadostne količine vode v vseh stopnjah svojega razvoja, da doseže optimalno količino in kakovost pridelka. Zaradi plitvih korenin je koruza občutljiva na pomanjkanje vode in hranil v tleh. Cilj integriranih praks pridelave je ublažiti te dejavnike z minimalno uporabo fitofarmacevtskih sredstev, hkrati pa ohraniti trenutne pridelke ali jih po možnosti povečati. Hiperspektralno slikanje omogoča neinvazivno odkrivanje napadov škodljivcev, ter ločevanje med biotskim in abiotskim virom stresa. Hiperspektralni sistemi zajemajo slike, ki so sestavljene iz številnih prostorskih slikovnih ravnin istega objekta različnih valovnih dolžin. Območje svetlobnega spektra od 400 do 2500 nm vsebuje informacije o rastlinskih pigmentih, celični zgradbi listov in vsebnosti vlage. V tej raziskavi smo analizirali hiperspektralne posnetke dveh hibridov koruze, ZP 341 in Futurixx, v skupno 28 različnih obravnavanjih; kombinacije prisotnost/odsotnost sušnega stresa, dveh koreninskih škodljivcev (ogorčic koreninskih šišk *Meloidogyne luci* in ličink koruznega hrošča *Diabrotica v. virgifera*), dveh mikrobih inokulumov (*Bacillus firmus* sev I-1582 in *Trichoderma afroharzianum* sev 2885), ter kontrolnih skupin. Hiperspektralne slike smo radiometrično korigirali, segmentirali in preračunali v svetlobni odboj. Iz teh podatkov smo izračunali povprečne spektralne podpise vseh rastlin, ter izračunali Savitzky-Golay derivate drugega reda. Klasifikacije smo izvedli z metodo ekstremnega gradientnega spodbujevanja. Ločevanje vseh 28ih obravnavanj je doseglo 75% uspešnost. Z delitvijo podatkov na podenote glede na skupino obravnavanja smo izboljšali zanesljivosti klasifikacij nad 80%. Na primer, določanje prisotnosti škodljivcev je doseglo 85% pravilnih uvrstitev, določanje sušnega stresa 91%, ter določanje prisotnosti mikrobnih inokulumov 82%. Visoka zanesljivost določanja biotskega stresa nad 85% je bila dosežena tudi ob dodatni delitvi glede na prisotnost sušnega stresa. Podoben rezultat je bil pri ločevanju hibrida koruze, kjer je pri hibridu Futurixx zanesljivost 87%, med tem ko je pri ZP 341 81%. Rezultati nakazujejo, da je možno razmeroma zanesljivo neinvazivno določiti prisotnost talnih škodljivcev pri koruzi, ne glede na hibrid koruze in prisotnost sušnega stresa. Zahvala: finančna podpora s strani ARRS (MR 38128, MR 54720, MR 52034, L4-1840, P4-0072, P4-0431).

ABSTRACT

Non-invasive detection of root pests and drought in maize using hyperspectral imaging

Maize requires sufficient amounts of water at all stages of its development to achieve optimal quantity and quality of the crop. Maize is sensitive to lack of water and lack of nutrients in the soil, because of its shallow roots. The aim of integrated management practices is to mitigate these factors with minimal use of pesticides, while maintaining current yields or even increasing them where possible. Hyperspectral imaging enables non-invasive detection of pests, as well as the separation between biotic and abiotic stress. Hyperspectral systems include images that consist of many spatial image planes of the same object of different wavelengths. The light spectrum range from 400 to 2500 nm contains information on plant pigments, leaf cell structure and moisture content. In this study, we analysed hyperspectral images of two maize hybrids, ZP 341 and Futurixx, in a total of 28 different treatments: combinations of presence/absence of: (1) drought stress, (2) two root pests (root knot nematode *Meloidogyne luci* and western corn rootworm *Diabrotica v. virgifera* larvae), two microbe inocula (*Bacillus firmus* strain I-1582 and

Trichoderma afroharzianum strain 2885), and control groups. Hyperspectral images were radiometrically corrected, segmented and converted into light reflection. From these data, we calculated the average spectral signatures of all plants, and calculated second-order Savitzky-Golay derivatives. Classifications were performed using Extreme gradient boosting. Separation of all 28 treatments achieved 75% success. By dividing the data into subunits according to treatment, we improved the reliability of classifications above 80%. For example, the success of correct pest detection was 85%, detection of drought stress 91%, and detection of microbial inoculants 82%. A high success rate of biotic stress detection above 85% was achieved even when data were additionally divided according to drought stress. A similar result was obtained when separating the maize hybrid, where the reliability of the Futurixx hybrid was 87%, while that of ZP 341 was 81%. The results suggest that a relatively reliable non-invasive detection of root pests in maize is possible, regardless of maize hybrid or the presence of drought stress.

Daljinsko zaznavanje učinkov bakterije *Bacillus firmus* v rizosferi paradižnika

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Ogorčice koreninskih šišk (RKN) so najpomembnejša skupina rastlinsko-parazitskih ogorčic, ki zajedajo širok nabor gostiteljskih rastlin in lahko privedejo do gospodarske škode zaradi zmanjšanja ali izpada pridelka. Kemični nematicidi so primarni način varstva pred RKN. Zaradi ekotoksičnosti večinoma niso več v široki uporabi, zaradi česar je potrebno razvijati nove strategije obvladovanja, vključujoč biotično varstvo rastlin. Primer so bakterije seva *Bacillus firmus* I-1582, ki delujejo nematicidno, vendar pa o naravi nematicidnega delovanja ter spodbujanja rasti rastlin ni veliko znanega. Študijo smo zastavili v več delih: 1) Ovrednotili smo nematicidno aktivnost bakterije *B. firmus* I-1582 proti RKN *Meloidogyne luci* v lončnem poskusu in poskusu na mikroparcelah. 2) Z bioinformacijsko analizo smo določili genetsko osnovo bakterij *B. firmus* I-1582 za spodbujanje rasti rastlin in jo primerjali z izmerjenimi vsebnostmi elementov v listih. 3) Izmerili smo učinke bakterij na fiziologijo rastlin in biološko aktivnost substrata/zemlje. 4) Testirali smo uporabnost hiperspektralnega slikanja za klasifikacijo rastlin v različnih obravnavanjih. V lončnem poskusu je sev I-1582 zmanjšal število ogorčic za 51%, v poskusu na mikroparcelah pa za 53% v primerjavi z netretirano kontrolo. Prisotnost bakterij *B. firmus* I-1582 v rizosferi je vodila v sočasno nematicidno delovanje ter spodbudila rast rastlin, glede na meritve morfologije rastlin, relativne vsebnosti klorofila, vsebnosti elementov in analizo hiperspektralnih posnetkov. Pri sevu smo našli gene povezane z različnimi mehanizmi privzema hranil. S hiperspektralnim slikanjem v območju spektra 400-2500 nm ter nadzorovano klasifikacijo z metodo delnih najmanjših kvadratov in podpornih vektorjev, smo uspešno razlikovali med rastlinami, tretiranimi z *B. firmus* in rastlinami brez dodanih bakterij. V lončnem poskusu smo dosegli 97,4% natančnost, na mikroparcelah pa 96,3%. Za razlikovanje so bila najpomembnejša območja v vidnem in kratkovalovnem infrardečem delu spektra, ki so sicer povezana s klorofilom, N–H ter C–N vezmi v beljakovinah. Zahvala: finančna podpora s strani ARRS in MKGP (MR 38128, P4-0072, V4-1602).

ABSTRACT

Remote sensing of effects of *Bacillus firmus* in tomato rhizosphere

Root-knot nematodes are the most important group of plant-parasitic nematodes considering their wide range of hosts and role in yield losses in agricultural production systems. Chemical nematicides are the primary control method. However, ecotoxicity of some compounds has led to their phasing-out and the development of new control strategies, including biological control. One such example is the bacterial strain *Bacillus firmus* I-1582 with nematicidal properties, although the complete description of nematicidal and plant growth-promoting properties of these bacteria are lacking. Our study was multifaceted: 1) We evaluated the nematicidal activity of *B. firmus* I-1582 against *Meloidogyne luci* on tomatoes in a glasshouse pot experiment, and microplot experiments approximating field conditions. 2) We surveyed the genetic basis of *B. firmus* I-1582 for plant growth-promoting traits through bioinformatics analysis and compared it with the measured elemental composition of plant tissue. 3) We measured the effects of *B. firmus* I-1582 on plant physiology and substrate/soil biological activity. 4) We tested the ability of hyperspectral imaging to classify plants in different treatments. *B. firmus* I-1582 reduced nematode counts by 51% and 53% compared to the untreated control in pot and microplot experiments, respectively. *B. firmus* I-1582 presence in the rhizosphere had concurrent nematicidal and plant growth promoting effects, measured by plant morphology, relative chlorophyll content, elemental composition and hyperspectral imaging. In I-1582 strain we determined genes associated with various nutrient uptake mechanisms. Hyperspectral imaging in the 400-2500 nm spectral range and supervised classification with partial least squares support vector machines, differentiated *B. firmus*-treated and untreated plants, with accuracies of 97.4% and 96.3% in pot and microplot experiments, respectively. Visible and shortwave infrared spectral regions associated with chlorophyll, N–H and C–N stretches in proteins were determined to be the most relevant to discriminate plants in different treatments.

Virus lisavosti in mozaika paradižnika: nov sovražnik paradižnika in paprik

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Virus lisavosti in mozaika paradižnika (tomato mottle mosaic virus; ToMMV) je bil kot novi predstavnik iz rodu tobamovirusov (družina *Virgaviridae*), prvič opisan leta 2013 v Mehiki. Kmalu po odkritju se je ToMMV razširil po nasadih paprike in paradižnika v Severni in Južni Ameriki ter Aziji in na pridelku povzročil veliko gospodarsko škodo. V Evropi je bil virus do sedaj odkrit le v Španiji in na Češkem. ToMMV na okuženih rastlinah povzroča bolezenska znamenja kot so deformacija listov, lisavost, mozaik in nekroze, okužba pa lahko prizadene tudi sorte z genom za odpornost na tobamoviruse. Čeprav je epifitocija tega virusa še neraziskana, vemo, da se virus lahko prenaša kontaktno, na primer ob stiku okuženega orodja z rastlino pri obrezovanju ali ob pobiranju plodov.

Podobno kot v primeru virusa rjave grbančavosti plodov paradižnika (tomato brown rugose fruit virus; ToBRFV), tudi za ToMMV ni izključena možnost prenosa s čmrlji. Potencialno možnost širitve na nova območja/države, predstavljajo okužena semena in sadike. Zaradi velikega gospodarskega pomena paradižnika in paprike ter pomanjkanja ustreznih strategij za omejevanje širjenja ToMMV, je bil ta virus uvrščen na EPPO opozorilni seznam. V sklopu ARRS aplikativnega projekta (http://projects.nib.si/tobamo), bomo poskušali raziskati možnost preživetja ToMMV v vodnem okolju in širjenja z namakalno vodo ter s tem razširiti znanje o razumevanju epifitocije tega virusa. Z namenom, da bi izboljšali laboratorijsko diagnostiko, razvijamo visoko občutljive diagnostične teste, za zaznavanje virusa v semenih in zelenih delih rastline, saj je hitra in zanesljiva detekcija, ključna pri obvladovanju širjenja ToMMV.

ABSTRACT

Tomato mottle mosaic virus: new enemy affecting tomatoes and peppers

Tomato mottle mosaic virus (ToMMV) was firstly described in tomatoes in 2013 in Mexico as a new member of the genus *Tobamovirus*, family *Virgaviridae*. After its first finding, ToMMV spread rapidly in tomato and pepper crops in North and South America, and Asia causing significant losses. In Europe virus was found until now in Spain and Czech Republic. ToMMV causes severe symptoms in affected plants including leaf deformations, mottle, mosaic, and necrosis. It may also cause severe disease in varieties carrying a tobamovirus resistance gene. Even though the epidemiology of the virus still needs to be clarified we know that virus can be transmitted mechanically in the production site by contact between plants and by doing common agricultural practices (such as pruning or harvesting). Probably, like the other emergent tobamovirus tomato brown rugose fruit virus (ToBRFV), it can be spread by bumblebees. The potential pathway for introduction to new countries/regions are seed and planting material. The economic importance of tomatoes and peppers and the lack of efficient control strategies initiated the inclusion of ToMMV on EPPO Alert List. In the ARRS applicative project (http://projects.nib.si/tobamo/) we will try to fill the knowledge gaps related to the epidemiology of the virus, by studying the survival of the virus in a water environment and the possibility of transmission with irrigation water. We are also working to improve ToMMV diagnosis by developing a new high sensitivity diagnostic test to detect virus in seeds and leaf material, as rapid and accurate detection is a cornerstone of successful control.

Uporaba stroja za ožiganje plevelov v čebuli

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V letu 2020 smo izvedli poskus na čebuli, v katerem smo uporabili stroj za medvrstno ožiganje plevelov. Zanimal nas je vpliv hitrosti ožiganja na pridelek čebule in na porabo plina. Hitrosti ožiganja so bile 0,5 km/h, 1 km/h in 2 km/h in kontrola brez ožiganja. Poskusna zasnova so bili slučajni bloki s tremi ponovitvami. Ožiganje smo izvedli v treh terminih, in sicer 7. maja, 2. junija in 29. junija 2020. Poleg tega smo izvedli še poskus na 100 m dolgi stezi, pri katerem smo merili porabo plina pri ožiganju. Na koncu poskusa

smo izmerili pridelek in ovrednotili učinek ožiganja. Ugotovili smo, da se je s povečanjem hitrosti ožiganja iz 0,5 km/h na 2 km/h, poraba plina znižala iz 239 kg/ha na 71 kg/ha. Med hitrostmi ožiganja ni bilo razlik v pridelku čebule, medtem ko je bil najnižji pridelek dosežen na kontrolni parceli. V prihodnje bo potrebno še bolj optimirati število ožiganj in hitrost ožiganja glede na doseženi pridelek.

ABSTRACT

The use of weed burning machine in onions

In 2020 field trial was executed in onions, where the inter row weed burning machine was applied. We were interested in the influence of burning speed on the onion yield and gas consumption. The burning speeds were 0.5 km/h, 1 km/h, 2 km/h and the control without burning. The trial design were random blocks with three repetitions. Burning was done in three terms, namely on 7th May, 2nd June and 29th June 2020. Beside that we made the trial on 100 m long path in which gas consumption was measured. At the end of the trial yield was measured and the burning effect was evaluated. We found out that by increasing of burning speed from 0.5 km/h to 2 km/h, gas consumption decreased from 239 kg/ha to 71 kg/ha. There were no differences in onion yield between burning speeds, while the lowest yield was on the control plot. In the future, it will be necessary to further optimize the number of burns and burning speed according to the achieved yield.

Primerjava učinkovitosti izvajanja slepe setve z uporabo glifosata in mehanskih postopkov zatiranja plevelov

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Optimalno izvedena predsetvena priprava tal omogoča ustrezne pogoje za setev in hkrati učinkovito zmanjša konkurenčno sposobnost plevela v začetnih razvojnih fazah gojene rastline. Glede na rezultate anket o porabi herbicidov v Sloveniji, ki smo jo izvedli na Kmetijskem inštitutu Slovenije v letu 2020, približno tretjino primerov uporabe glifosata na njivskih površinah, predstavlja uporaba pred setvijo. Z namenom primerjave učinkovitosti uporabe glifosata in klasičnega mehanskega zatiranja plevelov s česalom v sistemu slepe setve, je bil na površinah Infrastrukturnega centra Jablje konec maja leta 2020 zasnovan bločni poljski poskus v treh ponovitvah. Pri tem sta bila uporabljena dva odmerka glifosata (1,08 kg a.s./ha in 0,54 kg a.s./ha), ki smo ju primerjali z mehanskim postopkom - dvakratno uporabo česala. Pri kontrolnem postopku plevelna vegetacija po osnovni predsetveni pripravi tal z vrtavkasto brano ni bila zatirana. Pri prvem vizualnem ocenjevanju, tri tedne po izvedbi ukrepov zatiranja plevelov, je bila najnižja pokrovnost (0,9 %) ugotovljena pri višjem odmerku glifosata, pri čemer so večino v plevelni populaciji (75 rastlin/m^2) predstavljali novo vznikli pleveli. Pri mehanskem postopku smo sicer ugotovili manjšo gostoto plevelne populacije (35 rastlin/m^2), vendar je bil zaradi bistveno višjih razvojnih faz plevela, le-ta precej manj učinkovit (pokrovnost 8 %). Tudi 7 tednov po uporabi preučevanih sredstev so bili rezultati podobni. Pokrovnost in suha biomasa plevela sta bili pri mehanskem postopku slepe setve statistično značilno večji v primerjavi z uporabo obeh odmerkov glifosata (*P<0,001). Pri višjem odmerku glifosata sta

pokrovnost in suha biomasa plevela znašala 30 % in 55 g/m^2, medtem ko se je dvakratna uporaba česala odrazila v bistveno višji pokritosti tal s pleveli (62 %) in štirikrat višji suhi biomasi plevela (241 g/m^2). Za primerjavo so bila tla na kontrolni površini popolnoma prekrita s plevelno biomaso (99 %), izmerjeno pa je bilo 716 g/m^2 suhe plevelne biomase. Naši rezultati nakazujejo, da so pri izvedbi slepe setve nizki odmerki glifosata bistveno bolj učinkoviti v primerjavi z mehanskim postopkom česanja in lahko na ta način uspešno zatremo večino plevelov, ki povzročajo izgube v začetnih fazah razvoja posevka.

ABSTRACT

Efficacy of false seedbed preparation with glyphosate in comparison to mechanical weed control

Optimal seedbed preparation provides appropriate seedbed conditions and effective reduction of weed competition in the early development stages of the crop. According to the results of the survey, approximately one third of the glyphosate used on arable land is applied before the crop sowing. In order to compare the efficacy pre-sowing glyphosate use and the conventional mechanical weed control with a spring tine harrow within the false seedbed technique, a field experiment was conducted at the experimental field of Jablje Infrastructure Center, at the end of May 2020. Two doses of glyphosate (1.08 kg a.i./ha; and 0.54 kg a.i./ha) were used and were compared with a mechanical treatment – two passing with a spring tine harrow. In the weedy treatment, vegetation was left uncontrolled after the primary spring pre-sowing seedbed preparation with a rotary harrow. In the first visual assessment, three weeks after the mechanical and chemical false seedbed treatments were applied, the lowest weed cover (0.9 %) was found when a higher dose of glyphosate was used. The majority of the weed population was comprised out of newly emerged weeds (75 plants/m^2). In the mechanical false seedbed treatment much lower weed density (35 plants/m^2) was observed. However, due to substantially higher developmental stages of weeds, the mechanical treatment was much less effective (weed cover 8 %). The similar trend was also observed in the second 7 weeks after seedbed preparation. Weed cover and dry weed biomass were significantly higher in the mechanical seedbed treatment compared to both higher and lower dose of glyphosate ($P<0.001$). At higher glyphosate dose, weed cover and dry biomass were 30 % and 55 g/m^2, while two weed harrowing resulted in a significantly higher weed cover (62 %) and four times higher dry weed biomass (241 g/m^2). The ground in the weedy treatment was completely overgrown with weeds (99 %) and 716 g/m^2 of dry weed biomass was determined. Our results suggest that low glyphosate doses can be an effective tool in false seedbed technique with sufficient weed control level in the initial stages of crop development.

Smo z uporabo proheksadion-kalcija in bakterije *Pseudomonas fluorescens* bližje rešitvi pri zatiranju enoletne latovke (*Poa annua* L.) na nogometnih tratah?

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Leta 2020 smo v steklenjaku na Laboratorijskem polju Biotehniške fakulteti v Ljubljani izvedli lončni poskus, kjer smo preučevali delovanje štirih pripravkov na tri vrste trav, in

sicer trpežno ljuljko (*Lolium perenne*), travniško latovko (*Poa pratensis*) in enoletno latovko (*Poa annua*). Trpežna ljuljka in travniška latovka sta pomembni vrsti trav na nogometnih tratah, enoletna latovka pa na slednjih predstavlja enega od najbolj nezaželenih plevelov. Vse tri vrste trav smo posejali samostojno v lonce. Poskus smo razdelili v dva (ločena) dela. V obeh smo v poskus vključili štiri različna obravnavanj oz. škropljenja, in sicer škropljenje trav s pripravki na podlagi aktivnih snovi proheksadion-kalcij, etefon, *Pseudomonas fluorescens* x *Azospirillum brasilense* in mezotrion, peto obravnavanje pa je predstavljala negativna kontrola (neškropljeno). V prvem delu poskusa smo delovanje pripravkov ocenjevali na predhodno nepokošeni trati, v drugem delu poskusa pa smo s škropljenjem začeli, ko smo trave v loncih predhodno pokosili. V obeh poskusih smo škropljenje s pripravki na podlagi aktivnih snovi proheksadion-kalcij, etefon, *Pseudomonas fluorescens* x *Azospirillum brasilense* izvedli v šestih različnih terminih, medtem ko smo rastline s pripravkom na podlagi mezotriona poškropili dvakrat. V obeh poskusih smo v različnih terminih ocenjevali povprečno višino rastlin in število poganjkov. Rezultati poskusa so pokazali, da lahko s škropljenjem nogometnih trat s pripravki na podlagi proheksadion-kalcija in bakterij *Pseudomonas fluorescens* x *Azospirillum brasilense* na njih zaviramo širjenje enoletne latovke. V prispevku bodo podrobneje predstavljeni rezultati obeh poskusov z našimi ugotovitvami o možnostih uporabe preučevanih pripravkov za zatiranje enoletne latovke na nogometnih tratah.

ABSTRACT

Application of prohexadione-calcium and the bacterium *Pseudomonas fluorescens* on football pitches – are we closer to a solution for the control of annual bluegrass (*Poa annua* L.)?

In 2020, we conducted a pot experiment in a greenhouse at the Laboratory Field of the Biotechnical Faculty in Ljubljana, where we studied the effects of four products on three grass species, namely perennial ryegrass (*Lolium perenne*), Kentucky bluegrass (*Poa pratensis*), and annual bluegrass (*Poa annua*). Perennial ryegrass and Kentucky bluegrass are important grass species on football pitches, where annual bluegrass is one of the most undesirable weeds. All three grass species were sown independently in pots. The experiment was divided into two (separate) parts. In both, we included four different treatments in the experiment, namely spraying grasses with products based on the active substances prohexadione-calcium, ethephon, *Pseudomonas fluorescens* x *Azospirillum brasilense* and mesotrione, and the fifth treatment was a negative control (unsprayed). In the first part of the experiment, the activity of products was evaluated on a previously uncut grasses, and in the second part of the experiment, we have started spraying when the grasses in the pots was previously cut. In both experiments, spraying with products based on the active substances prohexadione-calcium, ethephon, *Pseudomonas fluorescens* x *Azospirillum brasilense* was performed at six different times, while the plants were sprayed twice with a mesotrione-based product. In both experiments, we have estimated the average plant height and number of shoots at different terms. The results of the experiment showed that by spraying football lawns with products based on prohexadione-calcium and bacteria *Pseudomonas fluorescens* x *Azospirillum brasilense*, we can inhibit the spread of annual bluegrass. The paper will present in more detail the results of both experiments with our findings on the possibilities of using the studied products for the control of annual bluegrass on football pitches.

Vsebinska analiza raziskav o skladiščnih škodljivcih na primeru revije Journal of Stored Products Research

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Ustrezno skladiščenje prehranskih izdelkov ima pomemben vpliv na prehransko varnost. Na količino in kakovost zalog vplivajo ustrezni fizični pogoji skladiščenja, številne bolezni, predvsem pa škodljivci. Ob upoštevanju interdisciplinarnih znanstvenih spoznanj lahko danes v praksi dosežemo zadovoljivo zaščito skladiščenih izdelkov z različnimi postopki, tudi z uporabo metod, ki so manj škodljive za ljudi in okolje. Namen našega dela je vsebinska analiza znanstvenih člankov iz revije, ki je v celoti posvečena temu področju - Journal of Stored Products Research (JSPR) - za obdobje 1965-2020, s poudarkom na različnih ciljnih organizmih in raziskovalnih temah. Rezultati pokažejo, da je približno dve tretjini raziskav povezanih s proučevanjem žuželk. Hkrati se povečuje zanimanje za proučevanje učinkovitosti strategij zatiranja škodljivcev, ki zmanjšujejo tveganja za zdravje in okolje. Izbrani kvantitativni bibliometrični pristopi omogočajo izgradnjo celovitega profila izbranega področja na bolj pregleden in razumljiv način. Dober pregled nad raziskovalnimi potmi, pa nudi dodatne priložnost za nova odkritja.

ABSTRACT

Content analysis of storage pests research in the case of the Journal of Stored Products Research

Proper storage of food products has a significant impact on food security. The physical environment during storage, as well as diseases and especially pests, impact both the quality and quantity of these products. Acceptable protection of products can be achieved through interdisciplinary approaches that use a variety of methods, especially those that are less detrimental to the people involved, and taking into account care for the environment. The purpose of our work is a substantive analysis of scientific articles from a journal devoted entirely to this field - the Journal of Stored Products Research (JSPR) - for the period 1965-2020, with an emphasis on various target organisms and research topics. The results show that about two-thirds of the research is related to the study of insects. At the same time, there is growing interest in studying the effectiveness of pest control strategies that reduce risks to health and the environment. A quantitative approach using bibliometric methods allows a comprehensible representation of the research profile of this field in a more detailed form. Such information on research directions provides additional opportunities for new breakthroughs.

Prepoznavnost pametnih tehnologij v integriranem varstvu vrtnin v Sloveniji

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Raziskovalci s fitomedicinskega dela Katedre za fitomedicino, kmetijsko tehniko, poljedelstvo, pašništvo in travništvo Oddelka za agronomijo Biotehniške fakultete v Ljubljani že tretje leto sodelujejo v mednarodnem projektu SmartProtect, ki ga financira program Evropske unije Horizon 2020 (GA 862563). Cilj projekta je ustvariti tematsko mrežo, ki se bo osredotočala na medregionalno izmenjavo znanja o pametnih rešitvah integriranega varstva rastlin (SMART IPM) za kmete in svetovalce. Cilj projekta je tudi spodbuditi pretok znanja v regionalnih AKIS-ih (sistemih inovacij in prenosa znanja v kmetijstvu) po vsej EU in jih povezati o inovativnem potencialu naprednih metodologij za integrirano zatiranje škodljivcev (IPM) v pridelavi zelenjave, z integracijo tehnologij natančnega kmetovanja in analitike podatkov. Projektni konzorcij sestavlja 15 partnerjev iz 12 držav v Evropi, ki podpirajo pristop z več akterji, ki spodbuja izmenjavo znanja. V sklopu projekta smo v vseh 12 državah izvedli ankete, kjer smo strokovnjake (svetovalce za varstvo rastlin, svetovalce za zelenjadarstvo, raziskovalce, …) in tržne pridelovalce zelenjave povprašali o njihovem dosedanjem znanju o uporabi pametnih tehnologij v varstvu rastlin. V Sloveniji smo v anketo vključili 31 strokovnjakov in 12 pridelovalcev tržne zelenjave, ki so odgovorili na vprašanja o tehnikah nanosa fitofarmacevtskih sredstev, monitoringu škodljivih organizmov, metodah detekcije in diagnostike in podpornih sistemih, ki olajšajo uporabo vseh tehnik. na posterju bodo predstavljeni rezultati anket.

ABSTRACT

Awareness of smart technologies in vegetable IPM management in Slovenia

Researchers from the plant protection team of Chair for Phytomedicine, Agricultural Engineering, Crop Production, Pasture and Grassland management from Department of Agronomy of the Biotechnical Faculty in Ljubljana take part in the international project SmartProtect, funded by the European Union Horizon 2020 (GA 862563). The aim of the project is to create a thematic network that will focus on the interregional exchange of knowledge on smart integrated plant protection solutions (SMART IPM) for farmers and advisors. The project also aims to stimulate the flow of knowledge in regional AKISs (Agricultural Knowledge and Innovation Systems in Transition) across the EU and link them to the innovative potential of advanced integrated pest management (IPM) methodologies in vegetable production, integrating precision farming and innovative technologies. The project consortium consists of 15 partners from 12 countries in Europe, supporting a multi-actor approach that promotes knowledge sharing. As part of the project, surveys have been conducted in all 12 countries, where experts (plant protection consultants, vegetable consultants, extension agents and researchers, etc.) and market

vegetable growers were asked about their current knowledge of the use of smart technologies in plant protection. In Slovenia, the survey included 31 experts and 12 market vegetable growers who answered questions about plant protection product application techniques, pest and crop monitoring, detection and diagnostic methods as well as decision support systems that facilitate the use of all techniques and their incorporation in modern production systems. The current poster presents the results of surveys.

Pomen zanesljivega odkrivanja prisotnosti virusa rjave grbančavosti plodov paradižnika v semenih paradižnika in paprike

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Virus rjave grbančavosti plodov paradižnika (ang. tomato brown rugose fruit virus; ToBRFV) je nov rastlinski virus, ki povzroča bolezen na paradižniku in papriki. Na okuženih rastlinah se običajno pojavi kloroza, mozaik in pegavost listov. Plodovi lahko neenakomerno zorijo, so deformirani, drobnejši, na njih se pogosto pojavijo rjave ali rumene pege ter grbančavost. Na cvetovih, pecljih in steblu se lahko pojavijo nekroze. Znamenja okužb so odvisna od sorte paradižnika/paprike ali rastnih pogojev. Virus lahko v nasad vnesemo z okuženimi sadikami ali s semeni, znotraj nasada pa se lahko zelo hitro razširi z orodjem ali na drug mehanski način. Ker lahko že eno okuženo seme ali ena okužena sadika povzroči veliko škode v nasadu, so na ravni EU predpisane posebne zahteve za uvoz in trženje semen in sadik paradižnika ter paprike, diagnostične metode za preverjanje morebitne okuženosti semen pa morajo biti visoko občutljive in zanesljive. Z namenom zagotavljanja zanesljive diagnostike, smo sodelovali v testu preizkušanja ustreznosti metod za detekcijo ToBRFV v semenih, ki je bil organiziran v okviru EUPHRESCO projekta, ter v testu preverjanja usposobljenosti laboratorijev. Poleti 2020 in spomladi 2021 smo prisotnost virusa ToBRFV odkrili v štirih vzorcih semen paradižnika in petih vzorcih semen paprike, ki so prispele iz Kitajske v Luko Koper kot vstopno točko v EU. Na podlagi rezultatov laboratorijskih analiz sta Uprava RS za varno hrano, veterinarstvo in varstvo rastlin ter fitosanitarna inšpekcija nemudoma odredili uničenje okuženih semen in s tem je bila preprečena škoda, ki bi lahko nastala v EU, če virusa v semenih ne bi odkrili.

ABSTRACT

The importance of reliable detection of presence of tomato brown rugose fruit virus in tomato and pepper seeds

Tomato brown rugose fruit virus (ToBRFV) is a new plant virus that infects tomato and pepper plants. Infected plants exhibit chlorosis, mosaic patterns, and mottling on the leaves. Fruits may be deformed and smaller, show uneven ripening, and have yellow or

brown spots or rugose patches. Necrosis may be observed on flowers, petioles, and stems. Symptoms of infection may vary with cultivar and growing conditions. The virus may be introduced into the greenhouse with infected seedlings or seeds and spread in the greenhouse by infested equipment or other mechanical means. As a single infected seed or seedling can cause great damage in the greenhouse, special rules apply in the EU for the import and marketing of seeds and seedlings of tomato and pepper plants. We need diagnostic methods with high sensitivity and reliability for the detection of possibly infected seeds. In order to ensure reliable diagnostic methods, we participated in a test performance study organized under the EUPHRESCO project and in a proficiency test. In summer 2020 and spring 2021, we detected ToBRFV in four tomato seed and five pepper seed samples that arrived from China in Luka Koper, the point of entry to the EU. Based on the laboratory tests, the Administration of the republic of Slovenia for food safety, veterinary sector and plant protection and phytosanitary inspection ordered the destruction of the infected seeds. In this way, we prevented damage that could occur in the EU if the virus were not detected.

Črna žilavka kapusnic – kritične točke v pridelavi zelja

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Črna žilavka kapusnic je gospodarsko pomembna bakterijska bolezen kapusnic, ki jo povzročajo bakterije *Xanthomonas campestris* pv. *campestris* (Xcc). Bakterija se prenaša s semenom, mehansko in s pomočjo žuželk, prezimuje in se ohranja v tleh na rastlinskih ostankih. Nanjo so občutljive številne sorte in hibridi zelja, med njimi tudi avtohtona sorta varaždinsko zelje. Še pred 30 leti v Sloveniji to ni bila pomembna bolezen, medtem ko je danes ena najpomembnejših. Njeno obvladovanje je težavno, saj nimamo na voljo nobenih učinkovitih FFS-jev. Uporaba sredstev na osnovi bakra v Sloveniji ni registrirana, zato so pridelovalci soočeni z izzivom kateri pristop izbrati. V letu 2021 smo preučili literaturo in pripravili priporočila za obvladovanje žilavke za pridelovalce sadik in glav zelja. V prispevku podrobneje predstavljamo identificirane kritične točke v pridelavi zelja, kjer lahko pride do okužbe z bakterijami in lahko vsaj delno omejimo njihovo razširjanje. V pridelavi sadik moramo biti najbolj pozorni na kakovost semenskega/sadilnega materiala, na čistost setvenih plošč, na uporabo kakovostnega rastnega substrata, na izbiro načina zalivanja ter ves čas izvajati ukrepe za zdravstveno varstvo sadik. V pridelavi glav zelja najprej poskrbimo za primerno izbiro tal in kolobarja, uporabimo zdrave sadike, poskrbimo za primerno sadilno razdaljo, zmanjšamo pogostost mehanskih poškodb rastlin med samo obdelavo, skrbimo za čim manjšo zapleveljenost ter po spravilu pridelka ves rastlinski material zmulčimo in zadelamo v tla. Z znanjem o sami biologiji bakterije in poteku infekcije, lahko prilagodimo tehnologijo pridelave, da vsaj deloma zajezimo pojav bolezni oziroma, da kljub pojavu bolezni ni večjega izpada pridelka.

ABSTRACT

Black rot of crucifers – critical spots in production of cabbage

Black rot of crucifers is economically important bacterial disease of crucifers. It's caused by bacteria *Xanthomonas campestris* pv. *campestris* (Xcc). Bacteria are transmitted through seeds, mechanically and through insects. They survive and overwinter in the soil on plant debris. Many cabbage varieties are susceptible to the disease, among them Varaždinsko, an autochthonous Slovenian variety. Black rot was considered insignificant disease in Slovenia almost 30 year ago. Now it's one of the most important ones. Disease is increasingly difficult to control as we are limited by the availability of efficient pesticides. Restriction of copper use in Slovenia challenges growers to find other approaches in disease management. In 2021 we studied available literature and prepared guidelines for black rot management from seed to harvest meant for cabbage growers. Here we present an in-depth view on critical points in the process where bacterial infection can occur and where an efficient approach would limit the disease spread. In the process of seedling growing the seed quality is of utmost importance along with the use of clean seed trays and quality growth substrate, proper irrigation strategy, and constant surveillance of plant health. In cabbage production we should aim at selecting appropriate soil and crop rotation strategy, plant only healthy seedlings, maintain appropriate spacing between the plants, reduce mechanical damage during cultivation, control weeds, and soon after harvest mulch and deep-plough the plant debris. By understanding the biology of the bacteria and the disease we can adjust crop management technology to limit the spread of the disease or at least keep yield loss at a minimum.

Pomen izvajanja monitoringa na prisotnost begomovirusov in razvoj laboratorijske diagnostike

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Rod Begomovirusov (družina *Geminiviridae*) zajema veliko skupino virusov v kateri je opisanih več kot 400 vrst, ki lahko okužijo številne vrste rastlin. Med njimi jih več kot 200 lahko okuži bučevke in/ali paradižnik. Vsi begomovirusi, razen nekaj izjem, so uvrščeni na seznam karantenskih virusov. Najpogostejša znamenja okužb na rastlinah so zvijanje listov, porumenelost žil in rumeni mozaik na listih. Okužbe v zgodnji rastni dobi lahko povzročijo zastoj v rasti, razvoj manjšega števila cvetov, prekinjen razvoj plodov ter vsesplošno slabo stanje rastlin, kar lahko na kulturnih rastlinah povzroči veliko gospodarsko škodo. Okužbe se pojavljajo sporadično, predvsem v tropskih in subtropskih regijah, zaradi spremenjenih klimatskih razmer, pa obstaja tveganje za njihovo širitev tudi na druga območja. Begomoviruse lahko v nasad vnesemo z okuženimi sadikami, znotraj nasada pa jih učinkovito raznaša tobakov ščitkar (*Bemisia tabaci*), ki je pri nas prisoten. Laboratorijske metode odkrivanja begomovirusov vključujejo različne PCR teste,

sekvenciranje PCR produktov po Sangerju in visokozmogljivo sekvenciranje (HTS). PCR testi za odkrivanje begomovirusov so bili izbrani in preverjeni v medlaboratorijski primerjavi v okviru Euphresco projekta, dodatna preverjanja teh metod in metod primernih za identifikacijo odkritih begomovirusov pa smo izvedli v okviru aktivnosti, ki jih izvajamo kot EU referenčni laboratorij. Intenzivno smo vključeni tudi v pripravo EPPO (European and Mediterranean Plant Protection Organization) diagnostičnega protokola za določanje begomovirusov. V letu 2021 smo v okviru programa preiskav škodljivih organizmov rastlin testirali 28 vzorcev bučevk in 28 vzorcev paradižnika iz različnih delov Slovenije na prisotnost begomovirusov iz priloge II/A Uredbe 2019/2072/EU. V nobenem vzorcu nismo potrdili okužbe s temi begomovirusi.

ABSTRACT

The importance of monitoring begomoviruses and the development of their diagnostics

The genus Begomovirus (family *Geminiviridae*) comprises a large group of viruses with over 400 described species that can infect numerous plant species. Of these, more than 200 species can infect cucurbits and/or tomato plants. All begomoviruses, with some exceptions, are quarantine pests. Symptoms of begomovirus infections in plants usually include leaf curl, yellowing of leaf veins or yellow mosaic. Early infections result in reduced growth, reduced flowering, abortion of fruit development, and generally poor plant condition, which can cause major economic damage. Outbreaks occur sporadically, mainly in tropical and subtropical regions. Due to climate change, there is a risk of their spread to other parts of the World. Begomoviruses can be introduced into the plantation with infected seedlings. Within the plantation, they are successfully transmitted by the whitefly *Bemisia tabaci,* which also occurs in our region. Laboratory methods for the detection of begomoviruses include various PCR tests, Sanger sequencing of amplicons from PCR tests, and high-throughput sequencing (HTS). The PCR tests recommended for the detection of begomoviruses were selected and evaluated in a test performace study as part of the Euphresco project. A further review of these methods and other tests suitable for the identification of begomoviruses, has been carried out as part of our EU reference laboratory activities. We are actively involved in the preparation of the EPPO (European and Mediterranean Plant Protection Organization) diagnostic protocol for the detection and identification of begomoviruses. In 2021, as part of the national survey, we tested 28 samples of cucurbits and 28 samples of tomato plants from different regions of Slovenia to determine whether they were infected with any of the begomoviruses, listed in Annex II/A Regulation 2019/2072/EU. Infection was not confirmed in any of the samples.

Ciljni raziskovalni projekt QEntry - Vpeljava hitrih testov za identifikacijo karantenskih škodljivih organizmov, povzročiteljev bolezni in poškodb na rastlinah

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Poseben izziv pri določanju karantenskih škodljivih organizmov (KŠO) in s tem povezanim izvajanjem ukrepov proti njihovemu širjenju je identifikacija npr. morfološko zelo podobnih žuželk oziroma določitev nekaterih bakterij, gliv ali virusov, ki odražajo podobne vizualne znake na rastlini. V primeru najdbe karantenskih škodljivcev se ukrepa. Med ukrepi so odreditve inšpekcijskih ukrepov (zavrnitev ali uničenje pošiljk) ali v primeru najdbe KŠO v kmetijski pridelavi ali v naravi v okviru izvajanja preiskav na navzočnost KŠO (npr. začetek izkoreninjenja). Učinkovitost ukrepov in stroški ukrepov so neposredno povezani z zgodnjo detekcijo in identifikacijo povzročitelja. Hitri in zanesljivi testi nam omogočijo zgodnejše ukrepanje, ki bistveno prispeva k njihovi učinkovitosti in zmanjšanju stroškov povezanih z ukrepi. V zadnjem desetletju se v prakso uvajajo hitri testi oz. testi, ki omogočajo identifikacijo povzročiteljev tudi v omenjenih kritičnih primerih. V prispevku bomo predstavili ciljni raziskovalni projekt QEntry (V4-2003) katerega cilj je povečati možnosti uporabe hitrih testov, ki temeljijo na uporabi testov LAMP in/ali določanju DNA črtnih kod in z njihovo uporabo podpreti obstoječe pristope diagnostike škodljivih organizmov.

ABSTRACT

Targeted research project Q-ENTRY - Introduction of rapid tests to identify quarantine pests and pathogens harmful to plants

A particular challenge in the identification and management of quarantine pests (QPs) is the identification of e.g. morphologically very similar insects or the identification of certain bacteria, fungi or viruses that cause similar disease symptoms. Measures are implemented when a QP is detected. These can include various phytosanitary measures in trade (refusal or destruction of consignments) or eradication measures when a QP is detected in an agricultural production or in nature. The effectiveness of the measures and their costs directly relate to the early detection and identification of the causative pathogen. Fast and reliable tests allow us to take action earlier, which significantly contributes to their effectiveness and reduces the associated costs. In the last decade, rapid tests have been introduced into practice which allow identification of the causative organisms even in the mentioned critical cases. In this paper, we will present the targeted research project QEntry (V4-2003) which aims to increase the possibilities of using rapid tests based on LAMP tests and / or DNA barcoding to support existing approaches to diagnosing pests.

SMART-Surveillance: Razvoj metode in rezultati spremljanja zastopanosti spor *Phyllosticta citricarpa* v zraku

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Karantenska patogena gliva *Phyllosticta citricarpa* je povzročiteljica ekonomsko pomembne bolezni črne pegavosti agrumov, (Citrus black spot, CBS), ki se kaže predvsem s pegavostjo na plodovih in njihovim prezgodnjim odpadanjem ter tudi z lezijami na listih in poganjkih. Bolezen je prisotna v številnih delih sveta z ugodnimi klimatskimi pogoji, tudi v nam bližnji Tuniziji. Zaradi nevarnosti njene razširitve v evropski prostor, v ogroženih nasadih na Malti, v Italiji in Grčiji potekajo vzorčenja zraka in dežja, v katerih določamo prisotnost spor *P. citricarpa.* V okviru projekta SMART-Surveillance smo tako v obdobju od 2018 do 2021 vzorčili in analizirali preko 450 vzorcev zraka in dežja. Iz vzorcev z optimizirano metodo ekstrahiramo DNK in jih analiziramo s testoma PCR v realnem času. Trenutno objavljeni testi ne omogočajo ločitve *P. citricarpa* od njene nedavno opisane in tesno sorodne nekarantenske vrste *P. paracitricarpa*. Z namenom specifične določitve karantenske vrste *P. citricarpa* smo razvili in validirali nov PCR test v realnem času, ki temelji na kodirajočem genu (translacijskem elongacijskem faktorju 1 alfa) in omogoča nedvoumno razlikovanje med sorodnima vrstama. V vseh vzorcih smo potrdili prisotnost DNK gliv (s splošnim qPCR testom za glive), vendar ne *P. citricarpa* ali katere izmed njenih sorodnih vrst (*P. capitalensis, P. citriasiana, P. paracitricarpa)*. Novo razvit test se je izkazal kot 100% specifičen za *P. citricarpa*, visoko občutljiv in robusten. Pokazali smo linearnost testa v širokem območju koncentracij DNK in z večkratno ponovitvijo analiz dokazali njegovo ponovljivost. Test je zato primeren za specifično določanje *P. citricarpa* in se ga lahko uporabi za potrjevanje *P. citricarpa* v rastlinskih ali okolijskih vzorcih.

ABSTRACT

SMART-Surveillance: Method development and results of the monitoring of *Phyllosticta citricarpa* spores in air

The quarantine pathogenic fungus *Phyllosticta citricarpa* is the causative agent of citrus black spot (CBS) disease, which cause lesions on fruits and their premature drop as well as lesions on leaves and shoots. The disease is present in many parts of the world with favorable climate conditions, including nearby Tunisia. Due to the high risk of its spread to the European region, air and rain sampling is taking place in endangered orchards in Malta, Italy and Greece, in which we determine the presence of *P. citricarpa* spores. In the frame of SMART-Surveillance project, we sampled and analyzed over 450 air and rain samples in the time period from 2018 to 2021. The air and rain samples are subjected to DNA extraction according to optimized procedure and analyzed with two real-time PCR assays. Currently published assays cannot distinguish the quarantine fungus from its newly described and closely related non-quarantine species *P. paracitricarpa*. Therefore, we developed and validated a specific real-time PCR assay based on coding sequence (translation elongation factor 1-α) that allows specific determination of *P. citricarpa* and its distinction from *P. paracitricarpa*. The presence of fungal DNA was confirmed in all samples (general fungal qPCR test), but none belonged to *P. citricarpa* or any of its related species (*P. capitalensis*, *P. citriasiana* and *P. paracitricarpa*). The newly developed qPCR assay proved to be 100% specific for *P. citricarpa*, highly sensitive and robust. We demonstrated the linearity of the test over a wide range of DNA concentrations and proved its repeatability by performing the analyses several times. The qPCR assay is suitable for specific determination of *P. citricarpa* and can be applied for conformation of *P. citricarpa* in plant or environmental samples.

Preliminarno laboratorijsko preučevanje vpliva antagonističnih gliv *Trichoderma* spp. na rast izolatov patogene glive *Fusarium oxysporum*

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Laboratorijski poskus vpliva antagonističnih gliv iz rodu *Trichoderma* (*T. asperellum* sev T34 iz 2 pripravkov: Trifender Pro in Pannon Starter Perfect Pro) na rast 4 izolatov patogene glive *Fusarium oxysporum* (iz soje, solate, ciklame in jagode) se je izvajal v dvojnih kulturah pri temperaturah 15 in 25 °C. Pri 15 °C glive iz rodu *Trichoderma* niso imele večjega vpliva na rast micelija izolatov *Fusarium oxysporum*. Obe glivi v dvojni kulturi sta rasli počasi in tudi po 10 dneh ni prišlo do neposredne interakcije. Pri 25 °C pa so glive *Trichoderma* spp. močno vplivale na rast micelija izolatov *Fusarium oxysporum*. Do stika micelijev obeh gliv v dvojnih kulturah je prišlo že po štirih dneh, ko je gliva *Trichoderma* sp. zaustavila rast patogena in ga kasneje tudi prerasla. Višja temperatura je godila tudi izolatom patogena, vendar v laboratorijskih pogojih ni mogla tekmovati z antagonistom. Poskus na sadikah solate v gojitvenih komorah pri 15 in 20 °C z dodajanjem (zalivanjem) spor/pripravka patogena in antagonista med obravnavanji ni pokazal večjih odstopanj v rasti solate ali obsegu okužb

Laboratorijsko preizkušanje učinkovitosti hiperparazitske glive *Coniothyrium minitans* W.A. Campb. na sklerocijih različnih fitopatogenih gliv

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V laboratorijskih razmerah smo v dvojnih kulturah proučevali potencialno antagonistično delovanja glive *Coniothyrium minitans*, sev NCAIM 51/2004, proti šestim fitopatogenim glivam: *Sclerotinia sclerotiorum, Sclerotinia minor*, *Sclerotium cepivorum, Athelia rolfsii, Botrytis* sp. in *Macrophomina phaseolina*. Ugotoviti smo hoteli optimalne pogoje za učinkovito antagonistično delovanje te glive s poudarkom na parazitiranju sklerocijev fitopatogenih gliv. V dvojnih kulturah, pri temperaturi 15 °C, prisotnost patogenih gliv ni vplivala na rast antagonistične glive *C. minitans ,* medtem ko so pri temperaturah 20 in 25 °C prisotni patogeni vplivali na čas ustavitve rasti hiperparazitske glive *C. minitans.* Obseg parazitiranja sklerocijev fitopatogenih gliv je bil vrstno specifičen, medtem ko je bila hitrost parazitiranja odvisna od temperature. *C. minitans* v celoti parazitira sklerocije gliv *S. sclerotiorum* in *S. minor*, medtem ko sklerocije ostalih gliv samo posamično in pri določenih temperaturah (*Botrytis* sp., *S. cepivorum*) ali pa sploh ne (*A. rolfsii, M. phaseolina*). Optimalna temperatura za rast in parazitiranje hiperparazitske glive *C. minitans* je bila 20 °C.

Nacionalni referenčni laboratorij – žuželke in pršice v Sloveniji

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Nacionalni referenčni laboratorij (NRL) Insekti in pršice je eden od štirih NRL za škodljive organizme rastlin v Sloveniji. Uradno je bil imenovan s strani Uprave za varno hrano, veterinarstvo in varstvo rastlin (UVHVVR) 10. 10. 2019. Gre za konzorcij, v katerega sta vključena dva partnerja: Kmetijski inštitut Slovenije (KIS) in Gozdarski inštitut Slovenije (GIS), slednji je tudi koordinator konzorcija. NRL Insekti in pršice je del sistema uradnega nadzora na področju zdravja rastlin v Sloveniji, ki temelji na analitskih, preskusnih in diagnostičnih metodah, ki izpolnjujejo najsodobnejše znanstvene standarde ter zagotavljajo točne, zanesljive in primerljive rezultate. Odgovornosti in naloge NRL določa Uredba (EU) 2017/625 Evropskega parlamenta in Sveta v svojem 101. členu. NRL usklajujejo in izboljšujejo laboratorijske analitske, preskusne in diagnostične metode, vključno z njihovo uporabo, organizirajo medlaboratorijske primerjalne preskuse ali preskuse strokovne usposobljenosti med uradnimi laboratoriji in delijo informacije, ki jih dobijo od EU referenčnih laboratorijev. UVHVVR-ju zagotavljajo znanstveno in tehnično pomoč in v primeru izbruha škodljivega organizma rastlin, aktivno pomagajo pri diagnosticiranju škodljivega organizma. NRL po potrebi tudi validirajo reagente in partije reagentov, vzpostavljajo in vzdržujejo posodobljene sezname razpoložljivih referenčnih snovi in reagentov ter njihovih proizvajalcev in dobaviteljev in izvajajo programe usposabljanja za osebje uradnih laboratorijev. Znotraj NRL Insekti in pršice je delo razdeljeno tako, da GIS prevzema naloge, povezane z gozdnim drevjem, lesnatimi rastlinami in lesenim pakirnim materialom, KIS pa naloge, povezane s kmetijskimi in okrasnimi rastlinami. Od uradne potrditve je NRL Insekti in pršice sodeloval že pri več testih strokovne usposobljenosti in dosegel odlične rezultate, s čimer dokazuje svojo usposobljenost za diagnostiko karantenskih škodljivih organizmov pri nas.

ABSTRACT

National reference laboratory – insects and mites for Slovenia

The national reference laboratory (NRL) of Insects and Mites for Slovenia was officially named by the administration of food safety, veterinary sector and plant protection (UVHVVR) on the 10. 10. 2019. The NRL is a consortium consisting of two partners – Slovenian Forestry Institute (SFI) and Agricultural Institute of Slovenia (KIS). The general tasks of the NRL are written in article 101 regulation EU (2017/625): (1) collaborate with the European Union reference laboratories, and participate in training courses and in inter-laboratory comparative tests organized by these laboratories; (2) coordinate the designated activities of official laboratories with a view of harmonizing and improving the methods of laboratory analysis, tests or diagnosis and their use; (3) where appropriate, organize inter-laboratory comparative testing or proficiency tests between official laboratories, ensure an appropriate follow-up of such tests and inform the competent

authorities of the results of such tests and, if deemed necessary, undertake follow-up activities; (4) ensure the dissemination of information that the European Union reference laboratory supplies to the competent authorities and official laboratories ; (5) provide within the scope of their mission scientific and technical assistance to the competent authorities; (6) validate the reagents and reagent lots, establish and maintain up-to-date lists of available reference substances and reagents and of manufacturers and suppliers of such substances and reagents; (7) conduct training courses for the staff of official laboratories; and (8) assist actively UVHVVR having designated them in the diagnosis of outbreaks of pests of plants and in case of non-compliance of consignments, by carrying out confirmatory diagnoses, characterisation or taxonomic studies on pest specimens. SFI is in charge of insects and mites in forest trees and woody plants, and wood packaging material. KIS covers the insects and mites occurring on agricultural and ornamental plants. During the last few years, the NRL insects and mites already successfully executed several proficiency tests and thus showed its competence to determine quarantine pests in Slovenia.

Nacionalni referenčni laboratorij za škodljive organizme rastlin – glive in oomicete

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Nacionalni referenčni laboratorij za škodljive organizme rastlin – gliv in oomicet je konzorcij treh partnerjev, in sicer Gozdarskega inštituta Slovenije, Kmetijskega inštituta Slovenije ter Inštituta za hmeljarstvo in pivovarstvo Slovenije. Konzorcij je bil uradno imenovan kot nacionalni referenčni laboratorij z odločbo Uprave za varno hrano, veterinarstvo in varstvo rastlin dne 10. 10. 2019. Naloge so med partnerji v konzorciju opredeljene glede na vrsto rastlin in glede na vrsto škodljivega organizma, v primeru prekrivanja področij pa se partnerji dogovorijo o delitvi dela z dogovorom. Naloge nacionalnega referenčnega laboratorija so opredeljene v 101. členu Uredbe EU (2017/625): sodelovanje z Evropskim referenčnim laboratorijem, usklajevanje dejavnosti uradnih laboratorijev v RS, usklajevanje in skrb za izboljšanje laboratorijskih analitskih, preskusnih in diagnostičnih metod, organizacija med-laboratorijskih primerjalnih preskusov ali preskusov strokovne usposobljenosti med uradnimi laboratoriji, zagotavljanje strokovne in znanstvene pomoči UVHVVR za izvajanje večletnih nacionalnih načrtov nadzora in drugih usklajenih programov uradnega nadzora, zagotavljanje validiranja reagentov, vzpostavitev in vzdrževanje seznamov razpoložljivih referenčnih snovi in reagentov, nudenje strokovne pomoči UVHVVR pri diagnosticiranju izbruhov bolezni, ki se prenašajo s škodljivimi organizmi rastlin in v primeru neskladnosti pošiljk (potrditveno diagnosticiranje, ugotavljanje lastnosti, epidemiološke in taksonomske študije izolatov patogenov ali vzorcev škodljivih organizmov). Nacionalni referenčni laboratorij za glive in oomicete je v svojem dosedanjem delu sodeloval pri več medlaboratorijskih preskusih, kjer se je do sedaj

vedno izkazal s 100% skladnostjo. Partnerji v okviru konzorcija vzdržujejo tudi referenčne zbirke škodljivih organizmov, kjer so shranjeni pomembnejši izolati gliv in oomicet, ki so ključni pri izvajanju diagnostike vzorcev s sumom na karantenske ali druge škodljive organizme rastlin. Partnerji v konzorciju velik del aktivnosti usmerjajo v kakovost dela, skrb za raziskovalno infrastrukturo, usposobljenost kadrov ter mednarodno mreženje z diagnostičnimi in raziskovalnimi laboratoriji.

ABSTRACT

National reference laboratory for plant pests - fungi and oomycetes

The National Reference Laboratory for Plant Pests - Fungi and Oomycetes is a consortium of three partners, namely the Slovenian Forestry Institute, the Agricultural Institute of Slovenia and the Slovenian Institute of Hop Research and Brewing. The consortium was designated as the national reference laboratory by the decision of the Administration for Food Safety, Veterinary and Plant Protection (UVHVVR) on the 10. 10. 2019. Tasks of members of the consortium are defined based on host plants as well as pest species. In the case of overlapping areas, the partners agree on the division of labor by agreement. The tasks of the national reference laboratory are defined in Article 101 of the EU Regulation (2017/625): cooperation with the European reference laboratory, coordination of activities of official laboratories in the RS, coordination and care for improvement of laboratory analytical, test and diagnostic methods, organization of inter-laboratory comparative tests or testing expertise between official laboratories, providing professional and scientific assistance to the UVHVVR for the implementation of multiannual national control plans and other coordinated official control programs, ensuring validation of reagents, maintaining lists of available reference substances and reagents, providing expert assistance in UVHVVR diagnostics with plant pests in case of non-compliance of consignments (confirmatory diagnostics, determination of properties, epidemiological and taxonomic studies of pathogen isolates or samples of harmful organisms). In its work to date, the National Reference Laboratory for Fungi and Oomycetes has participated in several interlaboratory tests, where it so far proved to be 100% compliant. The partners within the consortium maintain reference collections of harmful organisms, where important isolates of fungi and oomycetes are stored, and those are crucial in performing diagnostics of samples with a suspicion of a quarantine or other plant harmful organisms. The partners in the consortium focus a large part of their activities to constantly improve the quality of their work, care for research infrastructure, staff training and an international networking of diagnostic and research laboratories.

Vpliv načina shranjevanja in izbire ekstrakcijskega postopka na rezultate molekularne analize podlubnikov

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Na območju Slovenije živi okoli devetdeset različnih vrst hroščev iz poddružine Scolytinae. V Laboratoriju za varstvo gozdov (LVG) na Gozdarskem inštitutu Slovenije redno izvajamo morfološke analize podlubnikov, vpeljujemo pa tudi molekularne postopke kot dopolnitev morfološkim pristopom identifikacije. Shranjevanje vzorcev pred molekularno analizo je pomemben del procesa in lahko vpliva na rezultat analize. V ta namen je bila v letu 2021 v LVG izvedena analiza vpliva načina shranjevanja podlubnikov

na uspeh celokupne ekstrakcije DNA in na kakovost tako pridobljene DNA. Primerjali smo dva različna načina shranjevanja hroščev vrste *Ips typographus* na -20°C: 1) suho shranjevanje in 2) shranjevanje v 96% etanolu. Pri tem smo uporabili tri ekstrakcijske kite različnih proizvajalcev, ekstrakcije pa so bile izvedene po štirih različnih ekstrakcijskih protokolih. Merili smo čas, porabljen za ekstrakcijo, ter koncentracijo in količino celokupne DNA v ekstraktih. Preizkusili smo več različnih protokolov za polimerazno verižno reakcijo (PCR) in ob tem opazovali uspešnost reakcije PCR. Pomnožke smo poslali v sekvenciranje. Kakovost pridobljenih sekvenc nam je služila kot pomoč pri oceni kakovosti ekstrahirane DNA oziroma primernosti le-te za postopke identifikacije s klasičnim PCR. Izbrali smo najprimernejšo kombinacijo načina shranjevanja primerkov in ekstrakcijskega kita za uporabo pri molekularni analizi podlubnikov s pomočjo analize sekvenc (ti. barcoding).

ABSTRACT

Influence of storage conditions and the extraction method on the results of molecular analysis of *Scolytinae* beetles

Around ninety different species from the subfamily *Scolytinae* are present in Slovenia. Morphological identification of Scolytid species is regularly performed in the Laboratory of Forest Protection at the Slovenian Forestry Institute. We are also in the process of introducing molecular methods in addition to the established morphological procedures. Storage of samples prior to molecular analysis is an important part of the analytical process and can influence the end result of the analysis. For this reason, an analysis of the influence of the storage conditions of *Scolytinae* on success of total DNA extraction and the quality of the extracted DNA was performed in 2021. Two different ways of storage of *I. typographus* specimens at -20°C were compared to each other: 1) dry storage and 2) storage in 96% ethanol. Three extraction kits from different manufacturers were used and total DNA extractions were performed according to four different extraction protocols. Measured variables included time required for extraction, concentration, and final amount of total DNA in the extracts. DNA extracts were used in multiple PCR protocols and the success rate of amplification was observed. PCR amplicons were sent for sequencing. The quality of resulting sequences was used to assess the quality of extracted DNA and its usefulness in identification procedures. The optimal combination of storage conditions and extraction protocol was chosen for use in molecular analysis of Scolytinae.

Non-chemical control of *Lymantria dispar* in different European countries by using traps and pheromones

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The gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Erebidae) is a polyphagous species that infects oak forests in Central and Southern Europe, Asia Africa and North America. It constitutes a severe environmental problem as it is a voracious eater that defoliates entire trees and causes health problems to humans or animals (e.g., allergies). Various insecticides have been used for its control, such as aerial sprayings, which negatively impact the biodiversity and may not be suitable for sub-urban recreational areas. Recently developed pheromone and non-pheromone traps have been successfully evaluated for the control of moths with different life cycle, such as the processionary pine moth, *Thaumetopoea pityocampa* (Denis and Schiffermüller) (Lepidoptera: Thaumetopoeidae). These traps allow the continuous monitoring of the insect's population and dispersion, while they substantially contribute to the emergence of an information system in forests, which can lead to increased resilience against this species, especially in protected areas (e.g., Natura 2000 sites). In this context, the LIFE eGymer project aims to utilize non-chemical control by developing and implementing e-traps, novel traps, mass larval trapping and mating disruption techniques to remotely monitor and effectively control more than one life stage of *L. dispar*. In that way, the design and efficiency of pheromone traps will be improved, the infestation level will be continuously monitored and the infestation in specific and diverse target areas will be minimized. Hence, non-chemical control that will be based in the aforementioned techniques will be carried out between 2022 and 2024 in different areas of Slovenia, Spain and Greece, through the LIFE eGymer consortium. The generated results will provide a replicable, transferable and eco-friendly integrated system for the effective management of *L. dispar* that can be applied to other infested areas of EU.
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IZVLEČEK

Uporaba pasti in feromonov za Nekemično zatiranje gobarja (*Lymantria dispar*) v različnih evropskih državah z uporabo pasti in feromonov

Gobar (*Lymantria dispar* [L.], Lepidoptera, Erebidae) je polifagna vrsta metulja, ki povzroča največjo škodo v hrastovih gozdovih v srednji in južni Evropi, Aziji, Afriki in Severni Ameriki. Žuželka predstavlja veliki okoljski problem, saj lahko požrešne gosenice povzročijo defoliacijo dreves in povzročijo zdravstvene težave (npr. alergije). Za zatiranje gobarja je možna uporaba različnih insekticidov, na primer s škropljenjem iz zraka, kar negativno vpliva na biotsko raznovrstnost, in ki niso primerni za primestna rekreacijska območja. Dosedanje raziskave so dokazale uporabnost feromonskih in neferomonskih pasti za lovljenje metuljev z različnim razvojnim krogom, kot je pinijev sprevodni prelec (*Thaumetopoea pityocampa* (Denis in Schiffermüller) (Lepidoptera: Thaumetopoeidae)).

Te pasti omogočajo neprekinjeno spremljanje populacije in razpršenosti žuželk, hkrati pa bistveno prispevajo k nastanku informacijskega sistema v gozdovih, kar omogoča lažje spremljanje te vrste, zlasti na zavarovanih območjih (npr. območja Natura 2000). V tem kontekstu je cilj projekta LIFE eGymer uporabiti nekemične metode zatiranja na osnovi razvoja in uporabe novih pasti, množičnega lovljenja ličink in tehnik motenja parjenja za daljinsko spremljanje in učinkovito zatiranje več kot enega razvojnega kroga preučevane žuželke. Na tak način bomo izboljšali zasnovo in učinkovitost feromonskih pasti, saj bomo nepretrgoma spremljali in s tem zmanjšali stopnjo škodljivosti na specifičnih in raznolikih ciljnih območjih. Nekemično zatiranje, ki bo temeljilo na omenjenih tehnikah, se bo izvajalo med letoma 2022 in 2024 na različnih območjih Slovenije, Španije in Grčije prek konzorcija LIFE eGymer. Pridobljeni rezultati bodo zagotovili ponovljiv, prenosljiv in okolju prijazen integriran sistem za učinkovito obvladovanje gobarja, ki se lahko uporablja na drugih območjih EU, kjer gobar povzroča izrazite defolacije.

Nova rastlinska bolezen – »Beech leaf disease« (BLD)

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Novo rastlinsko bolezen, imenovano »Beech Leaf Disease« (BLD), so prvič odkrili v Ohiu v ZDA leta 2012 na ameriški bukvi (*Fagus grandifolia*). Od takrat so o njej poročali predvsem iz gozdnih območij še v petih drugih zveznih državah severovzhodnih ZDA (New York, Connecticut, Pennsylvania, Rhode Island, Massachusettes) pa tudi v Kanadi (Ontario). Simptomi BLD vključujejo temnenje med žilami, nagubane in nepravilno odebeljene liste ter odmiranje vej, kar na koncu privede do odmiranja bukovih dreves v 3-7 letih. Vzrok za to bolezen z relativno hitrim širjenjem še vedno ni popolnoma znan. Leta 2018 je bila z Japonske opisana nova vrsta rastlinsko parazitskih ogorčic *Litylenchus crenatae*, izolirana iz simptomatičnih listov drevesa *Fagus crenata* in ugotovljena kot povzročitelj bolezni BLD. Iz Evrope ni poročil o prisotnost bolezni BLD ali povzročitelju bolezni - ogorčici *L. crenatae.* V okviru Euphresco projekta Fagustat - Zdravstveno stanje dreves bukev *Fagus spp.* želimo povečati ozaveščenost o BLD v Evropi in Sloveniji, narediti prvo oceno prisotnosti/odsotnosti v regiji ter raziskati možne načine vstopa in širjenja. Pridobljene informacije bodo prispevale k oceni tveganja za škodljivca ter ovrednotile tveganja za podobno epidemijo kot je bila opažena v Severni Ameriki v zadnjem desetletju. Zbrana znanja bodo pripomogla k razvoju ustreznih ukrepov za zaščito bukovih dreves v Evropi kot tudi v Ameriki. Sodelavci iz Gozdarskega inštituta Slovenije (GIS) opravljamo vizualne preglede in vzorčenje listov bukovih dreves po Sloveniji, sodelavci na Kmetijskem inštitutu Slovenije (KIS) pa analiziramo vzorcev listov bukve na prisotnost rastlinsko parazitskih ogorčic.

ABSTRACT

New plant disease – Beech leaf disease (BLD)

A new disease called 'Beech Leaf Disease' (BLD) was first detected in Ohio, USA, in 2012, on American beech (*Fagus grandifolia*). Since then, it has been reported from

mainly forest areas, but also landscapes, in 5 other north-eastern states of USA (New York, Connecticut, Pennsylvania, Rhode Island, Massachusettes), as well as in Canada (Ontario). The symptoms of BLD include interveinal darkening, crinkling and irregularly thickened leaves and branch dieback; ultimately leading to decline and death of beech trees within 3-7 years. The cause of this emerging disease with relatively rapid spread is still not fully understood. In 2018, a new nematode species *Litylenchus crenatae*, isolated from leaf galls on *Fagus crenata*, was described from Japan and determines as causative agent of BLD. From Europe there are no reports of the presence of BLD or the causative agent *L. crenatae*. Within the Euphresco project Fagustat - Plant health status of *Fagus* spp. - we plan to increase awareness of BLD in Europe and in Slovenia, make a first assessment of its presence/absence in the region and investigate possible ways of entry and spread. The obtained information will contribute to pest risk assessments which will evaluate the risks for a similar epidemic as has been observed in North America in the last decade. The gathered knowledge will contribute to the development of appropriate measures for protecting beach trees in Europe, both also America. Employees from the Forestry Institute of Slovenia (GIS) perform visual inspections and sampling of beech tree leaves in Slovenia, while employees at the Agricultural Institute of Slovenia (KIS) analyze samples for the presence of plant parasitic nematodes.

Analiza tehničnega stanja pršilnikov v občini Brda

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Na osnovi rednih pregledov naprav za nanos FFS smo analizirali stanje pršilnikov v občini Brda. Primerjali smo rezultate pregledov pršilnikov v letu 2018 in 2014. Leta 2018 je bilo pregledanih 543 pršilnikov. 89 pršilnikov oziroma 16,6 % je imelo vsaj eno napako. Na prvem mestu napak je zamašena šoba s 23,7 % deležem, sledi poškodovan ali neustrezen manometer z 20,3 % deležem. Leta 2014 je bilo pregledanih 235 pršilnikov. Od tega je imelo 36 % pršilnikov vsaj eno napako. Največ napak je bilo zaradi manometra in šob. Povprečna starost pršilnikov leta 2018 je bila 27 let, med proizvajalci pa prevladuje Agromehanika s 34,3 % deležem.

ABSTRACT

Analysis of the technical condition of air-assisted sprayers in the municipality of Brda

Based on regular inspections of pesticide application equipment, we analysed the condition of air-assisted sprayers in the municipality of Brda. We compared the results of air-assisted sprayer inspections in 2018 and 2014. In 2018, 543 air-assisted sprayers were inspected. 89 air-assisted sprayers or 16.6% had at least one defect. The most common defect was a clogged nozzle with a share of 23.7%, followed by a damaged or inadequate manometer with a share of 20.3%. In 2014, 235 air-assisted sprayers were inspected. Out of all inspected air-assisted sprayers 36% of them had at least one defect. Most of the defects were due to the manometer and nozzles. The average age of air-assisted sprayers in 2018 was 27 years, with Agromehanika predominating among manufacturers with a 34.3% share.

Analiza naprav za nanašanje FFS pregledanih od leta 2018 do 2021

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Analizirali smo podatke o pregledanih napravah za nanašanje FFS med leti 2018 in 2021. Podatkovna baza je javno dostopna na Upravi RS za varno hrano, veterinarstvo in varstvo rastlin. V letu 2018 so zaradi prehoda na testiranje na vsake tri leta pregledali samo 486 pršilnikov in 850 škropilnic. Najstarejši pregledani pršilnik je imel letnico izdelave1974, najstarejša škropilnica pa je bila izdelana leta 1970. V letu 2019 je bilo pregledanih 7278 naprav. Od tega je bilo 5087 škropilnic, 2190 pršilnikov in ena naprava za kemično obdelavo semenskega materiala. Kmetje so v letu 2019 kupili 43 novih pršilnikov in 79 novih škropilnic. V letu 2020 je bilo pregledanih 6562 naprav za nanašanje FFS. Pregledanih je bilo 4406 škropilnic, 2155 pršilnikov in tudi ena naprava za kemično obdelavo semenskega materiala. Leta 2021 je bilo v Sloveniji pregledanih 1971 naprav. Lastniki so prijavili 61 novih škropilnic in 31 novih pršilnikov. Proizvajalec Agromehanika je prevladujoč med proizvajalci pregledanih škropilnic in pršilnikov. Zakonsko sicer ustrezne naprave so v pretežni meri dejansko tehnično zastarele.

ABSTRACT

Analysis of pesticide application equipment inspected from 2018 to 2021

We analysed data on inspected pesticide application equipment between 2018 and 2021. The database is publicly available at the Administration of the Republic of Slovenia for Food Safety, Veterinary and Plant Protection. In 2018, due to the transition to testing every three years, only 486 air-assisted sprayers and 850 sprayers were inspected. The oldest air-assisted sprayers inspected had a year of production in 1974, and the oldest sprayer was manufactured in 1970. In 2019 7278 equipment were inspected. Of these, 5087 were sprayers, 2190 air-assisted sprayers and one equipment for chemical treatment of seed material. In 2019, farmers bought 43 new air-assisted sprayers and 79 new sprayers. 6562 pesticide application equipment were inspected in the year 2020. 4406 sprayers, 2155 air-assisted sprayers and one device for chemical treatment of seed material were inspected. In 2021, 1971 pesticide application equipment were inspected in Slovenia. Owners reported 61 new sprayers and 31 new air-assisted sprayers. The local producer Agromehanika is predominant among the producers of inspected sprayer and air–assisted sprayers. Legally otherwise suitable equipment is mostly technically outdated.

Application of gel-based PCR and Real-Time PCR in detection of *Xyllela fastidiosa* in Bosnia and Herzegovina

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Xylella fastidiosa (Xf) is a quarantine plant pathogenic bacterium native to the Americas that emerged in Europe in 2013 as a very serious threat to the EPPO region. Its first appearance is related to the epidemic of olive tree disease in Italy (Puglia). Since Xf is very polyphagous, the possibility of reducing its incidence is reflected in the early detection of latent infections of branches or cuttings with (mature) leaves attached, which helps direct prevention of their introduction and spreading. Therefore, aiming undertaking of prompt and efficient phytosanitary measures, it is very important to have reliable and fast detection and identification of pathogen presence. Because of high specificity, sensitivity and performance speed, molecular methods found their place in diagnostics of these quarantine diseases in the world, and they are one of possible recommended methods determined through legislative regulations. Federal Institute for Agriculture Sarajevo, authorized by Administration of Bosnia and Herzegovina for plant health protection, implemented gel-based PCR and Real-Time PCR method as the main test in detection of *Xyllela fastidiosa.* The application of these methods in the previous period was carried out through interlaboratory cooperation with the Mediterranean Agronomic Institute of Bari on the Phyto BiH project. Leaf petioles collected for isolation of *Xylella fastidiosa* are usually processed within 24 hours of collection. Positive and negative DNA controls as reference material were extracted at the Institute in Bari. CTAB method and DNeasy Plant Mini Kit (Qiagen) were used to isolate DNA from the samples. For gel-based PCR primers of Minsavage *et al*. (1994) were used to target part of the *rpoD* gene, and for Real Time PCR primers and probes of Harper *et al.* (2010, erratum 2013) designed to amplify part of the 16S rRNA processing protein *rimM* gene. Experimental samples gave consistent results beyond the variation of the detection limit. Establishment of systematic control of Xf and verification of prescribed methods for their identification and confirmation in domestic laboratories, enables better monitoring of the health status of imported, potentially infected plants, as well as the protection of agricultural producers in BiH.

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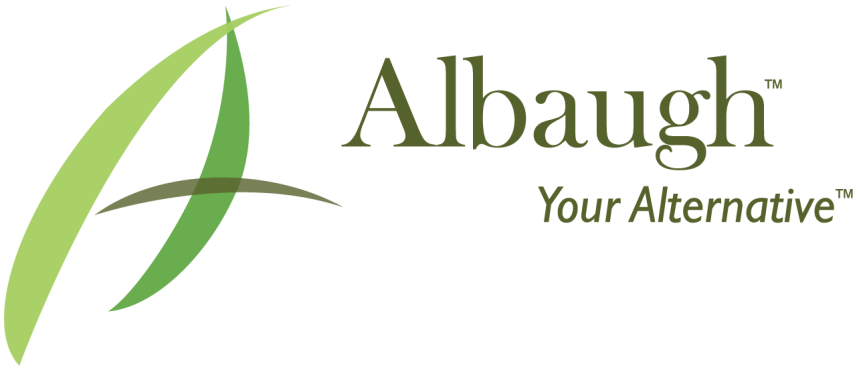


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