Debreceni Egyetem | 2015

ACTA AGRARIA DEBRECENIENSIS 66.

Agrártudományi Közlemények

Alapítva: 1966.

University of Debrecen

JOURNAL OF AGRICULTURAL SCIENCES 2015/66

ACTA AGRARIA DEBRECENIENSIS

7th International Plant Protection Symposium at University of Debrecen

21-22 October 2015

Debrecen

Editor:

Dr. György J. Kövics

Lectors:

Dr. András Bozsik (entomology, biological pest management)

Dr. Antal Nagy (entomology, ecology)

Arnold Szilágyi (weed biology, weed management)

Dr. István Szarukán (entomology)

Dr. Gábor Tarcali (integrated pest management, plant pathology)

Dr. György J. Kövics (plant pathology)

Dr. László Radócz (integrated pest management, weed management)

HU-ISSN 1587-1282

Contents

László Radócz[1] – Gábor Tarcali[1] – Tünde Szabó-Asbolt[1] – György János Kövics[1] – László Kiss[2] ([1]University of Debrecen, Institute of Plant Protection, Debrecen, [2]Hajdú-Bihar County Organization of Hungarian Chamber of Professionals and Doctors of Plant Protection, Debrecen, Hungary): Irén Dobos horticulturalist-teacher, plant protection engineer expert awarded by „Antal Gulyás medallion for crop protection" in 2015 (laudation) 8

György János Kövics (University of Debrecen, Institute of Plant Protection, Debrecen, Hungary): Let's talk about 'One fungus – One name'. Changes in the fungal taxonomy 11

Mahendra Rai[1,2] and Gabriela Kratosova[2] ([1]Nanobiotechnology Lab., Department of Biotechnology, SGB Amravati University, Amravati-444 602, Maharashtra state, India; [2]Nanotechnology Centre, VSB - Technical University of Ostrava, Ostrava – Poruba, Czech Republic): Management of phytopathogens by application of green nanobiotechnology: Emerging trends and challenges 15

György Zsigó (Hungarian Chamber of Plant Protection Engineers and Plant Doctors, Budapest): Arrival of invasive pests in our direct environment and control opportunities 23

László Gergely – Bernát Poós (National Food Chain Safety Office, Budapest, Hungary): The role of disease resistance in the registration of crop varieties in Hungary 27

Tamás Tóth – György János Kövics (University of Debrecen, Plant Protection Institute, Debrecen): White rust species (Chromista, Peronosporomycetes, Albuginales, *Albuginaceae*) on common weeds in Hungary 30

Viktor József Vojnich – Attila Hüvely – András Palkovics (Kecskemét College, Faculty of Horticulture, Department of Horticulture, Kecskemét): Examination of resistance to Sclerotinia stalk and head rot in sunflower (*Helianthus annuus* L.) hybrids 34

Gabriella Kovács – László Radócz (University of Debrecen, Institute of Plant Protection, Debrecen): Effect of the media on morphology of *Cryphonectria parasitica* (Murr.) Barr isolates and their Vegetative Compatibility Groups 38

Dóra Frommer[1] – Szilvia Veres[2] – László Lévai[2] – László Radócz[1] ([1]University of Debrecen, Plant Protection Institute, Debrecen; [2]University of Debrecen, Institute of Plant Sciences, Department of Agrobotany, Plant Physiology and Biotechnology, Debrecen): Old-new disease is maize smut (*Ustilago maydis*) 43

Péter Bónis – Tamás Árendás – Csaba Szőke – Eszter Sugár – Nándor Fodor – Éva Darkó – Lajos Csaba Marton (Agricultural Institute, Centre for Agricultural Research, Martonvásár, Hungary): Sensitivity of maize to herbicides in experiments in Martonvásár in 2015 47

Arnold Szilágyi[1] – Zoltán Balogh[2] – István Dávid[1] – László Szabó[2] – László Radócz[1] ([1]University of Debrecen, Plant Protection Institute, Debrecen; [2]Hungarian Plant Protection Services of the Ministry of Agriculture, Miskolc; [3]Hungarian Plant Protection Services of the Ministry of Agriculture, Debrecen): Woolly cupgrass (*Eriochloa villosa* /Thunb./ Kunth), a recently occured invasive weed in Trans-Tisza Region and a trial for control in maize 53

Szabolcs Szanyi[1], Antal Nagy[2], Attila Molnár[3], Miklós Tóth[4], Zoltán Varga[1] ([1]Department of Evolutionary Zoology, University of Debrecen, Hungary; [2]Institute of Plant Protection, University of Debrecen, Hungary; [3]Department of Biology and Chemistry, Ferenc Rákóczi II. Transcarpathian Hungarian Institute, Beregszász, Ukraine; [4]Plant Protection Institute, CAR HAS, Budapest, Hungary): Pest species of Macrolepidoptera in the Game Reserve of Velyka Dobron' (Transcarpathia, Ukraine) 58

András Bozsik (University of Debrecen, Institute of Plant Protection, Debrecen, Hungary): Slight damage of the great green bush-cricket (*Tettigonia viridissima*) (Orthoptera: Tettigoniidae) in some Hungarian maize fields 65

Antal Nagy[1] – István Szarukán[1] – Ferenc Gém[1] – Rita Nyitrai[1] – Bence Füsti-Molnár[1] – Attila Némerth[1] –Lajos Kozák[2] – Attila Molnár[3] – Krisztián Katona[4] – Szabolcs Szanyi[5] – Zoltán Varga[5] – Miklós Tóth[6] ([1]Institute of Plant Protection, University of Debrecen, Hungary; [2]Department of Nature Conservation Zoology and Game Management, University of Debrecen, Hungary; [3]Department of Biology and Chemistry, Ferenc Rákóczi II. Transcarpathian Hungarian Institute, Beregszász, Ukraine; [4]Faculty of Biology, Uzhhorod National University, Uzhhorod, Ukraine; [5]Department of Evolutionary Zoology, University of Debrecen, Hungary; [6]Plant Protection Institute, CAR HAS, Budapest, Hungary): Preliminary data on the effect of semi-synthetic baits for Noctuidae (Lepidoptera) on the non-target Lepidoptera species 71

György Bürgés[1] – György Németh[2] ([1]Pannon University, Georgikon Faculty, Keszthely, Hungary; [2]Hévíz Spa and Saint Andrew Hospital for Rheumatics, Hévíz, Hungary): Plant protection praxis on Hévíz Nature Conservation Area (Lake Balaton District, Hungary) 81

András Bozsik (University of Debrecen, Institute of Plant Protection, Debrecen, Hungary): Host plant preference of *Metcalfa pruinosa* (Say, 1830) (Hemiptera: Flatidae) in the north of Hungary 84

Erzsébet Voigt[1] – Dóra Kelemen[2] – Miklós Tóth[3] ([1]Hungarian Horticultural Propagation Material Non-Profit Ltd., Budapest, Hungary; [2]Research Institute of Fruit Production, Érd Research Station, Budapest Hungary; [3]Plant Protection Institute of CAR HAS, Budapest, Hungary): Contributions to the 2014 and 2015 flight pattern and damages of *Carpomyia schineri* Loew. 96

Gyula Oros (Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary): Varietal dependent response of barley to soil-borne *Waitea circinata* infection 100

Tartalom

Radócz László[1] – Tarcali Gábor[1] – Szabóné Asbolt Tünde[1] – Kövics György János[1] – Kiss László[2] ([1]Debreceni Egyetem MÉK Növényvédelmi Intézet, Debrecen; [2]Magyar Növényvédő Mérnöki és Növényorvosi Kamara Hajdú-Bihar Megyei Területi Szervezete, Debrecen): Dr. Dobos Irén kertészmérnök tanár, növényvédelmi szakmérnök a „Gulyás Antal emlékérem a növényvédelemért" 2015. évi kitüntetettje (laudáció) 8

Kövics György János (Debreceni Egyetem MÉK Növényvédelmi Intézet, Debrecen): Beszéljünk róla: egy gomba – egy név! Változások a gomba taxonómiában 11

Rai, Mahendra[1,2] –Kratosova, Gabriela[2] ([1]Nanobiotechnology Lab., Department of Biotechnology, SGB Amravati University, Amravati-444 602, Maharashtra state, India; [2]Nanotechnology Centre, VSB - Technical University of Ostrava, Ostrava – Poruba, Cseh Köztársaság): Növénykórokozók elleni védelem zöld nanobiotechnológia alkalmazásával: alakuló trendek és kihívások 15

Zsigó György (Magyar Növényvédő Mérnöki és Növényorvosi Kamara Növény,- Környezet- és Élelmiszerbiztonsági Bizottságának elnöke, Budapest): Jövevény károsítók megjelenése közvetlen környezetünkben és a védekezés lehetőségei. 23

Gergely László – Poós Bernát (Nemzeti Élelmiszerlánc Biztonsági Hivatal, NÉBIH, Budapest): A betegség-ellenállóság helye a magyarországi növényfajta regisztrációs eljárásban 27

Tóth Tamás – Kövics György János (Debreceni Egyetem, MÉK, Növényvédelmi Intézet, Debrecen): Fehér sömör kórokozó fajok (Chromista, Peronosporomycetes, Albuginales, *Albuginaceae*) közönséges gyomnövényeken, Magyarországon 30

Vojnich Viktor József – Hüvely Attila – Palkovics András (Kecskeméti Főiskola, Kertészeti Kar, Kertészeti Tanszék, Kecskemét): Rezisztencia vizsgálatok a szklerotíniás szár- és tányérrothadással napraforgó (*Helianthus annuus* L.) hibrideknél 34

Kovács Gabriella – Radócz László (Debreceni Egyetem Növényvédelmi Intézet, Debrecen): A táptalajok hatása a *Cryphonectria parasitica* (Murr.) Barr gomba izolátumainak és Vegetatív Kompatibilitási Csoportjainak morfológiájára 38

Frommer Dóra[1] – Veres Szilvia[2] – Lévai László[2] – Radócz László[1] ([1]Debreceni Egyetem Növényvédelmi Intézet, Debrecen; [2]Debreceni Egyetem Növénytudományi Intézet, Mezőgazdasági Növénytani, Növényélettani és Biotechnológiai Tanszék, Debrecen[2]): Régi-új betegség a kukorica golyvásüszög (*Ustilago maydis*) 43

Bónis Péter – Árendás Tamás – Szőke C. – Sugár E. –Fodor N. – Darkó É. – Marton Lajos Csaba (MTA AKK Mezőgazdasági Kutatóintézet, Martonvásár): Kukoricák herbicid-érzékenysége egy kísérletben, Martonvásáron, 2015-ben 47

Szilágyi Arnold[1] –Balogh Zoltán [2] –Dávid István[1] –Szabó László[3] –Radócz László[1] ([1]Debreceni Egyetem Növényvédelmi Intézet, Debrecen, [2]FVM Növényvédelmi Szolgálat, Miskolc, [3]FVM Növényvédelmi Szolgálat, Debrecen): Az ázsiai gyapjúfű (*Eriochloa villosa* /Thunb./ Kunth), egy nemrégiben megjelent invazív gyomnövény a Tiszántúlon, egy védekezési kísérlet kukoricában 53

Szanyi Szabolcs[1] – Nagy Antal[2] – Molnár Attila[3] – Tóth Miklós[4] – Varga Zoltán[1] ([1]Debreceni Egyetem Evolúciós Állattani Tanszék, Debrecen; [2] Debreceni Egyetem Növényvédelmi Intézet, Debrecen; [3]II. Rákóczi Ferenc Kárpátaljai Magyar Intézet, Biológiai és Kémiai Osztály, Beregszász, Ukrajna; [4]MTA AKK Növényvédelmi Intézet, Budapest): Kártevő Macrolepidoptera fajok a Velyka Dobron' vadvédelmi területen (Kárpátalja, Ukrajna) 58

Bozsik András (Debreceni Egyetem Növényvédelmi Intézet, Debrecen): A zöld lombszöcske (*Tettigonia viridissima*) (Orthoptera: Tettigoniidae) csekély kártétele néhány magyarországi kukoricásban 65

Nagy Antal[1] – Szarukán István[1] – Gém Ferenc[1] – Nyitrai Rita[1] – Füsti-Molnár Bence[1] – Németh Attila[1] – Kozák Lajos[2] – Molnár Attila[3] – Katona Krisztián[4] – Szanyi Szabolcs[5] – Varga Zoltán[5] – Tóth Miklós[6] ([1]Debreceni Egyetem Növényvédelmi Intézet, Debrecen; [2]Debreceni Egyetem Természetvédelmi és Vadgazdálkodási Tanszék, Debrecen; [3]II. Rákóczi Ferenc Kárpátaljai Magyar Intézet, Biológiai és Kémiai Osztály, Beregszász, Ukrajna; [4] Uzsgorodi Nemzeti Egyetem, Biológiai Kar, Uzsgorod, Ukrajna; [5]Debreceni Egyetem Evolúciós Állattani Tanszék, Debrecen; [6]MTA AKK Növényvédelmi Intézet, Budapest): Előzetes adatok a fél-szintetikus bagolylepke csalétkek hatásáról (Noctuidae, Lepidoptera) nem-célszervezet pikkelyesszárnyú fajokra 71

Bürgés György[1] – Németh György[2] ([1] Pannon Egyetem Georgikon Kar, Keszthely; [2] Hévízgyógyfürdő és Szent András Reumakórház, Hévíz): Növényvédelmi feladatok a Hévízi Természetvédelmi Területen 81

Bozsik András (Debreceni Egyetem Növényvédelmi Intézet, Debrecen): Az amerikai lepkekabóca (*Metcalfa pruinosa* /Say, 1830/ (Hemiptera: Flatidae) tápnövény kapcsolatai Magyarország északi részén 84

Voigt Erzsébet[1] – Kelemen Dóra[2] – Tóth Miklós[3] ([1]Magyar Kertészeti Szaporítóanyag Nonprofit Kft., Budapest, [2]NAIK Gyümölcstermesztési Kutató Intézet, Érdi Kutató Állomás, Budapest, [3]MTA ATK Növényvédelmi Intézet, Budapest): Adatok a rózsa-gyümölcslégy (*Carpomyia schineri* Loew.) 2014. és 2015. évi rajzásához és kártételéhez 96

Oros Gyula (MTA Növényvédelmi Kutató Intézete, Budapest, Hungary): Az árpa fajta-függő válasza a talajlakó *Waitea circinata* fertőzésre 100

Dr. Dobos Irén kertészmérnök tanár, növényvédelmi szakmérnök a „Gulyás Antal emlékérem a növényvédelemért” 2015. évi kitüntetettje (laudáció)

Radócz László[1] – Tarcali Gábor[1] – Szabóné Asbolt Tünde[1] – Kövics György János[1] – Kiss László[2]

[1]Debreceni Egyetem MÉK Növényvédelmi Intézet, Debrecen,
[2]Magyar Növényvédő Mérnöki és Növényorvosi Kamara Hajdú-Bihar Megyei Területi Szervezete, Debrecen
radocz@agr.unideb.hu

ÖSSZEFOGLALÁS

A Növényvédelem Oktatásának Fejlesztéséért Közhasznú Alapítvány (NOFKA) és a Magyar Növényvédő Mérnöki és Növényorvosi Kamara Hbm-i Területi Szervezete (Kamara) 2011-ben megalapította a közös Kitüntetési Bizottságot, amely a növényvédelem terén kiemelkedő teljesítményt nyújtó, példaértékű személyiségek erkölcsi megbecsülését kívánja szolgálni a „Gulyás Antal emlékérem” kitüntetés adományozásával „A Növényvédelemért”, melyet kiváló oktatók, kutatók, gyakorlati szakemberek nyerhetnek el. 2015-ben a „Gulyás Antal emlékérem a növényvédelemért” kitüntetettje **dr. Dobos Irén** kertészmérnök tanár, növényvédelmi szakmérnök *„az integrált növényvédelem gyakorlati kutatásában és a kapcsolódó ismeretátadásban betöltött kiemelkedő munkájáért” részesül az elismerésben.*

SUMMARY

The Public Utility for Development of Crop Protection Teaching (NOFKA) and The Hajdú-Bihar County Regional Association of Hungarian Chamber of Crop Protection Specialists and Plant Doctors established a joined Award Committee in 2011, which intend to serve as moral appreciation to prominent persons with excellent achievements by awarding the „Antal Gulyás medallion for crop protection” which are available for outstanding teachers, researchers, and practical crop protection specialists. In 2015 ***dr. Irén Dobos*** **horticulturist-teacher** and **plant doctor** *has been decorated with the „Antal Gulyás medallion for crop protection” for her “excellence in integrated plant protection practical research activity and effective knowledge transfer”.*

Kulcsszavak: Gulyás Antal emlékérem, kitüntetés, dr. Dobos Irén életrajz
Keywords: Antal Gulyás medallion, award, dr. Irén Dobos biography

BEVEZETÉS

A kitüntetést **dr. Gulyás Antal** emlékezetének megőrzésére 2011-ben hozták létre, aki a debreceni növényvédelem iskolateremtő professzora volt, és több mint harminc éven át az agrárszakemberek oktatásában és a tudományos kutatásban ért el kiváló eredményeket. A Növényvédelem Oktatásának Fejlesztéséért Alapítvány (NOFA) és a Magyar Növényvédő Mérnöki és Növényorvosi Kamara Hbm-i Területi Szervezete megalapította a közös Kitüntetési Bizottságot, amely a növényvédelem terén kiemelkedő teljesítményt nyújtó, példaértékű személyiségek erkölcsi megbecsülését kívánja szolgálni a „Gulyás Antal emlékérem” kitüntetés adományozásával „A Növényvédelemért”, melyet kiváló oktatók, kutatók, gyakorlati szakemberek nyerhetnek el. A Kitüntetési Bizottság 2015-ben úgy határozott, hogy **dr. Dobos Irén** kertészmérnök tanár, növényvédelmi szakmérnök asszony részesül a „Gulyás Antal emlékérem a növényvédelemért” elismerésben „az integrált növényvédelem gyakorlati kutatásában és az ismeretátadásban betöltött kiemelkedő munkájáért”.

DR. DOBOS IRÉN ÉLETRAJZA

Dr. Dobos Irén kertészmérnök tanár a Magyar Növényvédő Mérnöki és Növényorvosi Kamara Hajdú-Bihar Megyei Területi Szervezetének tagja (1. ábra).

1. ábra: **Dobos Irén kertészmérnök-tanár, növényvédő szakmérnök**
Figure 1: **Irén Dobos horticulturist-teacher, plant doctor**

Dobos Irén 1939. október 18-án született Debrecenben magyar nyelv és irodalom szakos tanár édesanya és kertészmérnök tanár édesapa házasságából, második gyermekként. Családjában 4 leánygyermek nevelkedett, mindannyiuk pályaválasztását a biológia és a tanári pálya iránti elkötelezettség jellemezte. Dobos Irénke tanulmányait Debrecenben kezdte, majd a Debrecen-Pallagi Mezőgazdasági technikumban érettségizett 1958-ban. A tehetséges fiatal lány még az évben felvételt nyert a Budapesti Kertészeti Főiskolára, ahol II. éves korától aktívan bekapcsolódott a Borászati Tanszék munkájába. A felsőfokú tanulmányok mellett aktívan bekapcsolódott az egyetemi diákok kulturális életébe tagja lett a néptánc, majd később a színjátszó csoportnak is.1963. februárjában végzett és kapott borász diplomát, diplomadolgozatát az akkor még teljesen újnak számító „Kovaföld szűrés új borok esetében” témakörben készítette.

2. ábra: **Dobos Irén szőlész kerületvezető**

Figure 2: **Irén Dobos viticulturist, regional manager**

A diploma megszerzése után a Szekszárdi Állami Gazdaságba került mint 200 hektár szőlőterületért volt felelős, új nyugat európai fajtákat telepített Kajmádon és országos viszonylatban először alkalmazta a Lens Moser féle művelésmódot (2. ábra).

1965. márciusában férjhez ment és nem sokkal később az anyai örömök elé néző fiatalasszony elfogadta a szekszárdi Garay János Gimnázium felkérését az akkor induló szőlész-borász tagozatra mérnöktanárnak. A mérnöktanári diplomáját 1968-ban szerezte meg Gödöllői Agrártudományi Egyetem Tanárképző Intézetében.

1969. augusztusában családi körülményeiben bekövetkezett változások miatt visszaköltözött Debrecenbe, ahol a Debreceni Kertészeti Vállalatnál kapott állást és a 2. számú dísznövénytermesztő telep vezetője lett. Itt cserepes levélzöldeket és árvácskákat termeltek éves szinten milliós nagyságrendben. Szakmai munkájában nagy siker volt az általa szaporított *Begonia rex*-szel a zágrábi nemzetközi virágkiállításon elért II. helyezés, 1970-ben.

Ugyanebben az évben megpályázta a Debrecen-Pallagi Mezőgazdasági Szakközépiskola kertész mérnöktanári állását, ahol szeptembertől az iskola tanára lett. A rá jellemző lendülettel, és szakmai precizitással kezdte el a szőlőtermesztés és dísznövénytermesztés elméleti oktatását, valamint gyakorlatait vezetni, valamint az iskola gyakorlókertjét és üvegházát a kertészeti termesztés céljaira formálni. A minőségi gyakorlati oktatásra törekvés jegyében és széleskörű szakmai kapcsolatrendszerének, valamint ismertségének köszönhetően szervezett gyakorlatokat jól működő vállalatokhoz, termelő szövetkezetekhez.

A szakközépiskolában a növényvédelmi képzés megjelenése igényelte a tanárok továbbképzését is, így Dobos Irén a DATE posztgraduális növényvédelmi szak hallgatója lett. Nagynevű oktató gárda segítségével sajátította el a növényvédelmi szakma fortélyait, nem kis szorgalommal és szakmai érdeklődéssel. Szakdolgozatában (Szepessy professzor javaslatára) a még akkor élő (93 éves) dr. Gulyás Antalnak, a Magyar Kir. Gazdasági Akadémia volt igazgatójának, első virológusunknak a munkásságát dolgozta fel. Megnyerő személyiségével sikerült elérni azt, hogy az idős, zárkózott professzor újra megnyílt és a dokumentum-értékű iratok, szakkönyvek és visszaemlékezések gazdagítják és pontosítják ismereteinket arról a korról és annak nagy szülötteiről, korszak formáló személyiségeiről. A növényvédelmi szakmérnöki diplomáját 1979-ben vette át, és Pallagon az első növényvédős osztály osztályfőnöke is lett (3. ábra). Többen, volt tanítványaiként mondhatjuk mindig maximális pontossággal, szigorúan, de korrekt módon törekedett az ismeretek minél szélesebb körű átadására, a növényvédelmi témákban tartott gyakorlatai legendásan jók és lebilincselőek voltak. Szakmai igényességét jól jelzi, hogy 1987-ben dr. Szepessy István professzor vezetése mellett egyetemi doktori címet szerzett (4. ábra).

3. ábra: **Dobos Irén és tanítványai**

Figure 3: **Irén Dobos and her students**

4. ábra: **Dobos Irén átveszi doktori diplomáját a DATE-n, 1987**
Figure 4: **Confer of Doctorate on Irén Dobos at Debrecen Agricultural University in 1987**

A Pallagon eltöltött évek során volt megbízott igazgató, 7 éven keresztül szakmai igazgatóhelyettes, a kertészeti és növényvédelmi munkaközösség vezetője. Mint a GATE és a DATE Tanárképző Intézeteinek vezető tanára vonult nyugdíjba 1996-ban.

Nyugdíjas éveiben sem tétlenkedett, a Debreceni Művészeti Szakképző Intézetben tanított virágkötők részére dísznövénytermesztést és a debreceni Köszméte és Oltványtermesztő Szövetkezet elnöke lett. 2000-ben „A köszméte, a ribiszke és a josta" című nagysikerű könyv társszerzője, a növényvédelmi fejezetek kidolgozója. Aktív résztvevője szakmai rendezvényeknek, továbbképzéseknek. Tanulmányaiban és oktató, kísérletező munkájában nagyon sok segítséget, támogatást kapott 2. férjétől dr. Madai Gyulától a DATE Dékáni Hivatalának volt vezetőjétől.

Dr. Dobos Irén országosan is ismert kertész és növényorvos szakember, kivívta nagyon sok növényvédő mérnök és növényorvos kolléga elismerését, hiszen szakmai tapasztalatára épített előadásai és gyakorlati szaktanácsadásai jelentős mértékben segítették és segítik az integrált növényvédelem terjedését, térhódítását. Munkájára a korrekt szakmai felelősséggel párosuló, igen sokszínű gyakorlati tevékenység, környezetkímélő szemlélet, innovatív és kreatív gondolkodásmód jellemző.

A Gulyás Antal emlékérem kitüntetéshez gratulálnak tanítványai, munkatársai, a növényvédő szakma művelői, kívánva elégedett, jó egészségben töltendő éveket, további gyümölcsöző munkát Dobos Irén asszonynak!

Beszéljünk róla: egy gomba – egy név! Változások a gomba taxonómiában

Kövics György János
Debreceni Egyetem MÉK Növényvédelmi Intézet, Debrecen
kovics@agr.unideb.hu

ÖSSZEFOGLALÁS

*A mikológusok néhány százezer latin nevet használtak fel a gombák elnevezésére, és ez manapság mintegy 70.000 önálló fajnak felel meg. A molekuláris technikák alkalmazása a gomba taxonómiában az elmúlt 25 év során tömeges információt szolgáltatott a filogenetikai kapcsolatok felderítéséhez, melyet különböző támogatások segítettek, és meglehetősen bonyolulttá tették a klasszikus gomba-rendszertanon felnőtt mikológusok munkáját. A taxonómusok jórészt hagyománytisztelők, de az utóbbi időben összefogtak a nevezéktani szabályok modernizációja érdekében, hogy elhagyják a latin nyelvű leírásokat, támogassák az elektronikus publikálást, és azt, hogy legyen vége a nevezéktanban a kettős elnevezés (teleomorf és anamorf) alkalmazásának, melyet a faj ivaros és ivartalan fázisainak elnevezésére egymás mellett alkalmaztak a pleomorf gomba fajok esetében. A taxonómusok egy csoportja 2011-ben elfogadta az ún. „Amszterdami Deklaráció"-t (*The Amsterdam Declaration on Fungal Nomenclature*), amely alapelve, az – „egy gomba – egy név" – beépült a „Melbourne-i Jogszabály Gyűjtemény"-be (*Code of Nomenclature, 'Melbourne Code'*). A következő, még problematikusabb lépés az lesz, hogy kialakítsák a mindenki által elfogadható standardokat a szekvencia-alapú gomba osztályozáshoz. Mivel az „Egy gomba – egy név" tanítás teljesen új a magyar növényorvosok és gyakorló növényvédő szakemberek számára, ésszerűnek látszik a fentiek összefoglalása, hogy ezáltal is elősegítsük a nemzedékek közötti magyar nyelvű párbeszédet.*

SUMMARY

Mycologists have recorded a few hundred thousand Latin names for fungi and these are thought to refer to 70 000 or so separate species. The use of molecular techniques in fungal taxonomy and systematics in the last 25 years has provided massive amounts of information to clarify phylogenetic relationships, encouraged grant support, and complicated the jobs of classically-trained mycologists. Taxonomists have a reputation for being traditionalists, but the community has recently embraced the modernization of the nomenclatural rules by discarding the requirement for Latin descriptions, endorsing electronic publication, and ending the dual system of nomenclature, viz. teleomorph and anamorph names, which used parallel for the sexual and asexual phases of pleomorphic species. A group of taxonomists accepted 'The Amsterdam Declaration on Fungal Nomenclature' and its basic principle the 'One fungus – one name' has been incorporated in the Code of Nomenclature ('Melbourne Code') in 2011. The next, and more difficult step will be to develop community standards for sequence-based classification. As the'One fungus – One name' theory is a brand-new issue for the Hungarian plant doctors and practical specialists, it seems reasonable to review this to promote conversations between generations in Hungarian language.

Kulcsszavak: gomba taxonómia, pleomorf gombák, „egy gomba – egy név", Amszterdami Deklaráció, Melbourne-i Jogszabály Gyűjtemény
Keywords: fungal taxonomy, pleomorphic fungi, 'One fungus – one name', Amsterdam Declaration, Melbourne Code

A fitopatogén gombákkal való ismerkedés során az egyetemi hallgató szembe találkozik a gombák pleomorfizmusa és a gomba holomorf fogalmakkal, amelyek ismerete, tartalmának megértése és összekapcsolása a teleomorf-anamorf kapcsolat biológiai lényegével, kulcsot jelent a kórokozó ivaros és ivartalan spóraképzése sajátosságainak megismeréséhez. Így van ez már közel másfél évszázada. Most azonban történelmi mérföldkőhöz érkezett a mikológia: az **egy gombafaj** elnevezésében **egyetlen** binominális **név** használatához. Ennek átvétele és gyakorlati bevezetése hosszabb időt igénylő folyamat: amíg a pleomorfizmuson nevelkedett generációk hozzászoknak a kettős elnevezés helyett (mellett) az egyetlen gombanév használatához, s az új generációk tagjaival megtalálják a „közös hangot", a gomba okozta betegségek megnevezésében. Az új szabályozásban nem érvényes a teleomorf név használatának elsőbbsége, ezért a mikológusok közössége által javasolt, majd jogilag is megerősítésre kerülő nevek használatának bevezetéséről van szó, függetlenül attól, hogy az ivaros vagy ivartalan gombanemzetség névhez kapcsolódik. Mivel a mikotaxonómusok közössége nem egységes, ebben a „Melyik lenne az igazi?" meghatározásában még számos ütközetre számíthatunk!

A GOMBÁK PLEOMORFIZMUSA

A mikológusok néhány százezer latin nevet létesítettek és használtak fel a mintegy 70 000 önálló fajnak megfelelő, eddig megismert fajok elnevezésére (Bass and Richards, 2011). Becslések szerint a gombák számát, ide értve a még nem ismert és megnevezett fajok tekintetében egymillió felettire teszik (Hibbet and Taylor, 2013).

A tömlősgombák (Ascomycota) körében elég gyakori, hogy a gomba kétféle alakjával is találkozunk, melyet napjainkig együttesen használunk az ivaros (teleomorf) és ivartalan (anamorf) alakok megnevezésére. Ezek a gomba megjelenési formák térben és időben gyakran nem egyszerre fordulnak elő.

Először Hennebert and Weresub (1977), Weresub and Hennebert (1979) javasolták a **teleomorf** és az **anamorf** alak elnevezést. Ugyanezekre régebben használatban voltak a **perfect** és **imperfect** kifejezések is.

A kettős névalkalmazás során az almafa varasodás kórokozójának az egyik tudományos név használata mellett (az ivaros, teleomorf, perfect, aszkospórás alak, pl. *Venturia inaequalis* /Cooke/ G. Winter, 1875) az ivartalan alakra is **külön nevet alkalmaztunk** (anamorf, imperfect, konídiumos alak, nevezetesen: *Spilocaea pomi* Fr., 1819) – közel másfél évszázadon át. Ma az ajánlott név a ***Venturia inaequalis***, a *S. pomi*-t pedig – sok más ivaros és ivartalan (pl. *Fusicladium dendriticum* /Wallr./ Fuckel, 1870) névvel együtt – a szinonim nevek között tartják nyilván (Species Fungorum, 2015).

A lehullott almafa levelekben tavasszal a tömlősgomba aszkospóráinak érését követjük nyomon (két egyenlőtlen méretű, „cipőtalp" alakú spóra színtelenből /hyalin/ barnássá válik (teleomorf alak, a gomba életében a szaprobionta életszakasznak felel meg). A vegetációs időszakban (a gomba anamorf, ivartalan spórái, konídiumai keletkeznek 10-12 nemzedékben) a gomba már a parazita életszakaszában van, és folytonos veszélyt jelent a gyümölcsfa részek (virág, levél, gyümölcs) megfertőzésére, rendszeres, preventív gombaölőszer-kijuttatás feladatát adva a növényorvosnak.

A kettős névalkalmazás hosszú történet. Ahhoz, hogy visszamenjünk az időben, a gombák pleomorfizmusához kalauzunk Weresub and Pirozynski (1979) kitűnő gombatörténeti munkája lehet. Az 1860-as években Berkley (1857), valamint Charles és Louis Rene Tulasne figyelték meg a tömlősgombák fejlődésének bonyolultságát, azaz egy gombafaj **különböző típusú telepei nem hasonlítottak a másikéra** a mikroszkópi megfigyeléseik során (Tulasne and Tulasne, 1861-1865).

Linné növényrendszere a **virág morfológiáján alapul**, aki bemutatta, hogy minden egyes növénynek van virága, de csak ***egyfajta***. Abban az időben a gombákat még növényeknek tekintették, és a gombaspórákat megegyezőnek tartották a növények magvaival, és Linné kiterjesztette a taxonómiai koncepcióját a gombákra is. Ez aztán nagy számban vezetett el ahhoz, hogy két vagy több fajnevet is alkottak a kor mikológusai, ugyanazon organizmus esetében.

Akkoriban a gombák legjellemzőbb tulajdonságát, az (ivaros) meiospórát használták az osztályozásra, és ha ilyet a gomba nem képezett, akkor nem volt más választás, mint a **kettős fajnév** használata (Taylor, 2011).

Az elgondolás folytatódott Fuckel (1870) és Saccardo munkáiban is, utóbbi a *Sylloge Fungorum*-át 1882-ben kezdte közzétenni, 25+1 kötetben (Saccardo, 1882-1931).

Saccardo a kiérlelt anamorf morfológiát alkalmazva egy nagyszerű, kényelmes megoldást biztosított a pleomorf gombák osztályozásra, de természetesen ez nem alapozott az evolúciós rokonsági viszonyokra.

Kendrick (1979) és Sivanesan (1984) klasszikus mikológusok voltak azok, akik kísérletet tettek az ivartalan és ivaros alakok integrálására. Sutton (1980) ugyancsak összekapcsolta a Coelomycetes ivartalan alakok és azok ivaros alakjait, míg Seifert *et al.* (2011) megtették ugyanezt a Hyphomycetes nemzetségek vonatkozásában.

Az oktatás-kutatás szintjein is nélkülözhetetlen volt a már megismert anamorf – teleomorf nevek összekapcsolása, ennek első hazai, didaktikus gyűjteménye a „Növénybetegséget okozó gombák névtára" (Kövics, 2000).

A konídiumos (mitospórás) gombák kutatásásának evolúciós kapcsolatokkal rendelkező feltárása Vuillemin (1910a, b) és Mason (1933, 1937) munkáival kezdődött és vezetett el Hughes (1953), Tubaki (1958) és Barron (1968) munkásságához. A mitospórás gombák elegáns mikroszkópos kutatásait követően (Cole and Samson, 1979) a csúcspontját a Kendrick-szerkesztette két-kötetes könyv publikálásakor (1979) érte el.

Az utóbbi két évtizedben nagyobb gombacsoportok DNS jellemzőinek megismerése nagyban elősegítette a különböző formák (teleomorf, anamorf, andromorf) egyetlen fajba történő egyesítésének lehetőségét, a filogenetikai rokonságon nyugvó kapcsolódást (Schoch *et al.,* 2014).

A mikológusok, taxonómusok többsége a jogszabályokhoz alkalmazkodik, ennek legutóbbi összefoglaló gyűjteménye a 2011-es ún. Melbourne Code, a Nemzetközi Szabályzat az algák, gombák és növények nevezéktanára (International Code of Nomenclature for algae, fungi and plants, ICN) (McNeill *et al.,* 2012).

Éleshangú vitákat követően az „**egy gomba = egy név**" koncepció látszik győzedelmeskedni, ez tükröződik az ún. Amszterdami Deklarációban (Hawksworth *et al.,* 2011), melyben vezető mikológusok (2011. április) kinyilvánították, hogy **a pleomorf gombák különböző fajnevei**, melyeket hagyományosan az ivaros és ivartalan alakok (teleomorf, anamorf) elnevezésére használtak, **ugyanazon faj esetében feleslegesek**.

MELYEK A MELBOURNE-I JOGSZABÁLY GYŰJTEMÉNY ('Melbourne Code') FONTOSABB KITÉTELEI?

- **A kettős gomba elnevezés megszüntetésével párhuzamosan** megszavazták **a latin nyelvű leírás elhagyhatóságát** (az angol nyelvű elegendő), 2012-től a nevek akkor tekinthetők érvényesnek, ha **vagy angol, vagy latin nyelvű leírás** (*descriptio*), illetve **jellemzés** (*diagnosis*) társul az új fajnévhez.
- 2012-től a tudományos nevek **publikálhatók elektronikus formátumban is** (nyomtatott megjelenés hiányában).
- 2013. január 1- től **minden új gomba taxonómiai nevet regisztrálni kell** egy vagy több online, **publikusan**

hozzáférhető adatbázis (repozitórium) **egyikében**, pl. **Index Fungorum** (http://www.IndexFungorum.org) vagy a **MycoBank** (http://www.MycoBank.org) (Norvell, 2011; Redhead and Norvell, 2013; Schoch *et al.,* 2014).

Ez a döntés sok kutatónak már így is kissé elkésettnek tűnt, míg mások a változásokat földindulás-szerűnek tartják (Hawksworth, 2011).

MELYIK FAJNÉV KERÜL MAJD KIVÁLASZTÁSRA?

- Az **alapelv**, miszerint **annak**, **melyet a legrégebben írtak le** (függetlenül attól, hogy az teleomorf vagy anamorf *genus*) **prioritása van**, **de a régi** szabályok szerint publikált **nevek**ről **nem** lehet kijelenteni, hogy azok **illegitimek vagy érvénytelenek** (invalid) lennének.
- Azonban ezen alapelv sem ad biztos fogódzót, hiszen ugyanazon taxonokra széleskörűen használatos nevek mind az anamorf, mind a teleomorf nevek körében is vannak, például a *Fusarium* (anamorf) és *Gibberella* (teleomorf) *genus*-ok eseteiben.

A 2013. január 1. előtti **széleskörűen használt név lehet ajánlott**, akár teleomorfként meghatározott, akár anamorfként tipizált, a **prioritást nem kapcsolják automatikusan a teleomorf név mellé.**

- A filogenetikai vizsgálatokhoz már hosszú ideje a legszélesebb körben használt genomi régiók a sejtmagban és a mitokondriumban található riboszomális rDNS (rRNS) szekvenciák (Moncalvo *et al.,* 2002; Avise, 2004). A molekuláris biológia, ezen belül a gombák ITS régióinak szekvenálása elismerten értékes eszköz a filogenetikai rokonság tanulmányozására a különböző taxonok között. **Az alap** egy **ITS** (Internal Transcribed Spacer 1,2) **szekvencia** adatokból álló **vonalkód** (*barcode A*), amihez elengedhetetlenül **társulna a** különböző gombafajok **morfológiai leírása** (*barcode B)* (Money, 2013). Bár az ITS gomba szekvenciák univerzális alkalmazhatóságát (Schoch *et al.,* 2012) többen vitatják, illetve más markereket is javasolnak alkalmazásra (pl. TEF-1α gén), amely helyettesítheti vagy kiegészítheti az ITS szekvenciát (Stielow *et al.,* 2015).

A növekvő számú molekuláris ökológiai és mikrobiomikus[1] projekteknek is szükségük van a szekvenálásra alapozó gyors és hatékony módszerekre az „*en messe*” (tömeges) faji leírásokhoz (Schoch *et al.* 2014). Egy ilyen próbálkozás az „Index Fungorum online” is, amely 2012-ben elindult, és jelenleg (2015.szeptember 30.) a No. 259 taxonómiai újdonság közzététel bejegyzésnél tart (Kirk *et al.,* 2012-15).

A taxonómusok szerint a pleomorf gombákra kialakítandó **egységes nevezéktani rendszer** elő fogja segíteni a hatékony párbeszédet a gombákkal, zuzmókkal foglalkozó különböző szakemberek között. Ennek a kölcsönös megértésnek az elősegítését szolgálja ezen összeállítás is, elősegítve a növényvédő/növényorvos nemzedékek közötti magyar nyelvű szakmai párbeszédét a gomba névalkalmazás területén.

IRODALOM

Avise, J.C. (2004): Molecular markers, natural history, and evolution. 2nd ed. Underland, MA: Sinauer Associates

Backhed, F., Ley, R.E., Sonnenburg, J.L., Peterson, D.A. and Gordon, J.I. (2005): Host-bacterial mutualism in the human intestine. Science, 307: 1915–1920.

Barron, G.L. (1968): The Genera of Hyphomycetes from Soil. Baltimore: Williams & Wilkins.

Bass, D. and Richards, T.A. (2011): Three reasons to re-evaluate fungal diversity "on Earth and in the ocean". Fungal Biol. Rev., 25: 159–164.

Berkeley, M.J. 1857. Introduction to cryptogamic botany. Bailliere, London, 604 pp.

Cole, G.T. and Samson, R.A. (1979): Patterns of Development in Conidial Fungi. London: Pitman.

Fuckel, L. (1870): Symbolae mycologicae. Beiträge zur Kenntnis der rheinischen Pilze. Jahrbücher des Nassauischen Vereins für Naturkunde, 23-24: 1–495.

Hawksworth, D.L. (2011): A new dawn for the naming of fungi: impacts of decisions made in Melbourne in July 2011 on the future publication and regulation of fungal names. IMA Fungus, 2: 155–162.

Hawksworth, D.L., Crous, P.W. Redhead, S.A., *et al.* (2011): The Amsterdam declaration on fungal nomenclature. IMA Fungus, 2: 105–112.

Hennebert, G.L. and Weresub, L.K. (1977): Terms for states and forms of fungi, their names and types. Mycotaxon, 6: 207–211.

Hibbett, D.S. and Taylor, J.W. (2013): Fungal systematics: is a new age of enlightenment at hand? Nat. Rev., 11: 129–133.

Hughes, S.J. (1953): Conidiophores, conidia, and classification. Canadian Journal of Botany 31: 577–659.

Kendrick, B. (ed.) (1979): The Whole Fungus: the sexual-asexual synthesis. 2 vols. Ottawa: National Museums of Canada.

Kirk, P.M., *et al.* (2012 - 2015): Index Fungorum no. 1-255. Index Fungorum [online] http://www.indexfungorum.org/Publications/Index%20Fungorum%20no.259.pdf

Kövics Gy. (2000): Növénybetegséget okozó gombák névtára. Mezőgazda Kiadó, Budapest. 255 pp.

[1] **mikrobiom** = A kommenzalista, szimbionta és patogén mikroorganizmusok, melyek a szó szoros értelmében osztoznak a testüregeinken (Lederberg és McCray 2001). A kifejezést először J. Lederberg, alkalmazta, aki vitatta a az emberi testben megtalálható mikroorganizmusok szerepét az egészség és a betegség kialakulásában. Számos publikáció megkülönbözteti a „mikrobiom” és a „mikrobióta” kifejezést, az előbbi a mikroorganizmusoknak együttes genomját írja le, amelyek reziduálisak egy környezeti *niche*-ben, utóbbi, a mikrobióta, magukat a mikroorganizmusokat jelenti (Backhead *et al.* 2005). Azonban ezek az eredeti kifejezések ma többnyire szinonímok.

Lederberg, J. and McCray, A.T. (2001): ’Ome Sweet’Omics – a genealogical treasury of words. Scientist, 15: 8.
Mason, E.W. (1933): Annotated account of Fungi received at the Imperial Mycological Institute, List II (Fasc. 2). Mycological Papers, 3: 1–67.
Mason, E.W. (1937): Annotated account of Fungi received at theImperial Mycological Institute, List II, Fasc. 3 gen. part. Mycological Papers, 4: 69–99.
McNeill, J., Barrie, F.R., Buck, W.R. *et al.* (2012): International Code of Nomenclature for algae, fungi, and plants (Melbourne Code). In: McNeill, J. (ed). Regnum Vegetabile, Vol. 154. Koeltz Scientific Books, Königstein. 240 pp.
Moncalvo, J.M., Wang, H.H. and Hseu, R.S. (1995): Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. Mycologia, 87: 223–238.
Money, N.P. (2013): Against the naming of fungi. Fungal Biology, 11(7): 463–465.
Norvell, L.L. (2011): Fungal nomenclature. 1. Melbourne approves a new Code. Mycotaxon, 116: 481–490.
Redhead, S.A. and Norvell, L.L. (2013): Report of the Nomenclature Committee for Fungi 19: Official repositories for fungal names. Taxon, 62: 173–174.
Saccardo, P.A. (1882-1931): *Sylloge Fungorum Omnium Hucusque Cognitorum.* Vol. 1-25. és 26. (Index of fungi, 1972)
Schoch, C.L., Robbertse, B., Robertet, V., *et al.* (2014): Finding needles in haystacks: linking scientific names, reference speciments and molecular data for Fungi. Database. The Journal of Biological Databases and Curation. Vol. 2014, Article ID bau061 1-21. doi: 10.1093/database/bau061
Schoch, C.L., Seifert, K.A., Huhndorf, S. *et al.* (2012): Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. Proc. Natl Acad. Sci. USA 109, 6241–6246.
Seifert, K., Morgan-Jones, G., Gams, W., Kendrick, B. (2011) The Genera of Hyphomycetes. CBS-KNAW Fungal Biodiversity Centre Utrecht, The Netherlands
Sivanesan, A. (1984) The Bitunicate Ascomycetes and their Anamorphs. J. Cramer, Vaduz
Species Fungorum (2015): *Venturia inaequalis*. (Cooke) G. Winter http://www.speciesfungorum.org/Names/GSDSpecies.asp?RecordID=164141
Stielow, J.B., Lévesque, C.A., Seifert, K.A. *et al.* 2015. One fungus, which genes? Development and assessment of universal primers for potential secondary fungal DNA barcodes. Persoonia - Molecular Phylogeny and Evolution of Fungi 352417192427222628(2): 242-263.
Sutton, B.C. (1980) The Coelomycetes: fungi imperfecti with pycnidia, acervuli and stromata. Commonwealth Mycological Institute, Kew
Taylor, J.W. (2011): One fungus - one name: DNA and fungal nomenclature twenty years after PCR. IMA Fungus, 2: 113–120.
Tubaki, K. (1958): Studies on the Japanese Hyphomycetes, 5. Leaf and stem group with a discussion of the classification of Hyphomycetes and their perfect stages. Journal of the Hattori Botanical Laboratory, 20: 142–244.
Tulasne, L.R. and Tulasne, C. (1861–1865): *Selecta Fungorum Carpologia*. In: *Imperiali Typographeo Excudebatur*. Imperatoris Jussu, Paris.
Vuillemin, P. (1910a): Les conidiospores. Bulletin de la Société des Sciences du Nancy, 11: 129–172.
Vuillemin, P. (1910b): Les aleuriospores. Bulletin de la Société des Sciences du Nancy, 12: 151–175.
Weresub, L.K. and Hennebert, G.L. (1979): Anamorph & teleomorph: terms for organs of reproduction rather than karyological phases. Mycotaxon, 8: 181–186.
Weresub, L.K. and Pirozynski, K.A. (1979): Pleomorphism of fungi as treated in the history of mycology and nomenclature. In: The Whole Fungus (B. Kendrick, ed.) 1: 17–25. Ottawa, National Museums of Canada.

Management of phytopathogens by application of green nanobiotechnology: Emerging trends and challenges

Mahendra Rai[1,2] and Gabriela Kratosova[2]
[1]Nanobiotechnology Lab., Department of Biotechnology, SGB Amravati University, Amravati, India
[2]Nanotechnology Centre, VSB - Technical University of Ostrava, Ostrava – Poruba, Czech Republic
mahendrarai@sgbau.ac.in and pmkrai@hotmail.com

SUMMARY

Nanotechnology is highly interdisciplinary and important research area in modern science. The use of nanomaterials offer major advantages due to their unique size, shape and significantly improved physical, chemical, biological and antimicrobial properties. Physicochemical and antimicrobial properties of metal nanoparticles have received much attention of researchers. There are different methods i.e. chemical, physical and biological for synthesis of nanoparticles. Chemical and physical methods have some limitations, and therefore, biological methods are needed to develop environment-friendly synthesis of nanoparticles. Moreover, biological method for the production of nanoparticles is simpler than chemical method as biological agents secrete large amount of enzymes, which reduce metals and can be responsible for the synthesis and capping on nanoparticles.

Biological systems for nanoparticle synthesis include plants, fungi, bacteria, yeasts, and actinomycetes. Many plant species including Opuntia ficus-indica, Azardirachta indica, Lawsonia inermis, Triticum aestivum, Hydrilla verticillata, Citrus medica, Catharanthus roseus, Avena sativa*, etc., bacteria, such as* Bacillus subtilis, Sulfate-Reducing Bacteria, Pseudomonas stutzeri, Lactobacillus sp., Klebsiella aerogenes, Torulopsis *sp., and fungi, like* Fusarium *spp.* Aspergillus *spp.,* Verticillium *spp.,* Saccharomyces cerevisae *MKY3,* Phoma *spp. etc. have been exploited for the synthesis of different nanoparticles. Among all biological systems, fungi have been found to be more efficient system for synthesis of metal nanoparticles as they are easy to grow, produce more biomass and secret many enzymes. We proposed the term myconanotechnology (myco = fungi, nanotechnology = the creation and exploitation of materials in the size range of 1–100 nm). Myconanotechnology is the interface between mycology and nanotechnology, and is an exciting new applied interdisciplinary science that may have considerable potential, partly due to the wide range and diversity of fungi.*

Nanotechnology is the promising tool to improve agricultural productivity though delivery of genes and drug molecules to target sites at cellular levels, genetic improvement, and nano-array based gene-technologies for gene expressions in plants and also use of nanoparticles-based gene transfer for breeding of varieties resistant to different pathogens and pests. The nanoparticles like copper (Cu), silver (Ag), titanium (Ti) and chitosan have shown their potential as novel antimicrobials for the management of pathogenic microorganisms affecting agricultural crops. Different experiments confirmed that fungal hyphae and conidial germination of pathogenic fungi are significantly inhibited by copper nanoparticles. The nanotechnologies can be used for the disease detection and also for its management. The progress in development of nano-herbicides, nano-fungicides and nano-pesticides will open up new avenues in the field of management of plant pathogens. The use of different nanoparticles in agriculture will increase productivity of crop. It is the necessity of time to use nanotechnology in agriculture with extensive experimental trials. However, there are challenges particularly the toxicity, which is not a big issue as compared to fungicides and pesticides.

Keywords: Nanoparticles, pathogen detection, antimicrobials, nano-herbicides, nano-fungicides, nano-pesticides, toxicity

INTRODUCTION

Due to the extensive use of fungicides and pesticides there is rapid increase in ecotoxicity (Chen *et al*., 2015; Vu *et al*., 2015) and development of resistance in plant pathogenic microbes (Dzhavakhiya *et al*., 2012; Alghuthaymi *et al*., 2015). The possible solutions include biological control of plant pathogens by using extracts of the plants or microbes. Although, biological control methods for the management of phytopathogens have been useful, several inherent challenges need to be addressed (Frampton *et al*., 2012). Therefore, there is a pressing need to search for alternatives for the management of phytopathogens. The emerging nanobiotechnology seems to be of paramount importance for the management of phytopathogens particularly in early detection of plant disease, as potential fungicides, in development of varieties resistant to fungal diseases, and also for smart delivery of fungicides to the plants. The fungi affecting agricultural production can be controlled by application of nanofungicides. The use of nanotechnology both in developing and developed countries will bring dramatic changes in agriculture. This would really be a journey from green revolution to green nanobiorevolution.

Nanotechnology (NT) is highly interdisciplinary technology with size range of 1-100 nm. NT involves physics, chemistry, biology, engineering, medicines, agriculture and all other sciences. It is also considered as enabling technology since the property and activity of nanoparticles changes with change in size and shape (Satalkar *et al*., 2015).

Nanotechnology and biotechnology are two very important subjects, which are highly interdisciplinary. The fusion of these two subjects has given rise to Nanobiotechnology. The emerging science nanobiotechnology has revolutionized the world and it is believed that the present century will be the century of smart technologies represented by nanobiotechnology. There are various reports which provide evidence of *in vitro* efficacy of different kind of nanoparticles (Guo *et al*., 2015). But of course, the need of extensive experimental trials are necessary in order to utilize the fullest potential of nanobiotechnology. Different kind of nanoparticles in general and biodegradable nanoparticles in particular can be used for plant disease management (Chowdappa and Gowda, 2013).

Nanoparticles have higher surface area to the volume ratio. Therefore, they have more chances of interaction with the pathogenic microbes and killing them. As a matter of fact, they have better potential to kill the microbes as compared to bulk materials. The nanoparticles shows unique physical, chemical and biological properties due to their nanosize, and therefore can be utilized in gene transfer (Rai *et al*., 2012), for management of insect-pests in and pathogens in agriculture (Rai and Ingle, 2012; Mishra and Singh, 2015).

The bacteria and fungi are developing resistance to microbicides or fungicides and thus causing major problem for tackling the pathogens like *Phytophthora*. Considering this fact, it is a pressing need to develop alternative antimicrobial agents. Since ancient times, silver has been known for its antibacterial activity, and now silver nanoparticles are being used as antimicrobials (Rai *et al*., 2009). Encouragingly, AgNPs have been rightly called as nanoweapon against plant pathogens (Mishra and Singh, 2015). The American Biotech Labs have spent millions of dollars on testing the safety and efficacy of nanosilver technology products. Their studies have concluded that nanosilver products are not toxic to cells, animals or humans at low concentration.

Usually, the nanoparticles are synthesized by physical, chemical and biological methods. The first two methods are energy intensive and may require toxic chemicals whereas, biogenic technique is eco-friendly, clean, non-toxic and economically viable. However, the main draw-back of biogenic method is that it is difficult to achieve monodispersity, and control over the size and shape (Nayak *et al*., 2011). The formation of nanoparticles by using fungi (Ingle *et al*., 2009; Bawaskar *et al*., 2010; Kumar *et al*., 2012; Dar *et al*., 2013; Potara *et al*., 2015), plants (Narayan *et al*., 2008; Gade *et al*., 2010; Bonde *et al*., 2012; Rai and Yadav, 2013; Mallikarjuna*et al*., 2015) bacteria (Kumar *et al*., 2008; Shahverdi *et al*., 2009; Tiwari *et al*., 2014), actinomycetes (Golinska *et al*., 2014), algae (El-Kassas and El-Sheekh, 2014) have been reported by many researchers.

The main focus of the present talk is to discuss the role of green nanobiotechnology for the detection of diseases and also for the management of different phytopathogens in general and fungal pathogens in particular. In addition, the toxicity issue has also been addressed so that the nanofungicides may be formulated for the strategic management of plant diseases caused by different pathogens.

NANOTECHNOLOGY IN PATHOGEN DETECTION

There is increasing demand for the food production owing to the fast growing human population and therefore, food security has become an international issue. It is estimated that by 2050 an additional 70% food production is needed to fulfil the demand of growing population (Godfray *et al.,* 2015). Unfortunately, the food loss caused by bacteria, fungi and viruses ranges from 20 to 40% (Savary *et al*., 2012).

There are various recent methods for detection of diseases caused by microbial pathogens which are mostly laboratory-based (Fang and Ramasamy, 2015). These include polymerase chain reaction (PCR), enzyme-linked immunosorbent assay (ELISA), immunofluorescence (IF), fluorescence *in-situ* hybridization (FISH), flow cytometry (FCM) and gas chromatography-mass spectrometry (GC-MS). However, there is need of nanobiosensors for rapid detection of the pathogens (Rai *et al*., 2012). Many biosensors have been developed for different applications particularly in medical and environmental field. Such sensors can be developed for plant disease identification and their efficiency can be enhanced by the use of nanomaterials. Different nanomaterials, such as metal and metal oxide nanoparticles, quantum dots, carbon nanotubes, graphene, etc. can be used in nanobiosensors (*Table 1*). The nanoparticles are most widely used materials, for example, nanoparticles are used with antibodies for detection of *Xanthomonas axonopodis* (Yao *et al*., 2010).

Prunus necrotic ringspot virus (PNRSV), which causes disease in *Prunus* species (peach, plum, apricot, sweet cherry and almonds) resulting into yield loss. Traditionally, the trees which suffer from disease have to remove from the orchard. Hence, the rapid and early identification of the pathogen is necessary in order to control this disease. In 2014, Zong *et al*. developed a new method for rapid detection of *Prunus necrotic ringspot virus* using magnetic-nanoparticle-based reverse Transcription loop-mediated isothermal amplification (RT-LAMP). The authors reported this technique to be highly specific and more sensitive to PNRSV than than reverse-transcription polymerase chain reaction (RT-PCR).

Table 1

List of different nanomaterials used in nanobiosensors

S.No.	Nanomaterials	Disease	Reference
1	AuNps-based optical immunosensor	Karnal bunt disease of wheat	Singh *et al*. (2010)
	Gold nanorods (AuNRs) functionalized by antibodies	Cymbidium mosaic virus (CymMV) or Odontoglossum ringspot virus (ORSV)	Singh *et al*. (2010)
2	Nanochips (made of microarray)	Bacteria and viruses	López *et al*. (2009)
3	Fluorescent silica nanoparticles (FSNPs)	*Xanthomonas axonopodis* pv. *vesicatoria*	Yao *et al*. (2009)
4	Quantum dots-based sensors	General disease detection, viruses	Algar and Krull (2008); Safarpour *et al*. (2012)
5	SnO_2 and TiO_2	General disease, detection of p-ethylguaiacol secreted by infected strawberry	Fang *et al*. (2014)
6	Polymers such as polypyrrole (PPy) nanoribbon modified chemiresistive sensors	Cucumber mosaic virus (CMV)	James (2013)
7	Magnetic-nanoparticl-based reverse transcription loop-mediated isothermal amplification (RT-LAMP)	Prunus necrotic ring-spot virus (PNRSV)	Zong *et al*. (2014)

NANOANTIMICROBIALS FOR TACKLING THE PROBLEM OF PLANT PATHOGENS

The use of metals as antimicrobials against pathogens is well known since ancient times. The metals such as copper, silver, palladium, ruthenium and their compounds have been used against human and plant diseases (Medici *et al*., 2015). With the advent of nanobiotehnology, different nanomaterials including nanoparticles have been evaluated for their potential for the management of plant pathogens (*Table 2).* Cioffi and his collaborators in 2004 studied antifungal activity of nanocopper against plant pathogenic fungi. Gul *et al*. (2014) presented an informative review on role of nanotechnology in crop protection.

Lamsal and his colleagues in 2011 evaluated different concentrations of AgNPs against powdery mildew and found that 100 ppm silver nanoparticles (7-25 nm) demonstrated highest inhibition rate of the disease in cucumbers and pumpkins in field conditions. In 2011, they further studied different concentrations (10, 30, 50, and 100 ppm) of AgNPs on six species of *Colletotrichum* including *C. acutatum, C.dematium, C. gloeosporioides, C. higginsianum, C. nigrum* and *C. orbiculare* and reported the significant inhibition of growth of all the species of *Colletotrichum* tested in their experiment. They also reported that the treatment should be given to the plants before appearance of the symptoms on the host plants. Encouragingly, the highest percentage of inhibition was recorded with 50 ppm nanoparticles in field trials while 100 ppm AgNPs was needed *in vitro* inhibition.

Ocsoy and his colleagues (2013) on their study found leaf-spot disease caused by *Xanthomonas perforans* (Cu resistant) can be inhibited by DNA-directed silver (Ag) nanoparticles (NPs). The *in vitro* studies and nanoparticle-treated plants demonstrated that at 16 ppm the growth was inhibited, which provides evidence of remarkable antibacterial activity against *X. perforans*. The disease was significantly reduced, when 100 ppm Ag@dsDNA@GO was applied in green house experiment.

In another study, the biogenically synthesized nanoparticles by leaves and stem of *Piper nigrum* were tested against two bacteria, namely, *Citrobacter freundii* and *Erwinia cacticida* causing diseases on *Abelmoschus esculentus* and *citrullus lanatus*. The authors reported excellent antibacterial activity when silver nanoparticles impregnated antibiotic discs (Chloramphenicol) were used against the test bacteria (Paulkumar *et al.* 2014). Interestingly, Anusuya and Sathiyabama (2014) applied chitosan nanoparticles to induce antifungal hydrolases in turmeric plant (*Curcuma longa*). The author performed foliar spray of chitosan nanoparticles and found that chitinases and chitosanases were increased.

Table 2

List of different nanomaterials and nanocomposites used against phytopathogens

S.No.	Type of Nanoparticles	Phytopathogens	References
1	Copper nanoparticles	Antifungal	Cioffi *et al.* (2004)
2	Silica-silver nanoparticles	*Rhizoctonia solani, Pythium ultimum, Botrytis cinerea, Magnaporthe grisea* and *Colletotrichum gloeosporioides*	Park *et al.* (2006)
3	AgNPs	*Bipolaris sorokiniana* and *Magnaporthe grisea*	Jo *et al.* (2009)
4	AgNPs	Sclerotium-forming phytopathogenic fungi	Min *et al.* (2009)
5	AgNPs	Oak wilt pathogen *Raffaelea* sp.	Kim *et al.* (2009)
6	AgNPs	Stem-end bacteria on cut gerbera *Gerbera jamesonii*) cv. Ruikou	Liu *et al.* (2009)
7	AgNPs	*Fusarium culmorum*	Kasprowicz *et al.* (2010)
8	AgNPs	Powdery mildew on cucumber and pumpkin	Lamsal *et al.* (2011)
9	AgNPs	*Colletotrichum acutatum, C. dematium, C. gloeosporioides, C. higginsianum, C. nigrum, C. orbiculare*	Lamsal *et al.* (2011)
10	AgNPs	Cut *Acacia holosericea*	Liu *et al.* (2012)
11	AgNPs colloidal solution	*Alternaria alternata, A. brassicicola, A. solani, Botrytis cinerea, Cladosporium cucumerinum, Corynespora cassiicola, Cylindrocarpon destructans, Didymella bryoniae, Fusarium oxysporum* f.sp. *cucumerinum, Fusarium oxysporum* f.sp. *lycopersici, Fusarium oxysporum, Fusarium solani, Glomerella cingulata, Monosporascus cannoballus, Pythium aphanidermatum, P. spinosum, Stemphylium lycopersici*	Kim *et al.* (2012)
12	Nanosized Ag-silica-hybrid	*Pseudomonas syringae* pv. *tomato*	Chu *et al.* (2012)
13	DNA-directed silver (Ag) nanoparticles (NPs)	Bacterial spots caused by *Xanthomonas perforans* in tomatoes	Ocsoy *et al.* (2013)
14	Chitosan NPs	Rhizome-Rot Disease of Turmeric Caused by *Pythium aphanidermatum*	Anusuya and Sathiyabama (2013)
15	Silver – chitosan composite	Gray mold (*Botrytis cinerea*) in straberry	Moussa *et al.* (2013)
16	ß- D – glucan nanoparticles	Rhizome-Rot Disease of Turmeric Caused by *Pythium aphanidermatum*	Anusuya and Sathiyabama (2014)
17	Biogenic AgNPs	*Bipolaris sorokiniana* causing Spot Blotch Disease in Wheat	Mishra *et al.* (2014)
18	AgNPs	*Citrobacter freundii, Erwinia cacticida*	Paulkumar *et al.* (2014)
19	Silica NPs	*Fusarium oxysporum* and *Aspergillus niger*	Suriyaprabha *et al.* (2014)
20	Copper NPs	*Fusarium oxysporum*, *Curvularia lunata*, *Alternaria alternata*, and *Phoma destructiva*	Kanhed *et al.* (2014)
21	Nanotitania	*Alternaria brassicae*	Palmqvist *et al.* (2015)
22	AgNPs	*Phytophthora parasitica*, *P. infestans*, *P. palmivora*, *P. cinnamomi*, *P. tropicalis*, *P. capsici*, and *P. katsurae*	Ali *et al.* (2015)
23	Cu-Chitosan NPs	*Alternaria solani* and *Fusarium oxysporum* pathogenic fungi of tomato	Saharan *et al.* (2015)
24	Chitosan NPs	*F. oxysporum* f.sp. *lycopersici* in tomato	Sathiyabama and Charles (2015)

Note: AgNPs = Silver nanoparticles; NPs = Nanoparticles

These enzymes are responsible for defense of the host plants. The treated plants of *C. longa* were found to be resistant to *Pythium aphanidermatum,* the causal organism of rhizome-rot of turmeric. In 2014, they also applied ß-D-glucan nanoparticles, which reduced rot incidence by 23.3%. The authors found correlation between reduction on incidence of rhizome-rot and enhanced activity of defense enzymes such as peroxidases, polyphenol oxidases, protease inhibitors and ß-1,3-glucanases.

Mishra *et al.* (2014) synthesized AgNPs by using *Serratia* sp. and evaluated these AgNPs against spot blotch disease in wheat caused by *Bipolaris sorokiniana*. The AgNPs demonstrated remarkable antifungal activity when 2, 4 and 10 mg/ml concentrations were used. The conidial germination of *B. sorokiniana* was totally inhibited. In an interesting experiment, Suriyaprabha and colleagues (2014) treated maize with silica NPs (20-40 nm) to know the resistance against two important phytopathogens, *Fusarium oxysporum* and *Aspergillus niger*. The authors reported development of higher resistance in Silica nanoparticle treated maize plants than the bulk silica treated plants. In an interesting study, Palmqvist and colleagues (2015) used Titania NPs to understand the interaction between *Bacillus amyloliquefaciens*, a plant growth promoting bacterium and the host plant *Brassica napus* for providing protection against *Alternaria brassicae*. The authors observed increased number of bacteria on the roots of *B. napus* due to use of Titania NPs., which protects the test plant against infection caused by *A. brassicae.*

NANOTOXICITY: A MAJOR CHALLENGE

As discussed in the earlier sections nanoparticles have huge applicability for the management of plant diseases. But due to increased applications there is greater possibilities of getting accumulated in the environment and cause the harmful effects. By any kind of aqueous medium there are high chances of accumulation of nanoparticles in soil resulting into the soil ecosystem toxicity. Thus, if accumulated above certain limit they will bound to show the harmful effects. For instance, a study has shown that TiO_2 and ZnO nanoparticles have negatively affected the biomass of wheat growth and also inhibited the activities of soil enzymes such as protease, catalase and peroxidase activities, thereby affecting the soil quality and health (Du *et al.*, 2011). Yang and Watts (2005) were the first to report about the nanotoxicity to plants through the soil. According to their study Al_2O_3 conjugated with and without phenanthrene affected the root elongation of *Zea mays*, *Cucumis sativus, Glycine max*, *Brassica oleracea* and *Daucus carota*. Similar results were obtained by exposing MWNT, Al_2O_3, Al, Zn and ZnO on radish, rape, ryegrass, lettuce, corn, and cucumber. With affecting the root elongation, those nanoparticles also shown to affect the plant germination (Lin and Xing, 2007). TiO_2 were reported to reduce the water usage in *Z. mays* and changes the path of apoplast (Asli and Neumann, 2009). Palladium nanoparticles (PdNPs) were reported to get accumulated in leaves of barley (Battke *et al.*, 2008). Therefore, there is possibility of transfer of these nanoparticles in the animals. On the similar way, nano Fe_2O_3 were also found to get accumulated in tissue of pumkin (Zhu *et al.*, 2008).Through an interesting study Lin *et al.* (2009) reported the transmission of C_{70} into the progeny of nanoparticle exposed rice.

All of the reports suggest that as a consequence of presence of various nanoparticles in soil, there is possibility of threat to soil microorganisms and to plants by absorption of nanoparticles from soil. Moreover, such accumulation and/or toxic effects to plants may affect the complete food chain. The toxic effects to plants may further pass to animals such as fish, insects or mammals including humans who consume them (*Figure 1*). But still there is huge knowledge gap in the information on the mode of uptake of nanoparticles and consequences of their exposure to soil environment. There is also need to study the impact of surface functionalization, size, charge, agglomeration and stability of nanoparticles on the plants. Moreover, it is also essential to perform further studies on the transport of nanoparticles and the effects caused to food chain thereby affecting the humans and animals.

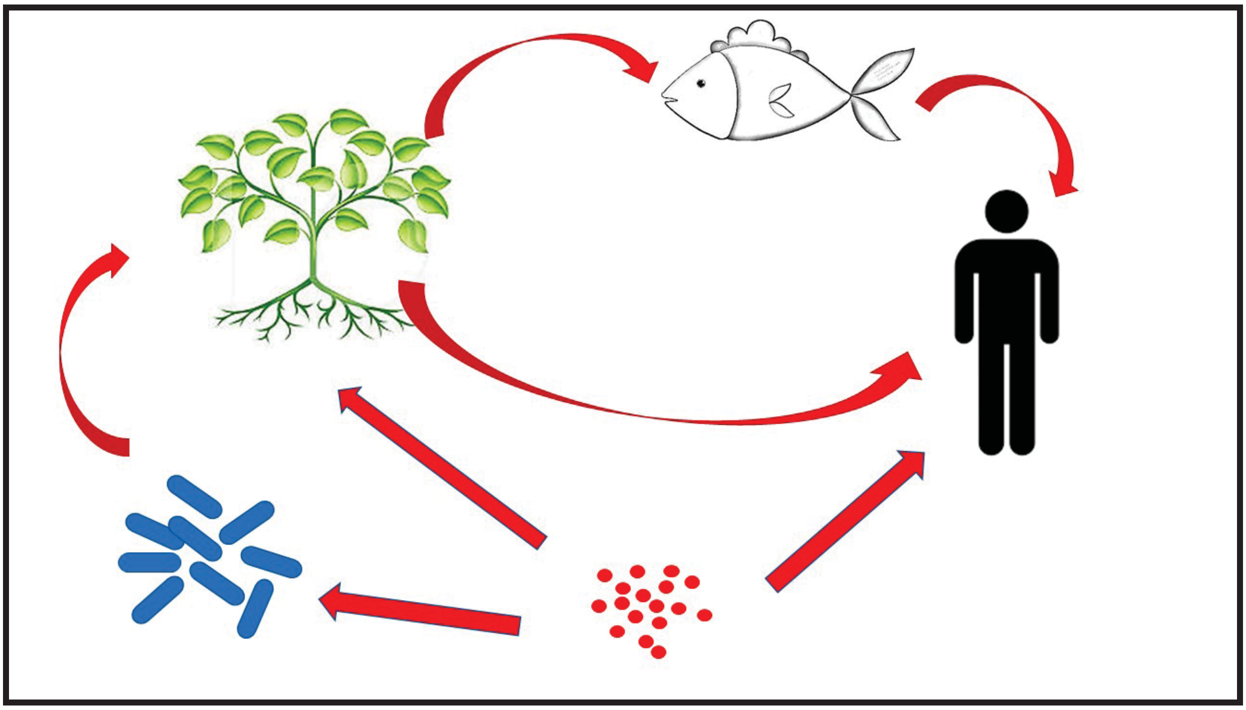


Figure 1: **Fate of nanoparticles in the soil environment. The nanoparticles may exert toxic effects to soil bacteria and plants, and if accumulated inside them, they can be ultimately transferred to animals and humans**

The straight red colored lines show the direct effect of nanoparticles. The curved red lines show the pathway of nanoparticles in food chain.

CONCLUSIONS

It can be concluded that extensive application of chemical fungicides and antimicrobials have generated huge pollution resulting into toxicity to all the living flora and fauna. Considering this fact, it is felt that there is an urgent need to search for alternatives to manage the phytopathogens for the sustainable plant production. The application of biocontrol agents for the management of different diseases is an interesting strategy but there are several inherent issues, which prompts us to search for other viable alternatives, and therefore, the use of eco-friendly green nanobiotechnology has become the main focus of the scientists all over the world. The synthesis of nanomaterials by biogenic methods mainly microbes and plants is green, eco-friendly, rapid and economically viable. These can be utilized for the development of nanobiosensors, which can be used for the detection of plant diseases. Moreover, different types of nanomaterials in general and nanoparticles in particular may solve the problem of microbes resistant to microbicides or fungicides. In addition, the pollution and toxicity of fungicides can be avoided. However, extensive experimental field trials are needed to understand the toxicity of the nanoparticles in food chain. Finally, the application of green nanobiotechnology may open up new avenues for research pertaining to the management of plant pathogens.

ACKNOWLEDGEMENT

This paper was elaborated with the financial support of the project MSMT CR IRP 207/2015.

REFERENCES

Algar W.R. - Krull U.J. (2008): Quantum dots as donors in fluorescence resonance energy transfer for the bioanalysis of nucleic acids, proteins, and other biological molecules. Analytical and Bioanalytical Chemistry 391: 1609-1618.

Alghuthaymi M.A. - Almoammar H. - Rai M. - Said-Galiev E. - Abd-Elsalam K.A. (2015): Myconanoparticles: synthesis and their role in phytopathogensmanagement.Biotechnology and Biotechnological Equipment 29(2): 221-236.

Anusuya S.-Sathiyabama M. (2013): Effect of chitosan on rhizome rot disease of turmeric caused by *Pythiumaphanidermatum*. ISRN Biotechnology 2014:305349. doi: 10.1155/2014/305349.

Asli S. - Neumann P. M. (2009): Colloidal suspensions of clay or titanium dioxide nanoparticles can inhibit leaf growth and transpiration via physical effects on root water transport. Plant Cell and Environment 32: 577-584.

Battke F. - Leopold K. - Maier M. - Schmidhalter U. - Schuster M. (2008): Palladium exposure of barley: uptake and effects. Plant Biology10: 272-276.

Bawaskar M. - Gaikwad S. - Ingle A. - Rathod D. - Gade, A. - Duran N. - Marcato P.D. - Rai M. (2010): A New Report on Mycosynthesis of Silver Nanoparticles by *Fusarium culmorum*. Current Nanoscience 6: 376-380.

Bonde S.R. - Rathod D.P. - Ingle A.P. - Ade R.B. - Gade A.K. - Rai M.K. (2012): *Murrayakoenigii* mediated synthesis of silver nanoparticles and its activity against three human pathogenic bacteria. Nanoscience Method s 1: 25-36.

Chen L. - Song Y. - Tang B. - Song X. - Yang H. - Li B. - Zhao Y. - Huang C .- Han X. - Wang S. -Li Z. (2015): Aquatic risk assessment of a novel strobilurin fungicide: A microcosm study compared with the species sensitivity distribution approach. Ecotoxicology and Environmental Safety doi: 10.1016/j.ecoenv.2015.06.027.

Chowdappa P. - Gowda S. (2013): Nanotechnology in crop protection: Status and scope. Pest Management in Horticultural Ecosystems 19 (2):131-151.

Cioffi N. - Ditaranto T. L. - Sabbatini N. - Zambonin L. - Tantillo P.G. - Ghibelli G. - D'Alessio L. - Bleve-Zacheo M. - Traversa E. (2004): Antifungal activity of polymer-based copper nano-composite coatings. Applied Physics Letters 85: 2417-2419.

Dar M.A. - Ingle A. - Rai M. (2013): Enhanced antimicrobial activity of silver nanoparticles synthesized by *Cryphonectria* sp. Evaluated singly and in combination with antibiotics. Nanomedicine: Nanotechnology, Biology and Medicine 9: 105-110.

Du W. - Sun Y. - Ji R. - Zhu J. - Wub J. - Guo H. (2011): TiO2 and ZnO nanoparticles negatively affect wheat growth and soil enzyme activities in agricultural soil. Journal of Environmental Monitoring 13: 822-828.

Dzhavakhiya V. - Shcherbakova L. - Semina Y. - Zhemchuzhina N. - Campbell B. (2012): Chemosensitization of plant pathogenic fungi to agricultural fungicides. Front Microbiology 3: 1-9.

El-Kassas H.Y. - El-Sheekh M.M. (2014): Cytotoxic activity of biosynthesized gold nanoparticles with an extract of the red seaweed *Corallina officinalis* on the MCF-7 human breast cancer cell line. Asian Pacific journal of cancer prevention 15(10): 4311-4317.

Fang Y. - Ramasamy R. P. (2015): Current and Prospective Methods for Plant Disease Detection. Biosensors 4: 537-561.

Fang Y. - Umasankar Y. - Ramasamy R. P. (2014): Electrochemical detection of p-ethylguaiacol, a fungi infected fruit volatile using metal oxide nanoparticles. Analyst 139: 3804-3810.

Frampton R.A. - Pitman A.R. - Fineran P.C. (2012): Advances in bacteriophage-mediated control of plant pathogens. International Journal of Microbiology doi: 10.1155/2012/326452.

Gade A. - Gaikwad S. - Tiwari V. - Yadav A. - Ingle A. - Rai M. (2010): Biofabrication of Silver Nanoparticles by *Opuntiaficus indica*: *In vitro* antibacterial activity and study of the mechanism involved in the synthesis. Current Nanoscience 6: 370-375.

Godfray H.C.J. - Beddington J. R. - Crute I. R. - Haddad L. - Lawrence D. - Muir J. F. - Pretty J. - Robinson S. - Thomas S. M. - Toulmin C. (2010): Food security: The challenge of feeding 9 billion people. Science 327: 812-818.

Golinska, P. - Wypij M. - Ingle A.P. - Gupta I. - Dahm H. - Rai M. (2014): Biogenic synthesis of metal nanoparticles from Actinomycetes: Biomedical applications and cytotoxicity. Applied Microbiology and Biotechnology 98: 8083-8097.

Gul H.T. - Saeed S. - Khan F.Z.A. - Manzoor S.A. (2014): Potential of Nanotechnology in Agriculture and Crop Protection: A review. Applied Science and Business Economics 2:23-28.

Guo B.L. - Han P. - Guo L.C. - Cao Y.Q. - Li A.D. - Kong J.Z. - Zhai H.F. - Wu D. (2015): The Antibacterial activity of Ta-doped ZnO nanoparticles. Nanoscale Research Letters 10(1): 1047. DOI:10.1186/s11671-015-1047-4

Ingle A. - Gade A. - Bawaskar M. - Rai M. (2009): *Fusarium solani*: a novel biological agent for the extracellular synthesis of silver nanoparticles. Journal of Nanoparticle Research 11: 2079-2085.

James C. (2013): Polypyrrolenanoribbon based chemiresistiveimmunosensors for viral plant pathogen detection. Analytical Methods 5: 3497-3502.

Kanhed P. - Birla S. - Gaikwad S. - Gade A. - Seabra A. - Rubilar O. - Duran N. - Rai M. (2014): *In vitro* antifungal efficacy of copper nanoparticles against selected crop pathogenic fungi, Material letters, 115: 13-17.

Kumar R. - Priyadharsani K. - Thamaraiselvi K. (2012): Mycogenic synthesis of silver nanoparticles by the Japanese environmental isolate *Aspergillus tamarii*. Journal of Nanoparticle Research 14: 860.

Kumar U. - Shete A. - Harle A.S. - Kasyutich O. - Schwarzacher W. - Pundle A. - Poddar P. (2008): Extracellular bacterial synthesis of protein-functionalized ferromagnetic Co_3O_4 nanocrystals and imaging of self-organization of bacterial cells under stress after exposure to metal ions. Chemistry of Materials 20: 1484-1491.

Lamsal K. - Kim S.W. - Jung J.H. - Kim Y.S. - Kim K.S. - Lee Y.S. (2011): Application of silver nanoparticles for the control of *Colletotrichum* species *in vitro* and pepper anthracnose disease in field. Mycobiology 39(3): 194-199.

Lamsal K. - Kim S.W. - Jung J.H. - Kim Y.S. - Kim K.S. - Lee Y.S. (2011): Inhibition effects of silver nanoparticles against powdery Mildews on *Cucumber* and *Pumpkin*. Mycobiology 39(1): 26-32.

Lin D. - Xing B. (2007): Phytotoxicity of nanoparticles: inhibition of seed germination and root growth. Environmental Pollution 150: 243-250.

Lin S. - Reppert J. - Hu Q. - Hudson J.S. - Reid M.L. - Ratnikova T. A. - Rao A. M. - Luo H. - Ke P.C. (2009): Uptake translocation and transmission of carbon nanomaterials in rice plants. Nano micro Small 5:1128-1132.

Liu J. - Ratnayake K. - Joyce D.C. - He S. - Zhang Z. (2012): Effects of three different nano-silver formulations on cut *Acacia holosericea* vase life. Postharvest Biology and Technology 66: 8-15.

López M. M. - Lop P. - Olmos A. - Marco-Noales E. - Cambra M. - Bertolini E. (2009): Are molecular tools solving the challenges posed by detection of plant pathogenic bacteria and viruses?. Current Issues in Molecular Biology 11:13-46.

Mallikarjuna K. - Narasimha G. - John Sushma N. - Dillip G.R. - Subba Reddy B.V. - Sreedhar B. - Deva Prasad Raju B. (2015): Biogenic preparation of Gold nanostructures reduced from *Piper longum* leaf broth and their electrochemical studies. Journal of Nanoscience and Nanotechnology 15(2): 1280-1286.

Medici, S.- Massimiliano Peana- Valeria Marina Nurchi- Joanna I. Lachowicz- Guido Crisponi- Maria Antonietta Zoroddu (2015): Noble metals in medicine**:** Latest advances, Coordination Chemistry Reviews, 284: 329-350

Mishra S.-Singh B. R.-Singh A.-Keswani C.-Naqvi A. H.-Singh H. B. (2014): Biofabricated silver nanoparticles act as a strong fungicide against *Bipolarissorokiniana* causing spot blotch disease in wheat. PLoS One 9(5): e97881.

Mishra S.-Singh H.B. (2015): Biosynthesized silver nanoparticles as a nanoweapon against phytopathogens: exploring their scope and potential in agriculture. Applied Microbiology and Biotechnology 99:1097-1107.

Narayanan K.B.-Sakthivel N. (2008): Coriander leaf mediated biosynthesis of gold nanoparticles. Materials Letters 62:4588-4590.

Nayak R.-Pradhan N.-Behera D.-Pradhan K.-Mishra S.-Sukla L.-Mishra B. (2011): Green synthesis of silver nanoparticle by *Penicilliumpurpurogenum* NPMF: the process and optimization. Journal of Nanoparticle Research 13: 3129-3137.

Ocsoy I.- Mathews L.-Paret.-Ocsoy M.A.-Kunwar S.- Chen T.-You M.-Tan W. (2013): Nanotechnology in plant disease management: DNA-directed silver nanoparticles on Graphene oxide as an antibacterial against *Xanthomonasperforans*. *ACS Nano7* (10):8972-8980.

Ocsoy I. - Paret M.L. - Ocsoy M. A. - Kunwar S. - Chen T. - You M. - Tan W. (2013): Nanotechnology in plant disease management: DNA-directed silver nanoparticles on graphene oxide as an antibacterial against *Xanthomonas perforans*. ACS Nano 7(10): 10.1021/nn4034794.

Palmqvist N.G.M. - Bejai S. - Meijer J. - Seisenbaeva G.A. - Kessler V.G. (2015): Nano titania aided clustering and adhesion of beneficial bacteria to plant roots to enhance crop growth and stress management. Scientific Report 5: 10146.

Paulkumar K. - Gnanajobitha G. - Vanaja M. - Rajeshkumar S. - Malarkodi C. - Pandian K. - AnnaduraiG. (2014): *Piper nigrum* leaf and stem assisted green synthesis of silver nanoparticles and evaluation of its antibacterial activity against agricultural plant pathogens. The Scientific World Journal. http://dx.doi.org/10.1155/2014/829894.

Potara M. - Bawaskar M. - Simon T. - Gaikwad S. - Licarete E. - Ingle A. - Banciu M. - Vulpoi A. - Astilean S. - Rai M. (2015): Biosynthesized silver nanoparticles performing as biogenic SERS-nanotags for investigation of C26 colon carcinoma cells. Colloids and Surfaces B: Biointerfaces, 133: 296-303.

Rai M. K. - Gade A.K. - Gaikwad S. - Marcato P. D. - Duran N. (2012): Biomedical applications of nanobiosensors: The state-of-the-art. Journal of Brazilian Chemical Society 23(1): 14-24.

Rai M. K. - Yadav A.P. - Gade A.K. (2009): Silver nanoparticles as a new generation of antimicrobials. Biotechnology Advances 27(1): 76-82.

Rai M. - Ingle A. (2012): Role of nanotechnology in agriculture with special reference to management of insect pests. Applied Microbiology and Biotechnology 94:287-93.

Rai M.K. - Deshmukh S.D. - Gade A.K. - Kamel A.E. (2012): Strategic nanoparticle- mediated gene transfer in plants and animals- a novel approach. Current Nanoscience 8:170-179.

Safarpour H. - Safarnejad M. R. - Tabatabaei M.-Mohsenifar A. - Rad F. - Basirat M. - Shahryari F. - Hasanzadeh F. (2012): Development of a quantum dots FRET-based biosensor for efficient detection of *Polymyxa betae*. Canadian Journal of Plant Pathology 34: 507-515.

Satalkar P. - Elger B.S. - Shaw D.M. (2015): Defining Nano, Nanotechnology and Nanomedicine: Why Should It Matter? Science and Engineering Ethics[Epub ahead of print].

Sathiyanarayanan A. - Muthukrishnan S. (2013): Effect of chitosan on rhizome rot disease of turmeric caused by *Pythium aphanidermatum*. ISRN Biotechnology http://dx.doi.org/10.1155/2014/305349.

Savary S. - Ficke A. - Aubertot J. - Hollier C. (2012): Crop losses due to diseases and their implications for global food production losses and food security. Food Security 4: 519-537.

Shahverdi A.R. - Minaeian S. - Shahverdi H.R. - Jamalifar H. - Shahverdi N. - Wong C.W. - NurYasumira A.A. (2009): Rapid biosynthesis of silver nanoparticles using culture supernatant of bacteria with microwave irradiation. E-Journal of Chemistry 6(1): 61-70.

Singh S. - Singh M. - Agrawal V.V. - Kumar A. (2010): An attempt to develop surface plasmon resonance based immunosensor for Karnal bunt (*Tilletia indica*) diagnosis based on the experience of nano-gold based lateral flow immuno-dipstick test. Thin Solid Films 519: 1156-1159.

Tiwari M. - Narayanan K. - Thakar M.B. - Jagani H.V. - VenkataRao J. (2014): Biosynthesis and wound healing activity of copper nanoparticles. IET Nanobiotechnology 8(4): 230-237.

Vu H.T. - Keough M.J. - Long S.M. - Pettigrove V.J. (2015): Effects of the boscalid fungicide Filan® on the marine amphipod Allorchestescompressa at environmentally relevant concentrations. Environmental Toxicology and Chemistry doi: 10.1002/etc.3247.

Yang L. - Watts D. J. (2005): Particle surface characteristics may play an important role in phytotoxicity of alumina nanoparticles. Toxicology Letters 158: 122-132.

Yao K. S. - Li S. J. - Tzeng K. C. - Cheng T. C. - Chang C. Y. - Chiu C.Y. - Liao C. Y. - Hsu J. J. - Lin Z. P. (2009): Fluorescence silica nanoprobe as a biomarker for rapid detection of plant pathogens. Advanced Material Research 79: 513-516.

Zong X. - Wang W. - Wei H. - Wang J. - Chen X. - Xu L. - Zhu D. - Tan Y. - Liu Q. (2014): Rapid detection of *Prunus necrotic ringspot virus* using magnetic nanoparticle-assisted reverse transcription loop-mediated isothermal amplification. J. Virol. Methods. 2014 Nov; 208: 85-89. doi: 10.1016/j.jviromet.2014.07.033.

Zhu H. - Han J. - Xiao J.Q. - Jin Y. (2008): Uptake translocation and accumulation of manufactured iron oxide nanoparticles by pumpkin plants. Journal of Environmental Monitoring 10: 713-717.

Jövevény károsítók megjelenése közvetlen környezetünkben és a védekezés lehetőségei

Zsigó György
Magyar Növényvédő Mérnöki és Növényorvosi Kamara Növény,- Környezet- és Élelmiszerbiztonsági Bizottságának elnöke, Budapest
www.zsigogyorgy.hu

ÖSSZEFOGLALÁS

A közvetlen környezetünkben megtalálható növényeken, az újabban megjelent károsítókról és a védekezés lehetőségeiről, jelenlegi gyakorlatáról számol be a szerző. Kísérletet tesz a közterületi növényeken ténylegesen kárt okozó fajok áttekintésére, és csupán a lakosságot zavaró rovarok, kórokozók, gyomok csoportosítására is. A közterületi növényvédelem technológiai hátterének a bemutatása mellett utal a fővárosi gyakorlatra is. A fentiekből következően javaslatokat fogalmaz meg a hiányosságok kiküszöbölésére valamint ismerteti a Növényorvosi Kamara, közterületi növényeket érintő előrejelző és a készítményeket engedélyeztető tevékenységét is.

SUMMARY

The author refers about the nowadays applied practical plant protection activities against pests occuring on trees, shrubs and turfs of public domains. It is overviewed those insects, diseases and weeds which cause damages and touched also upon disturbing the local residents only and tasks to the plant protection engineer expert to manage them. Among the special features of public domains should be mentioned that the rules are difficult to harmonize according to the legal, public health, and horticulture requirements at the same time. The anti-pesticide attitude of EU and the modest range of pesticides which are applicable on public domains make difficulties in optimal management work. The author draws up proposals how to manage the complex plant protection on public domains.

Kulcsszavak: közterületi növényvédelem, levéltetvek, pókhálós molyok (*Hyponomeuta* spp.), vadgesztenyelevél-aknázómoly (*Cameraria ohridella*), platán csipkéspoloska (*Corythuca ciliata*), amerikai lepkekabóca (*Metcalfa pruinosa*), zöld vándorpoloska (*Nezara viridula*), platánbodobács (*Arocatus longiceps*), hársbodobács (*Oxycarenus lavaterae*), lisztharmatok, aranka fajok (*Cuscuta* spp.), parlagfű (*Ambrosia artemisiifolia*), harlekinkatica (*Harmonia axyridis)*, ázsiai márványospoloska *(Halyomorpha halys)*, cserebogarak lárvái, selyemfényű puszpángmoly *(Cydalima perspectalis),* vadgesztenye váladékos kéregrákosodása *(Pseudomonas syringae pv. aesculi).*
Keywords: plant protection on public domains, aphids, ermine moths (*Hyponomeuta* spp.), horse-chestnut leaf miner (*Cameraria ohridella*), platanus lace bug (*Corythuca ciliata*), citrus flatid planthopper (*Metcalfa pruinosa*), southern green shieldbug (*Nezara viridula*), plane tree bug (*Arocatus longiceps*), ground bugs (*Oxycarenus lavaterae*), powdery mildews, dodders (*Cuscuta* spp.), common ragweed (*Ambrosia artemisiifolia*)

BEVEZETÉS

Az utóbbi években több, eddig jelentős gondot nem okozó rovar, gomba és baktériumfaj jelent meg az emberek közvetlen környezetében élő növényeken, a közterületeken. Ezen fajok egy része növényi károsítónak tekinthető, míg mások csupán a lakosságot zavarják, undort keltőek vagy egészségügyi gondot okoznak. A jövevény fajok megjelenésével párhuzamosan, folyamatosan tisztázni kell a növényvédelem eszközeivel gyéríthető növényi károsítók körét. Milyen munkát vállalhatunk el szakmai felelősséggel? Remélem, hogy a fővárosban szerzett tapasztalataim átadásával segítek a válaszadásban.

A KÖZTERÜLETI NÖVÉNYVÉDELEM SZEMPONTJÁBÓL LEGTÖBB GONDOT OKOZÓ ISMERT és ÚJABBAN MEGJELNT KÁROSÍTÓK

A levéltetvek

Tapasztalatom szerint a téli időjárástól függetlenül, tavasszal mindig megjelennek a levéltetvek. Bodzán, juharon, rózsán, majd a hárson, akácon, szivarfán és még sok más tápnövényen is kialakulnak a kolóniák. Ekkor indul az első lakossági panaszhullám is, hiszen a mézharmattól ragacsos szélvédők, játszótéri padok sok bosszúságot okoznak. Nyár elejére már a járdák is ragadhatnak. A száraz - forró és a hűvös - esős nyarak egyaránt meggátolják a felszaporodásukat. Míg 15-20 éve biztosan számolni kellett egy egész kerületre kiterjedő juhar permetezéssel, addig manapság már inkább csak kisebb facsoportoknál kell beavatkozni.

Pókhálós molyok

Budapesten időnként már május elején tarrá rágott *Prunus*-ok jelzik az egyik vagy másik pókhálós molyfaj (*Hyponomeuta padi, H. evonymella*) jelenlétét. Szerencsére tápnövényét csak néhány parkban telepítették. Egy nemzedékes, látványos kártételét sokan észreveszik, de gyakran összetévesztik az amerikai fehér medvelepke (*Hyphantria cunea*) hernyófészkeivel.

Vadgesztenyelevél-aknázómoly

Városképi szempontból a főváros egyik legmeghatározóbb park-, sor- és szoliter fája a vadgesztenye. Időben és kellően hangosan kongatták meg a vészharangot a három nemzedékes vadgesztenyelevél-aknázómoly *(Cameraria ohridella)* megjelenésekor. A budapestiek, az önkormányzatok és a cégképviseletek is léptek. Kiegészítették a kerületi fakatasztert, anyagilag is segítették a magántulajdonú fák permetezését, több inszekticidet is engedélyeztettek, és kifejlesztették a törzsinjektálás technológiáját. Parazitái a biológiailag szegény városi környezetben még nem tudják „sakkban tartani" a molyokat, április végén – május elején mindenképpen kezelni kell a fákat. A Magyar Növényvédő Mérnöki és Növényorvosi Kamara országos előrejelző hálózata nagy segítséget nyújt a védekezés időpontjának pontos meghatározásában. A hetente frissülő táblázat mindenki számára elérhető a www.magyarnovenyorvos.hu-n illetve a www.zsigogyorgy.hu-n.

Platán csipkéspoloska

Egész nyáron szívogatja, sárgítja a platánokat a platán csipkéspoloska *(Corythuca ciliata*). Meleg, száraz nyarakon különösen kínozza a fákat, akár több száz egyede is megtalálható egyetlen levélen. A levélveszteséget nehezen bírják az idős, különben is rossz várostűrő képességű régebbi fajták. Minden évben védekezni kell a kártevő ellen. A vadgesztenyéhez hasonlóan kombinált kezelést javaslok, gombaölő szerrel és lombtrágyákkal egészítsék ki a permetlevet.

Amerikai lepkekabóca

Az amerikai lepkekabócát (*Metcalfa pruinosa*) 2004-ben találták meg az országban, azóta a legjelentősebb közterületi kártevők közé lépett. Fákon, bokrokon, egynyári dísznövényeken, útszéli gyomokon, sőt a parlagfüvön is szívogat. Torzulnak, ragadnak és csillognak váladékától a levelek, mézharmat-tócsák keletkeznek a fák alatt. A lárvatelepekről leperegnek a fehér viaszszálak, szennyezik a környezetet, megtapadnak az arra járók ruháin. A kerttulajdonosok jogosan panaszkodnak, hozzájuk is beköltözik és károsít. Természetesen ez fordítva is előfordulhat. Károsítja a növényeket és zavarja az embereket is. Mivel tápnövényeinek száma nagy, ezért nehéz kerületi szinten egységesen védekezni ellene. Megfelelő hatóanyagú rovarölő szerekkel még jól irthatók.

(Zöld) vándorpoloska

Érdemes lenne megvizsgálni, hogy miért csak néhány helyszínen jelennek meg nyár végén a (zöld) vándorpoloska (*Nezara viridula*) egyedei? Néhány éve újra és újra ugyanonnan kapjuk a bejelentéseket. Ezek alapján úgy tűnik, hogy egyes városrészeket előnyben részesítenek telelőre vonulásukkor. Jól repülnek, áttelelésre beköltöznek a lakásokba is, ezzel a legnagyobb a lakossági panaszáradatot indítják el. Úgy tapasztaltam, hogy főleg a kőrisekkel beültetett utcákból jelezték a vállas, nagy méretű, poloskaszagú, zöld és barna színű imágókat. Ezeken a fákon valóban jól érzik magukat, de nem károsítják a fákat.
A kertekben számos dísznövényen és zöldségfélén is megjelentek. Az eltérő színű és mintázatú lárvákat néha még a gyakorlott szakemberek is más fajnak vélik.

Platánbodobács

A platánbodobács (*Arocatus longiceps*) a poloskákhoz hasonlóan imágó alakban telel át a platán kéregpikkelyei alatt, de tömegesen keresi búvóhelyét a lakásokban is. Szétnyomva a poloskafélékre jellemző szagot áraszt, sokan még a felsöprésétől is undorodnak. 2015-ben már nyár közepén is a törzsön csoportosultak, „nyári lemosó permetezéssel" védekeztek ellenük.

Hársbodobács

A hárs fatörzsétől akár a vázágak csúcsáig végignyúló telepeket is képezhetnek ősz felé a hársbodobács *(Oxycarenus lavaterae)* példányai. Összebújva vészelik át a telet. Főleg az autótulajdonosokat zavarja, hogy parkoláskor nyakukba hullanak az állatok. A fák melletti házakból nem panaszkodnak, úgy tűnik, hogy ez a faj nem keresi az ember közelségét. Sokan a fákat féltik, az ijesztő mennyiségű poloska láttán kéregkártevőre gondolnak. Szívogatásával nem gyengíti a hársat, a lakossági nyomás hatására néha mégis permetzést követelnek a növényvédőstől. Őszi-téli lemosó permetezéssel könnyen eltávolíthatóak.

Harlekinkatica (*Harmonia axyridis)*

Jól repül, gyorsan terjed. Évente 2, de akár 4 nemzedéke is kialakulhat. Testében keserű anyagok találhatók, részben ezért sincs sok ellensége. Sok vegyszereknek ellenáll. A virágokat, a bogyós gyümölcsöket és a szőlőt is megrághatja, de a közterületi levéltetveket is szépen gyéríti. Télire a lakásokba költözhet, nem alszik téli álmot, az embereket is „megcsípheti" és különböző allergiás reakciókat válthat ki.
Tovább nehezíti a helyzetet az, hogy nehéz meghatározni a bogarat, nagyon változatos a mintázata.

Ázsiai márványospoloska (*Halyomorpha halys*)
Egy világszerte terjedőben lévő faj, zöldségek és elsősorban a fásszárú gyümölcsfélék kártevője. Már több mint 100 növényfajon leírták. Fitopolazmákat is terjeszt. Hazánkban 2013. őszén találták meg, Budapesten. Még közterületi kártételével nem találkoztam, az első jelzések az idén, 2015-ben a beköltözésével kapcsolatban érkeztek hozzám. A lakásokban is áttelel, erős szagképzéssel rendelkezik, allergizál.

Cserebogarak lárvái
Egyre nagyobb gondot jelentenek, elsősorban az egynyáriaknál károsítanak és a játszóterek homokozóiban panaszolják a lakosok. Több fajjal is számolnunk kell. Rajzásuk és berepülésük, tojásrakásuk időpontja eltérő, az imágókat nem tudjuk elpusztítani. A pajorok ellen nincs közterületi talajfertőtlenítő szerünk, így az ágyásokban az engedély nélküli és humánegészségügyileg is kockázatos beöntözéssel próbálkozhatunk. A homokozókban szigorúan tilos bármilyen növényvédő szeres beavatkozás.

Selyemfényű puszpángmoly (*Cydalima perspectalis*)
Gyakorlatilag lehetetlenné tette a buxusok közterületi alkalmazását. Csak folyamatos ellenőrzéssel, és speciálisan végrehajtott permetezéssel menthetők meg a sövények, bokrok. Megfelelő és engedélyezett rovarölő szerekkel rendelkezünk (Dimilin 25 WP, Dipol DF), de mechanikailag is gyéríthető. Budapesten 2015-ben március közepén rágott, majd kis szünet után július 17-én, a fénycsapdánk már a második nemzedék rajzását jelezte. Késő őszig rajzik és károsít.

Lisztharmat fajok
A közönséges vadgesztenyén (*Aesculus hippocastanum*) szerencsére eddig csak kisebb károkat okozott, a vadgesztenye lisztharmat (*Erysiphe flexuosa*), a piros virágú vadgesztenyén (*Ae. carnea)* viszont gyakrabban megjelenik. A platánon 2008-ban jelent meg a lisztharmat *(Erysiphe platani*), és egyből súlyos kórokozóvá vált. Dr. Vajna László 2009-2010-ben végzett széleskörű vizsgálatai szerint ez utóbbi betegség rendkívül gyorsan terjedt el az egész országban, 2010-ben sok területen már súlyos fertőzések következtek be. Jó várostűrése miatt előszeretettel telepítik a díszkörtéket (pl. a kínai díszkörtét, *Pyrus calleryana*). Varasodásra számítottam, de lisztharmattal (*Podosphaera leucotricha)* találkoztam 2007-ben egy kőbányai sétálóutca fasorán. Azóta is makacsul, minden évben megjelenik már a fiatal leveleken is. A deformálódott levelek színükön sárgulva foltosodnak, a fonákjukon kialakuló lisztharmat telepek az egész vegetációban megtalálhatóak. Folyamatos permetezést igényelnének.

Vadgesztenye váladékos kéregrákosodása
Az EPPO adatbázisában (https://gd.eppo.int/reporting/article-2674) már 2013-ban leírták a ***Pseudomonas syringae* pv. *aesculi*** károsítását vadgesztenyén, a gödöllői kastély fasorában. „A hivatalos magyar álláspont szerint, jelenleg, egy helyszínen található”- idézek a 2013. évi nemzetközi közleményből.
Itthon talán a „vadgesztenye váladékos kéregrákosodása” vagy a „vadgesztenye baktériumos kéregbetegsége” lesz a neve. A kastélyban, 2013. szeptemberében készült fotók alapján elmondhatjuk, hogy találók a magyar nevek. Minden próbálkozás ellenére, néhány év alatt kipusztult a német faiskolából importált fasor.

Aranka fajok
Elsősorban a kerületi kertészekkel kell megküzdeni az arankairtás elfogadtatásáért. Jogos az ellenállásuk. Nem értik, hogy miért kellene a szűkös pénzkeretből egy olyan gyom irtására költeni, amely nem zavarja sem a lakosokat, sem a közlekedést. Csak a jogszabályok ismertetésével indokolhatok. Az élelmiszerláncról és hatósági felügyeletéről szóló 2008. évi XLVI. törvény egyik végrehajtási rendelete, a növényvédelmi tevékenységről szóló 43/2010. (IV.23.) FVM rendelet 2. §-a külön kiemeli az aranka fajok *(Cuscuta* spp.) elleni védekezési kötelezettséget. Magja hosszú évekig elfekszik a talajban, tavasztól őszig folyamatosan csírázik, virágzik és érleli a magját. Csak a rendszeresen, kb. hetente elvégzett ellenőrzéssel és a szükség szerinti foltkezeléssel lehet küzdeni ellene. Amennyiben kihagyunk néhány hetet a felderítés-irtás folyamatából, úgy a beérlelt magját ismételten elhullajtja. Kezdődik az egész folyamat elölről. Ezzel magyarázhatóak az évről-évre ugyanott megjelenő arankás foltok. Járművekkel, állatokkal, pl. madarakkal könnyen és gyorsan terjed és bejuthat a fertőzésétől féltett szántóföldekre is.

Parlagfű
Már nagyon sok híradás jelent meg a parlagfűről (*Ambrosia artemisiifolia*), de még mindig sokan tévesztik a nevét, sőt a növényt sem ismerik fel. Keverik az ürömmel vagy pl. a büdöskével (bársonyvirág, *Tagetes* spp.).
Több szempontból is inkább a mechanikai gyomirtást javaslom. Egyrészt, mert a jó időpontban és kellő gyakorisággal elvégzett kaszáláshoz képest nem érünk el sokkal jobb eredményt a közterületeken bevethető tartamhatás nélküli, perzselő típusú gyomirtó szerekkel. Másrészt, mert a permetezések nyomán sárgán száradó kóró nemcsak ronda, de tűzveszélyes is. A glifozát származékokkal dolgozhatnak közterületeken. Óvatosan használják, mert a fiatal cserjék, fák kérgén felszívódva azok teljes pusztulását okozhatja!

KÖVETKEZTETÉSEK

Nincsenek könnyű helyzetben a közterületi növényvédősök. Az emberek által folyamatosan látogatott helyszíneken végzünk növényvédelmet. A romló gazdasági környezet hatott a parkfenntartási kiadásokra is. Kevesebb jut kaszálásra, gondozásra és növényvédelemre is. Különösen igaz ez, ha arra gondolunk, hogy az emberek zöldfelület iránti igénye nő, miközben új károsítók jelennek meg, és egyre idősebb fák védelmét kell megoldanunk.

Szűkös növényvédő szerkínálatból választhatunk. A 2015. évi „szerjegyzék"-ben egyetlen gyomirtó szer hatóanyaga mellett huszonegy készítmény szerepel a közterület címszó alatt. Bár a felhasználó szükséghelyzeti („eseti") engedélyt is kérhet bizonyos esetekben, de ez az eljárás mindenképpen hosszadalmas és költséges. A beteg fa előtt álló szakembernek nincs ideje kivárni a hatósági határozatot. Mindenképpen bővíteni kellene a bevethető készítmények körét. Egyetlen atkaölő szer sem rendelkezik közterületi engedéllyel, de még számos gombaölő, rovarölő és gyomirtó szerre szükségünk lenne. A Magyar Növényvédő Mérnöki és Növényorvosi Kamara tovább folytatja a „kiskultúrás" növényekkel kapcsolatos engedélyeztetési tevékenységét.

További nehézséget okoz egyes engedélyokiratok előírásainak a betartása:

„A készítmény közterületeken való felhasználása esetén a kezelésről az érdekelt lakosságot tájékoztatni kell. A permetezés kizárólag növényvédelmi szakirányító közvetlen felügyeletével, 22-03 óra közötti időszakban végezhető. A játszóterek 10 méteres körzetében a szer nem használható." A kamara részéről, a 43/2010 (IV.23.) FVM rendelet módosításához javasoltuk, hogy hagyatkozzunk a helyismerettel rendelkező növényorvosra, bízzunk meg a döntésében.

Az egy éves időtartamú vállalkozói szerződésekkel nem lehet hosszú távon eredményesen dolgozni. Különösen hosszabb időszak szükséges a terület megismeréséhez azokban a körzetekben, ahol még nincs fakataszter. De az előrejelző eszközök telepítése is csak ott éri meg, ahol több évben gondolkodhat a pályázó.

Hátráltató tényező az is, hogy az EU túlzottan vegyszerellenes közegében kell dolgoznunk. Mindenképpen harcolnunk kell azért, hogy parkfáink, fasoraink egészsége megmaradjon. Hangsúlyoznunk kell az optimális öntözés, tápanyagellátás és az ellenálló fajták jelentőségét. Segítsük a perspektivikus eljárások fejlesztését (pl. injektálás, termésnövelő anyagok növényvédelmi célú felhasználása). Ugyanakkor jelenleg még biztosítani kell a közterületi permetezések lehetőségét is.

The role of disease resistance in the registration of crop varieties in Hungary

László Gergely – Bernát Poós
National Food Chain Safety Office, Budapest, Hungary
gergelyl@nebih.gov.hu

SUMMARY

Variety testing including disease resistance test of the major crops has been carrying out since the 1960's in Hungary. Testing for resistance of the new candidate varieties is performed in the so-called VCU (Value for Cultivation and Use) trials under natural infection and in special small-plot or micro-plot trials using different disease provocative methods. Disease resistance, especially those of multiple and horizontal-type (race non-specific, partial or durable) resistances, has recently become a key limiting factor in the state variety registration. The role of disease resistance in the decision-making process of variety registration is demonstrated on the examples of winter wheat and sunflower as two major field crops in Hungary.

Keywords: variety testing, VCU and provocative trial, testing for resistance, multiple disease resistance, sustainable agriculture

INTRODUCTION

Variety testings including disease resistance test of the field crops has been carrying out since the 1960's in Hungary. Nowadays there are seventeen Variety Testing Stations belong to the National Food Chain Safety Office where the field performance (VCU) trials and the small-plot disease provocative trials are conducted. There are two additional resistance tests under glasshouse conditions and one test under walk-in plastic tunnel assessing the resistance of sunflower candidates to downy mildew (*Plasmopara halstedii*) and broomrape (*Orobanche cumana*), and the foliar resistance of new potato varieties to late blight (*Phytophthora infestans*), respectively (Gergely, 2007). In the last several decades there has been a change in the paradigm of breeding for resistance. Due to the vulnerability of vertical (race-specific) resistance resulted in new races that overcome the dominant genes for resistance in host plants, horizontal-type resistance (also called race-non-specific or partial resistance) has become a priority in the resistance breeding programmes providing a desirable durable resistance against plant diseases.

MATERIALS AND METHODS

The methodology used in resistance testing has been developed since the 1960's and is being developed continuously (Hinfner and Homonnay, 1966; Hinfner and Békési, 1971; Gergely, 2004). According to these studies the two principal components of resistance testing are the correct diagnosis and the precise determination of the infection rate. In general, three evaluation methods are used to determine the actual rate of infection. Firstly, percentage of infected plants (*infected plant %)* in case of systemic diseases caused by viruses, and wilts caused by fungi or bacteria. Secondly, estimating the rate of infection using a 1-5 or 1-10 grade scale of increasing susceptibility (*infected leaf/stem area %)* in case of powdery mildews, rusts, leaf and stem spot diseases, respectively. And thirdly, calculating an index of infection which is a combination of the last two methods expressing not only the incidence but the severity of the disease (*index of infection %).*
Candidate varieties tested are classified into five resistance categories according to their disease severity. Classification is practically based on the deviation between the infection rate of each genotype and the actual trial mean which is considered to be 100 %. If the trial mean is less than 50 %, a given candidate variety is

1 = resistant, if its rate of infection does not exceed 25 % of the trial mean,
2 = moderately resistant, if its rate of infection is 26-75 % of the trial mean,
3 = mid-susceptible, if its rate of infection is 76-125 % of the trial mean,
4 = susceptible, if its rate of infection is 126-175 % of the trial mean, and
5 = highly susceptible, if its rate of infection exceeds 175 % of the trial mean

In the cases when the trial mean exceeds 50 % (severe disease outbreaks, provocative trials) the percentage values of the actual disease severity correspond to the following ratings of resistance/susceptibility:

1 = resistant, if the disease severity is 0 – 20 %,
2 = moderately resistant, if the disease severity is 21 – 40 %,
3 = mid-susceptible, if the disease severity is 41 – 60 %,
4 = susceptible, if the disease severity is 61 – 80 %, and
5 = highly susceptible, if the disease severity is 81 – 100 %

(after Hinfner and Homonnay, 1966)

Testing for resistance of the new candidate varieties is performed in VCU trials under natural infection and in special small-plot or micro-plot trials using different disease-provocative methods. Four provocative methods and their combinations are used in practice:

- **Micro-climate provoked** one, when the geographical position of the trial site is favourable for disease development (e.g. high yearly precipitation and relative air humidity favour the incidence of fungal and bacterial diseases)
- **Monoculture** which is known to increase disease incidence through contamination of soil in the experimental site with resting spore of pathogens such as oospores, chlamidospores, sclerotia, etc.
- **Use of provocative plots** when every second plot in a field trial block is sown with susceptible varieties (e.g. wind-borne diseases such as powdery mildews and rusts). Its main advantages are earlier disease incidence and uniform infection pressure in the trial.
- **Inoculation** (artificial infection techniques) when the inoculum (mainly as a watery suspension of conidia or sporangia) is sprayed onto the foliage of candidate varieties in their susceptible growing stage)

In the field VCU and provocative trials the resistance/susceptibility is assessed when the infection pressure is high enough to determine the differences in the susceptibility of candidate varieties (practically when the trial mean is or exceeds 10%). Beside the agronomic standard varieties carrying high productivity and quality, resistant and susceptible standard cultivars are also used comparing the behaviour of candidate varieties to them.

The requirements of variety registration

- Fulfilment of the so-called **DUS** (**D=D**istinctness, **U=U**niformity, **S** = **S**tability) requirements for breeder's right protection. The candidate variety must be differentiated from any other known cultivar, and must be sufficiently uniform and stable.
- Successful VCU performance in the small-plot performance trials with 4 repetitions in 6-8 trial sites for 2-3 years using high-yielding and high-quality standard varieties to compare.
- Main components of Value for Cultivation and Use are productivity, quality, disease resistance and agronomical features such as earliness, resistance to lodging, drought tolerance, winter hardiness, etc.
- Proper (acceptable) variety denomination

RESULTS

Evaluation of disease resistance in the Variety Registration Process of Hungary

Demonstrated on example of winter wheat

Major diseases in Hungary that are considered to be compulsory-tested in VCU and/or provocative trials:

1. Powdery mildew (*Blumeria graminis* f. sp. *tritici*)
2. Black (stem) rust (*Puccinia graminis* f. sp. *tritici*)
3. Brown (leaf) rust (*Puccinia recondita*)
4. Yellow (stripe) rust (*Puccinia striiformis* var. *striiformis*)
5. Fusarium head blight (*Fusarium graminearum, F. culmorum*)
6. Tan leaf spot (*Pyrenophora tritici-repentis*, anamorph: *Drechslera tritici-repentis*)

If a given candidate variety is proved to be susceptible (resistance rank 4) to at least two or highly susceptible (resistance rank 5) to at least one of the above-mentioned major diseases, the trial officer's proposal to the National Variety Registration Committee must be refusal. In other words, candidate varieties carrying more than mid-level susceptibility to the economical important diseases can be excluded from state variety registration in Hungary (Poós, 2015).

Demonstrated on example of sunflower

Major diseases in Hungary that are considered to be compulsory-tested in VCU and/or provocation trials:

1. Having downy mildew (*Plasmopara halstedii*) resistance to the prevalent five races/pathotypes of the oomycete pathogen (100, 700, 710, 730, 330) is obligatory.
2. *Sclerotinia* stem and head rot (*Sclerotinia sclerotiorum*)
3. *Diaporthe* stem spot and rot (*Diaporthe helianthi*, anamorph: *Phomopsis helianthi*)

A given candidate variety cannot be susceptible (rank 4) to the last two major diseases or highly susceptible (rank 5) to one of them. In other words, candidate varieties carrying susceptibility to the prevalent races of sunflower downy mildew in Hungary or indicate susceptibility to the two other major diseases or prove to be highly susceptible to one of them can be excluded from the state variety registration.

DISCUSSION

Genetic uniformity of the variety structure of any field crop can cause severe disease outbreaks and subsequent considerable yield losses. Black (stem) rust on winter wheat caused an epidemic in 1972 in Hungary and a newly registered Hungarian wheat variety of that time, Kiszombor 1 proved to be highly susceptible and as a consequence it was cancelled (withdrawn) from the National List of Varieties. A sunflower disease called *Diaporthe* stem rot (*Diaporthe helianthi*) also caused an unexpected outbreak in 1997 when most of the cultivars proved susceptible resulting in practically half of the nationwide average yield (1.1 tons ha-1). The potato late blight pathogen, a fungus-like oomycete organism, *Phytophthora infestans* caused the Great Famine in Ireland in 1845-46 when a high-yielding but highly susceptible potato cultivar, Lumper was almost exclusively grown. An infamous pathotype (race T) of the fungus pathogen, *Helminthosporium maydis* (since reclassified as *Bipolaris maydis*) swept over the southern part of the USA in 1970. At that time about 80% of the hybrid maize in America contained T-cytoplasm which is determined the susceptibility to this disease (Southern Corn Leaf Blight). Consequently, the genetic uniformity in the America's maize crop was the principal cause of the 1970 epidemic.

The benefits of host resistance are the follows:

- This is the only effective control in some cases (e.g. virus diseases such as PVY in potatoes, BNYVV in sugar beet, ashy stem blight in sunflower and *Fusarium* wilt in peas),
- A cheap and easy-to-use way of plant protection (choosing resistant cultivar),
- It is practically not influenced by weather conditions
- The best strategy for avoiding disease epidemics (host resistance with diverse genetic background),
- Means the best solution to reduce pesticide pollution of the environment and derease human health risks.

CONCLUSIONS

Some changes in the paradigm of variety registration have been experienced in the last decades in Hungary since resistance (preferably multiple resistance) to the major diseases of field crops has become one of the top priorities. Usage of registered varieties carrying multiple disease resistance could be the best strategy for the sustainable crop production systems such as integrated and organic farming. Nationwide testing of new crop varieties in VCU and disease provocative trials are essential due to the great differences in climate conditions and population structure of pathogens among the EU member states.

REFERENCES

Hinfner, K. and Homonnay, F. (1966): A répa betegségei és kártevői. (Diseases and pests of sugar beet) Mezőgazdasági Kiadó, Budapest, pp. 151-158.

Hinfner K. and Békési P. (1971): Rezisztenciavizsgálatok elvi alapjai és a fertőzöttség mérésének módszerei. (Theoretical implications of testing for resistance and methods for measuring the infectiveness). 1971.évi Országos Fajtakísérletek (Az Országos Mezőgazdasági Fajtakísérleti Intézet kiadványa) (Publication of the National Institute for Agricultural Variety Testing), pp. 113-126.

Gergely L. (2004): Burgonyafajták rezisztenciavizsgálata fitoftóra- (*Phytophthora infestans*) fertőzéssel szemben és egyes környezeti tényezők hatása a betegség-ellenállóságra. (Testing for resistance of potato varieties to late blight agent (*Phytophthora infestans)* and the effect of certain environmental factors on disease resistance), Doktori (PhD) értekezés (Thesis), Keszthely, 94 pp.

Gergely L. (2007): Burgonya és napraforgó fajtakísérleti módszertan (Variety testing methodology of potato and sunflower), A Nemzeti Élelmiszerlánc-biztonsági Hivatal honlap-információja (Website information of the National Food Chain Safety Office, www.nebih.hu)

Poós B. (2015): Búza fajtakísérleti módszertan. (Variety testing methodology of wheat), A Nemzeti Élelmiszerlánc-biztonsági Hivatal honlap-információja (Website information of the National Food Chain Safety Office, www.nebih.hu)

White rust species (Chromista, Peronosporomycetes, Albuginales, *Albuginaceae*) on common weeds in Hungary

Tamás Tóth – György János Kövics
University of Debrecen, Plant Protection Institute, Debrecen, Hungary

SUMMARY

The obligate plant parasite fungi in the family Albuginaceae *are responsible for causing white rust diseases on weeds and they are rather common worldwide. Weedy plants with characteristic symptoms have been collected in 2014 and 2015 on location Hajdú-Bihar and Jász-Nagykun-Szolnok counties in Hungary. The determination of the species were based on the morphological characters both pathogens and hosts.* Albugo candida *was determined on shepherd's purse (*Capsella bursa-pastoris*). Common purslane (*Portulaca oleracea*) is a host for* Wilsoniana portulacae*. The fungus* Wilsonia bliti *(syn.:* Albugo bliti*), the causal agent of white rust disease was found on redroot pigweed (*Amaranthus retroflexus*).*

Keywords: white rust diseases, *Albugo candida*, *Wilsoniana portulacae*, *Wilsoniana bliti, Albugo bliti*

INTRODUCTION

The member of Albuginales fungus order are obligate biotrophic plant pathogens. White rust or white blister diseases caused by the members of the *Albuginaceae* family has been reported from a great variety of hosts.

Albugo candida was the first described species in the *Albuginaceae* under the name of *Aecidium candidum* Persoon (Gmelin, 1792), then it was transferred to *Uredo* (Persoon, 1801), finally it was replaced to its own genus, *Albugo* (de Roussel, 1806). The fungus *Albugo candida* has more than 400 host species, including cultivated plants from the family *Brassicaceae* like horseradish (*Armoracia rusticana*) wide ranging at Hajdú-Bihar County in East Hungary.

The next step was Wilson's findings in 1907, who listed 13 species of *Albugo*, but most of them was host- or at least plant-family specific.

More than a century after de Roussel's discovery, Biga (1955) recognized 40 species of *Albugo* which were almost impossible to differentiate base only on conidial morphology. This monogenic state of the *Albuginaceae* only changed when Thines and Spring (2005) made their revision. They used the ultrastucture of the sporangia observed in SEM (Scanning Electron Microscope) to identify the major lineages of the family *Albuginaceae*.

The newly introduced *Wilsoniana* genus contains some white rust pathogens, which are parasitic to the members of the Caryophyllales plant family. The two genera, *Albugo* and *Wilsoniana* can be differentiate on the base of sporangial ornamentation only. The sporangia of *Wilsoniana* are mostly broadly pyriform. The sporangium has a slight crescent moon-like wall thickening which covering large part of the lateral walls and this formation is the most prominent above the equator of the sporangia. The fertilization in *Wilsoniana* and *Albugo* differ also largely from each other (Davis, 1904).

The species of *Wilsoniana* have little economic importance because they infect harm weedy plants mostly.

MATERIALS AND METHODS

The weed plants were collected in 2014 and 2015 years on four locations (Debrecen, Szolnok, Kunszentmárton, Kisújszállás) in Hajdú-Bihar and Jász-Nagykun-Szolnok county (Middle and East Hungary) with characteristic white rust symptoms. The weed species were observed in maize and sunflower fields, next to roadsides and river banks. The samples were collected during the vegetation period, mostly in summer time. Collection were made mostly from leaves but in case of *Albugo candida* from stems, floral stems and inflorescences too.

Multiple plants were collected from each weed species, víz. shepherd's purse (*Capsella bursa-pastoris* /L./ Medik.), common purslane (*Portulaca oleracea* L.) and redroot pigweeed (*Amaranthus retroflexus* L.).

The morphological characteristics of the pathogens were examined by preparing freshly collected materials and observed them under light microscope. When host tissue contained sexual spores (oospores) they were cautiously compressed with a scalpel. Asexual spores (sporangiospores) and sexual spores (oospores) measurement were taken by using a Canon PowerShot A520 digital camera and ImageJ software. The identification based on host plant and morphology of pathogen. To assure the appropiate values the results were cross-checked with the descriptions of Choi and Priest (1995). 25 reproductive structures were measured per samples.

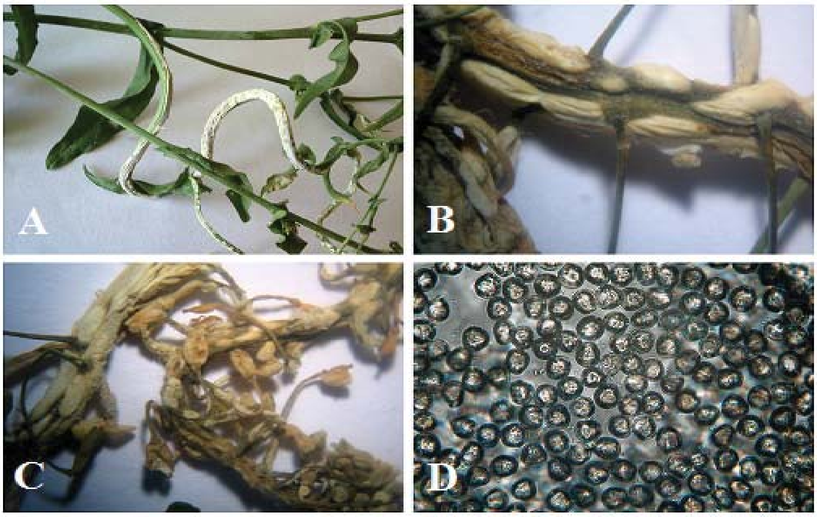
RESULTS AND DISCUSSION

***Albugo candida* (Pers.) Roussel on shepherd's purse (*Capsella bursa-pastoris* /L./ Medik.)**

According to Systematic Mycology and Microbiology Laboratory Fungal Database (Farr and Rossman, 2015) *Albugo candida* was recorded on more than 400 host plants. This is a common pathogen especially on shepherd's purse (*Capsella bursa-pastoris*) and throughout its vegetation period in almost any larger population the white rust symptoms on the leaves or stems are observable (Choi *et al*., 2007). In Hungary the disease caused by this pathogen is not so serious, but near horseradish (*Armoracia rusticana*) plantations (cultivated host of the pathogen) it could be harmful. There are two kinds of infection in case of *Capsella bursa-pastoris*, the first one is the local infection when only the white to cream-coloured pustules can be observed on leaves, stems, floral stems and inflorescences. The second one is systemic infection when swollen, malformed and sterile flower arose so the result of the infection is abnormal growth (*Figure 1/A, 1/C*).

In the collected plants the pustules were approximately between 1 to 3 mm in diameter (*Figure 1/B*). These blister-like lesions contains the asexual spores (sporangiospores). Under the microscope it was clearly visible that these hyaline sporangiospores produced in chains, mostly vacuolate, nearly spherical and their average size were 15.2 x 14.4 µm (*Figure 1/D*). Oospores could not be observed.

Figure 1: ***Albugo candida* - symptoms of systemic infection (A), white rust symptoms on stem (B), swollen, malformed and steril flowers (C), sporangiospores (D)**



***Wilsoniana portulacae* (DC.) Thines on common purslane (*Portulaca oleracea* L.)**

The pathogen was isolated from common purslane (*Portulaca oleracea* L.). In Hungary the disease is present in almost every region, but the intensity differe from year to year. Symptoms of disease are the following: multiple white pustules on the upper leaf side (*Figure 2/A, 2/B*), few pustules can be observed on stems. On the back side of the leaves were some chlorotic lesions, which were mostly small and irregular. In case of systemic infection the plant internodes were shortened and the leaves became smaller than regular, and when heavy infection appeared, the infested leaves fallen. The specialised hyphae which produce asexual spores (sporangiospores) are not branched, short and simple. Sporangiospores are translucent, mostly oval, sometimes almost spherical (*Figure 2/C*). The average size of them 20.2 x 18.8 µm. Sexual spores (oospores) can be observed in large numbers, which are dark-brown coloured, globose and the size in average of 25 measurements is 49.7 µm in diameter (*Figure 2/D*).

***Wilsoniana bliti* (Biv.) Thines on redroot pigweed (*Amaranthus retroflexus* L.)**

The last discussed white rust disease in this paper is *Wilsoniana bliti*, a common pathogen in Hungary which can be observed in almost every year on redroot pigweed (*Amaranthus retroflexus*). The characteristic white coloured pustules were formed on the lower leaves (*Figure 3/A*). On the leaf surface there were small, irregular chlorotic lesions (yellow spots) in different sizes. The pustules were groupped in the most cases with average size of 1-3(4) mm in diameter. Depending on the weather conditions of the year the scattered pustules can appeare only in few number on the leaves, but the fungus can often spread from one plant to another. Heavily infected plants may be shortened, their leaves became smaller and pitted, hereby the whole biomass of the plant

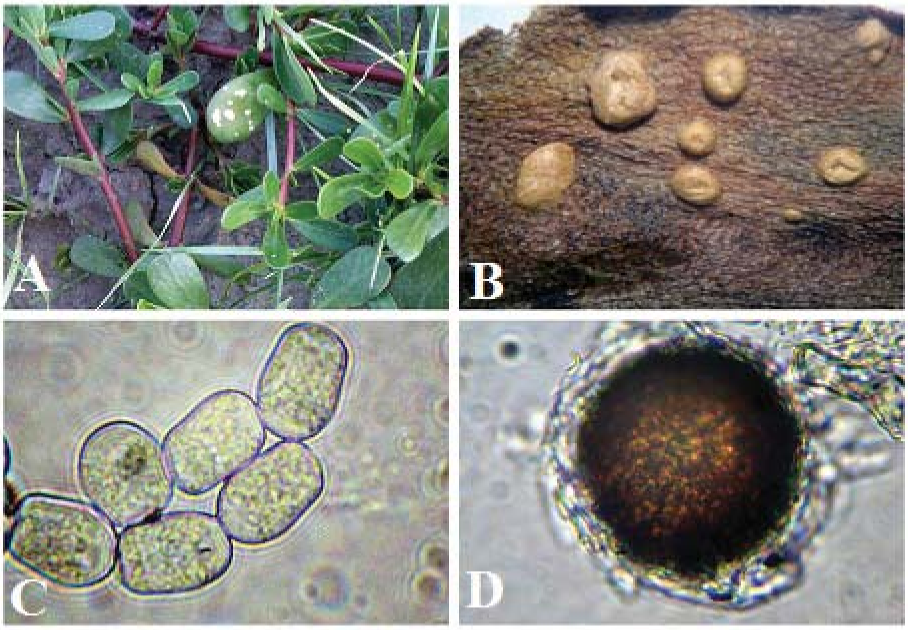


Figure 2: ***Wilsoniana portulacae*** **- white pustules on the upper leaf side (A), small irregular enlarged pustules (B), translucent and oval sporangiospores (C), dark-brown, globose oospore (D)**

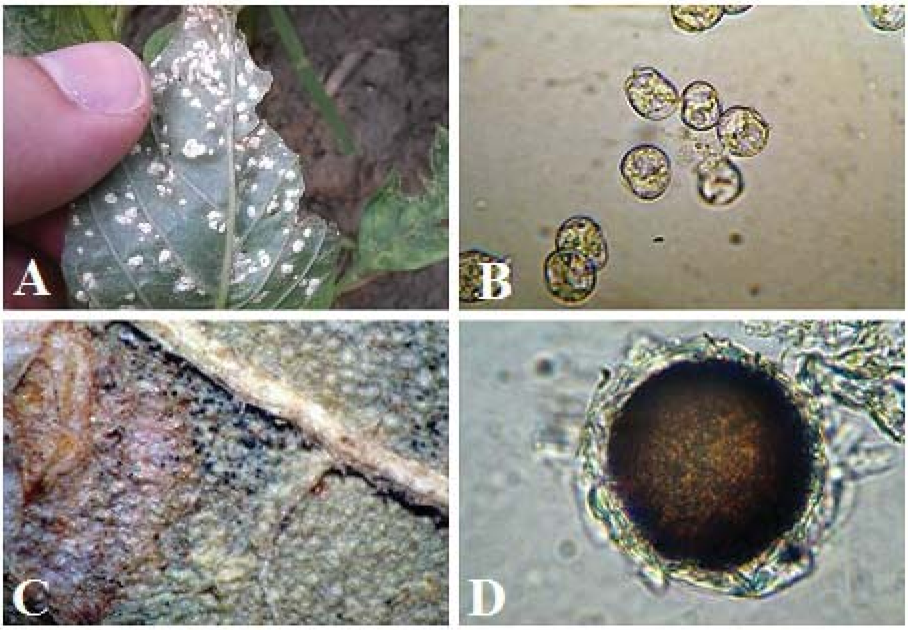


Figure 3:
Wilsoniana bliti **- white pustules on the backside leaf (A), hyaline, oval sporangiospores (B), oospores near to the leaf vein (C), dark-brown, globose oospore (D)**

decreased. In this fungus sporangiospores were also hyaline and oval to spherical (*Figure 3/B*), they formed in short and simple sporogenous hyphae. Average size of the asexual spores were 19.3 x 16,1 µm. Numerous oospores were observed. This sexual spores mostly occured close to the leaf veins (*Figure 3/C*).

This structures were formed within the leaves, also were globose and dark-brown coloured (*Figure 3/D*). Once in a while the oospores may formed as a net-like structure on the lower leaves. The average measured size was 52.3 µm in diameter.

REFERENCES

Biga, M.L.B. (1955): Riesaminazione delle specie del genre *Albugo* in base alla morfologia dei conidi. Sydowia 9: 339-358.

Choi, D. and Priest, M.J. (1995): A key to the genus *Albugo*. Mycotaxon 53: 261-272.

Choi, Y.-J. – Shin, H.-D. – Hong, S.-B. – Thines, M. (2007): Morphological and molecular discrimination among *Albugo candida* materials infecting *Capsella bursa-pastoris* worldwide. Fungal Diversity 27: 11-34.

Davis BM. (1904): The relationships of sexual organs in plants. Bot Gazette 38: 241–264. p.

Farr, D.F. and Rossman, A.Y. (2015): Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. Retrieved September 22, 2015, from http://nt.ars-grin.gov/fungaldatabases/

Gmelin, J.F. (1792): Caroli a Linné, Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis, 2.

Persoon, C.H. (1801): *Synopsis methodica fungorum*. Göttingen.

Roussel, H.F.A. de (1806): Flore du Calvados. 2nd ed. Caen.

Thines, M. and Spring, O. (2005): A revision of *Albugo* (Chromista, Peronosporomycetes). Mycotaxon 92: 443-458.

Examination of resistance to Sclerotinia stalk and head rot in sunflower (*Helianthus annuus* L.) hybrids

Viktor József Vojnich – Attila Hüvely – András Palkovics
Kecskemét College, Faculty of Horticulture, Department of Horticulture, Kecskemét, Hungary
vojnich.viktor@kfk.kefo.hu

SUMMARY

*Nowadays, phytopathogenic fungi cause the most serious yield loss in open field cultures, and sunflower (*Helianthus annuus*) is no exception to this phenomenon. Sclerotinia stalk and head rot (*Sclerotinia sclerotiorum*) is present in the whole area of Hungary, and can cause serious financial loss. In our experiment, sunflower hybrids were tested for resistance to* Sclerotinia sclerotiorum *infection. 16 sunflower hybrids were examined at the Experimental Breeding Site in Jászboldogháza. Pesticide treatment and also nutrient replacement were applied on the sunflower fields.*

Keywords: sunflower hybrids, *Helianthus annuus*, open field trial, *Sclerotinia sclerotiorum*

INTRODUCTION

The sunflower (*Helianthus annus*) gene center can be found in the west side of North America, but the first man who nationalized in Europe was a russian tsar Peter I. in the XVIII: century (Zhukovsky, 1950). Related to the extension of the arable farm area, oil mills have been spread and lots of local sunflower variety has occurred (Walter, 1974). When gene selection has been started here in the middle of the XIX century, it has immediately great success (Pustovojt, 1964). In Hungary the most significant habitats of sunflower were in the east-north counties (Szabolcs-Szatmár-Bereg, Borsod, Hajdú-Bihar) and in Transylvania. Thanks to the specific site and the orthodox religion (Kurnik, 1969) the first oil mill was established in 1812 in Ercsi, followed by many others.

Primarily sunflower was sown because of its high oil content (Antal, 1992; Bocz, 1992). It has been used in catering, animal feeding, and industrial purposes (colour stain, insecticide, cosmetics) (Vranceanu, 1977; Frank, 1999). Most of all: sunflower is a good honey plant and excellent to use like fuel substituted.

Today sunflower is a considerable plant among filed crops too. In the last decades crop area has grown in a huge rate worldwide (Antal, 2005), as long as the sunflower growing area in Hungary (2005-2014) is the same (*Table 1*). While sunflower crop yield might be 5-6 t/ha by applied suitable and effective production methods, then the Hungarian yield is approximately 2-3 t/ha.

Table 1

Sunflower production area, cumulated and mean yield (2005-2014) in Hungary

Year	Production area (1000 ha)	Cumulated (1000 t)	Mean (t/ha)
2005	511	1.108	2.170
2006	534	1.181	2.210
2007	513	1.060	2.070
2008	550	1.468	2.670
2009	535	1.256	2.350
2010	502	0.970	1.930
2011	580	1.375	2.370
2012	615	1.317	2.140
2013	597	1.484	2.490
2014	594	1.597	2.690

Source: KSH, 2015 (http)

The reason to lose crop yield is a phytopathogenic fungus, *Sclerotinia sclerotiorum*, which can be found everywhere in the country and may cause great economic losses. Water-soaked soft rot of sunflower can be affected to all parts of the plant, which can easily spread in vaporous, warm, rainy weather. In rare cases initial infestation can be found like flagging, necrosis (*Figure 1*). Later on tissues of stalks can be decayed and and heads can broken down (Antal, 2005).

MATERIALS AND METHODS

Our small plot tests were made in an experimental station in Jászboldogháza (Jász-Nagykun-Szolnok county), where we checked 16 sunflower hybrid resistance against to *Sclerotinia sclerotiorum*. We sown the hybrids in 70x30 cm of each other; one test field plot was 25.76 m^2. Sowing time was on 4-6th May in 2011 by 120 seeds per plot. The experimental design was a randomized blocks with 4 repetitions. The soil type was chernozem, with a 3.7 m/m% humus content, and 7.3 pH value. Nutrient supply were given in 2 periods: the first in the autumn (4th November 2010) with a multinutrient fertilizer 300 kg/ha, and the second in the spring (21th February 2011) with nitrogen fertilizer (NH_4-NO_3 34%) 200 kg/ha active substance. Chemical treatments were made two times during the season: on 4-5th May in 2011 with Force 1.5 G 7kg/ha, and on 11th in May with Racer 2.5 l/ha. There was no fungicide application on the area. The previous plants were rape in the year of 2008/2009 and winter wheat in 2007/2008.

Temperature and precipitation was an average of many years, which were advantageous for the sunflower hybrids from germination to the milk ripeness (15.5 mm in April, 30.6 mm in May, 45 mm in June, 91.2 in July and 39.2 in August).

Evaluation was made shortly after the symptoms have developed, on 15th in July.

RESULTS

Among the sunflower hybrids infestation were appeared in different values. Because rainy weather promoted the infection by ascospores, symptoms could be observed both on stalks and heads (*Table 2*).

Figure 1: ***Sclerotinia sclerotiorum* infection in sunflower head**

DISCUSSION

Today the number of certificated sunflower hybrids is more than 100. Our goal was to prove which hybrids process good resistance against Sclerotinia infections. In comparison of the tested hybrids the most resistant was 'Tamara' (6 stalk and 66 head infections). There were high head infection at the following hybrids: 'Sorenzo' (23 cases), 'Alibro' (17 cases), 'Maestro' (17 cases). The greatest stalk infection was occurred at the hybrid called 'Celia' (9 cases). The most resistant sunflower hybrid against *Sclerotinia sclerotiorum* were 'Luleo' and 'Neoma' considering both infection types.

This evaluation test was given a general impression about the whole course of infection, which can be useful for breeders in the future.

Table 2

Sclerotinia stalk and head rot in sunflower (*Helianthus annuus* L.) hybrids

Name of hybrid	Infection type	I. repetition	II. repetition	III. repetition	IV. repetition	Total number
1. Neoma st.	Sclerotinia stalk rot	2	0	1	0	3
	head rot	0	0	1	0	1
2. Ferti st.	Sclerotinia stalk rot	5	0	1	1	7
	head rot	0	6	2	0	8
3. Brio st.	Sclerotinia stalk rot	2	0	1	1	4
	head rot	1	1	4	1	7
4. P 102 CL st.	Sclerotinia stalk rot	2	1	3	1	7
	head rot	4	2	0	5	11
5. Celia st.	Sclerotinia stalk rot	1	0	6	2	9
	head rot	3	1	2	1	7
6. Sunflora st.	Sclerotinia stalk rot	0	1	5	0	6
	head rot	2	0	2	0	4
7. Tamara st.	Sclerotinia stalk rot	3	0	1	2	6
	head rot	14	17	15	20	66
8. Kendo	Sclerotinia stalk rot	2	0	2	0	4
	head rot	0	2	3	0	5
9. Palomino	Sclerotinia stalk rot	2	0	3	0	5
	head rot	1	2	2	3	8
10. Alibro	Sclerotinia stalk rot	2	1	0	1	4
	head rot	3	5	3	6	17
11. Lisboa	Sclerotinia stalk rot	3	1	2	1	7
	head rot	8	1	0	1	10
12. Maestro	Sclerotinia stalk rot	2	0	1	1	4
	head rot	1	6	7	3	17
13. Oslo	Sclerotinia stalk	2	0	4	1	7
	head rot	0	0	1	5	6
14. Luleo	Sclerotinia stalk rot	0	0	0	1	1
	head rot	2	0	0	0	2
15. Sorenzo	Sclerotinia stalk rot	1	0	2	0	3
	head rot	8	3	7	5	23
16. Pan 31-101	Sclerotinia stalk	1	0	1	1	3
	head rot	2	1	2	4	9
Total		79	51	84	67	**281**

ACKNOWLEDGEMENTS

This work was supported by Experimental Breeding Site in Jászboldogháza. Thanks for Ádám Antal, student of Kecskemét College.

REFERENCES

Antal, J. (1992): Napraforgó In: Bocz E. Szántóföldi növénytermesztés Mezőgazda Kiadó, Budapest

Antal, J. (2005): Növénytermesztéstan 2. Gyökér- és gumós növények, Hüvelyesek, Olaj- és ipari növények, Takarmánynövények. Mezőgazda Kiadó, Budapest

Bocz, E. (1992): Szántóföldi növénytermesztés. Mezőgazda Kiadó, Budapest

Frank, J. (1999): A napraforgó biológiája, termesztése. Mezőgazda Kiadó, Budapest

Kurnik, E. (1969): Napraforgó. p. 264-285. In: Kapás S. (Szerk.) Magyar Növénynemesítés, Budapest: Akadémia Kiadó. 285 pp.

Pustovojt, V.S. (1964): Conclusions of work on the selection and seed productin of sunflowers. Agrobiology, 5: 662-697.

Vranceanu, A.V. (1977): A napraforgó. Mezőgazda Kiadó, Budapest

Walter, H. (1974): Die Vegetation Osteuropas. Nord- und Zentralasiens. Vegetationsmonographien der einzelnen Grossraume. Stuttgart: Gustav Fischer Verlag. p. 452.

Zhukovszky, P.M. (1950): Cultivated plants and their wild relatives. (Kulturnüe rasztenija i ih gyikie szorodicsi.) Moszkva, Akad. Izd. 732 pp.

http://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn007.html

Effect of the media on morphology of *Cryphonectria parasitica* (Murr.) Barr isolates and their Vegetative Compatibility Groups

Gabriella Kovács – László Radócz
University of Debrecen, Institute of Plant Protection, Debrecen
kovacs.gabriella@agr.unideb.hu

SUMMARY

The most dangerous pathogen for the European and American chestnuts is the blight fungus Cryphonectria parasitica *(Murrill) Barr. Short after its introduction a big number of chestnut trees were destroyed on the infested area. The control could be really complicated, because of the numerous vegetative compatibility groups of the fungus. There is a type that carries a mycovirus viz. hypovirus in the cytoplasm. We are able to control effectively this pathogen by using mycovirus-carrying strains (called hypovirulent fungal strains also). In laboratory it is easy to multiply the virulent and the hypovirulent strains of the fungus but do not easy to differentiate colonies visually on simple PDA medium. During our research, we tested different types of media, based on potato and chestnut bark extract respectively. It was observed that on potato medium the virulent strains produce more orange pigments. So it is more easy to differentiate virulent or hypovirulent isolates of chestnut blight fungus based on colony colour and morphology.*

Keywords: *Cryphonectria parasitica*, chestnut blight fungus, different types of media, colony morphology

INTRODUCTION

The European chestnut (*Castanea sativa*) belongs to the plant family Fagaceae and it is endemic in Europe and Asia. It has many pathogens and injured by insects, but the most important pathogens were in the last century and even today *Phytophtora* spp. and *Cryphonectria parasitica* both in America and Europe as well. At the beginning of the 20th century *Cryphonectria parasitica* fungus was introduced first in the east coast of the USA (Merkel, 1906), and during the 40 next years it destroyed all American chestnut forests. This means about 4 million hectares of trees (Young *et al*., 2000). After the appearance of *Cryphonectria parasitica* in Europe it spread rapidly across the continent. While the fungus arrived to Italy from the USA (Biraghi, 1946), but the forests in France were infected by the fungus introduced directly from Asia. The chestnut blight fungus in Asia evolve together with the host trees (coevolution), so these tree species have got some tolerance to the fungus. That's why symptoms of *Cryphonectria parasitica* hardly visible on the infected Asian chestnut trees. During the sexual reproduction of the fungus many Vegetative Compatibility Groups (VCGs) could appear. So the disease control could be more difficult on these places. In Europe there are more than 65 VCGs (Heiniger, 1994). There is another form of the *Cryphonectria parasitica* with decreased virulence and called hypovirulent fungus strain. This contains a pathogenic mycovirus in its cytoplasm (Anagnostakis, 1977). By application this hypovirulent strains can be controlled the virulent fungus. While the virulent fungus spread rather fast in a forest, the hypovirulent one extend much slowly.

MATERIALS AND METHODS

The symptoms on the bark cancer can be various, so we have differentiated „sunking canker", „opened canker" and „surface canker" (Roane *et al.,* 1986; Radócz, 2010). In case of the opened and sunking cankers we have to identify which vegetative compatibility group belongs to the given fungus. In addition it is need to find the adequate hypovirulent fungus which belongs to the same VCG before starting the effective protection.

The surface canker, also called callused canker refers to the presence of the hypovirulent fungus, however during the recovery process the virulent fungus might occur. If we sampling this part and put on a simple PDA medium it is difficult to differentiate virulent and hypovirulent characteristics. During the VCG identification can not be obviously detect in on the base of hyphae (hyphae anastomosis).

During our tests we looked for such a culture medium, on which the pigmentation of virulent fungus and other morphological characters were clearly distinguishable. We separated our samples during the process to take the above-mentioned canker types into consideration, so probably received virulent and hypovirulent isolates.

The indentification process of the sampling and determination of VCGs are the following:
Taking small pieces from the border of the infected and healthy part of the chestnut bark. The sampler tools (knives, scalpels) were disinfected by 70% ethanol, and every single sample was put into marked paper bag and stored in fridge. Bark sample surface was sterilized also by 70% ethanol for 2 minutes and soaked in sterile distilled water for 1 minute just before putting them on the surface of culture medium. After this we incubated the Petri dishes in 24^{o}C thermostate for 3 days. Unfortunately it is possible that despite of the disinfection process, pathogens might remain in the bark, that's why multiple isolation is necessary.

The identification of the vegetative compatibility groups were completed by using EU tester strains. These are available in the Mycological Collection of the Institute of Plant Protection, University of Debrecen. The EU tester strains were propagated in Petri dishes on PDA culture media. Samples from the two media – EU-tester and the and the unidentified sample – were cut 5mm cubes and placed close to each other in a new Petri dish. If the two fungus strains were compatible, the hyphae anastomosis was formed and also the transmission of the double-standed RNA might happened.

In the case of hypovirulent fungus the hyphae textures are hardly visible, and it is difficult to evaluate the hyphae anastomosis has happened or not. That's why we tried different culture media enriched by chestnut bark extract.

We took into consideration requirement vitamin for the fungus and the circumstances of natural occurrence moreover our previous experiment results. The biotin was used by several persons previously (Radócz, 1995). Potato dextrose agar (Scharlab, S.L.) was added 1 mg/l biotin after sterilization (Autoclave AE 150 Dry Raypa).

As in most cases the growth of the fungus on PDA media is appropriate, another culture medium was made from cooked fresh potato, trusting in that the fungal morphological characteristics will be more clearly identifiable. For making 1 liter medium 200gramms of fresh potato was cut, cooked 20 minutes and was filtrated. To the natural medium were added 20g agar-agar (Spektrum 3D) and 20g glucose (Reanal Rt.) per liter as well. The quantity of medium was amended by distilled water to 1 liter and it was sterilized in autoclave.

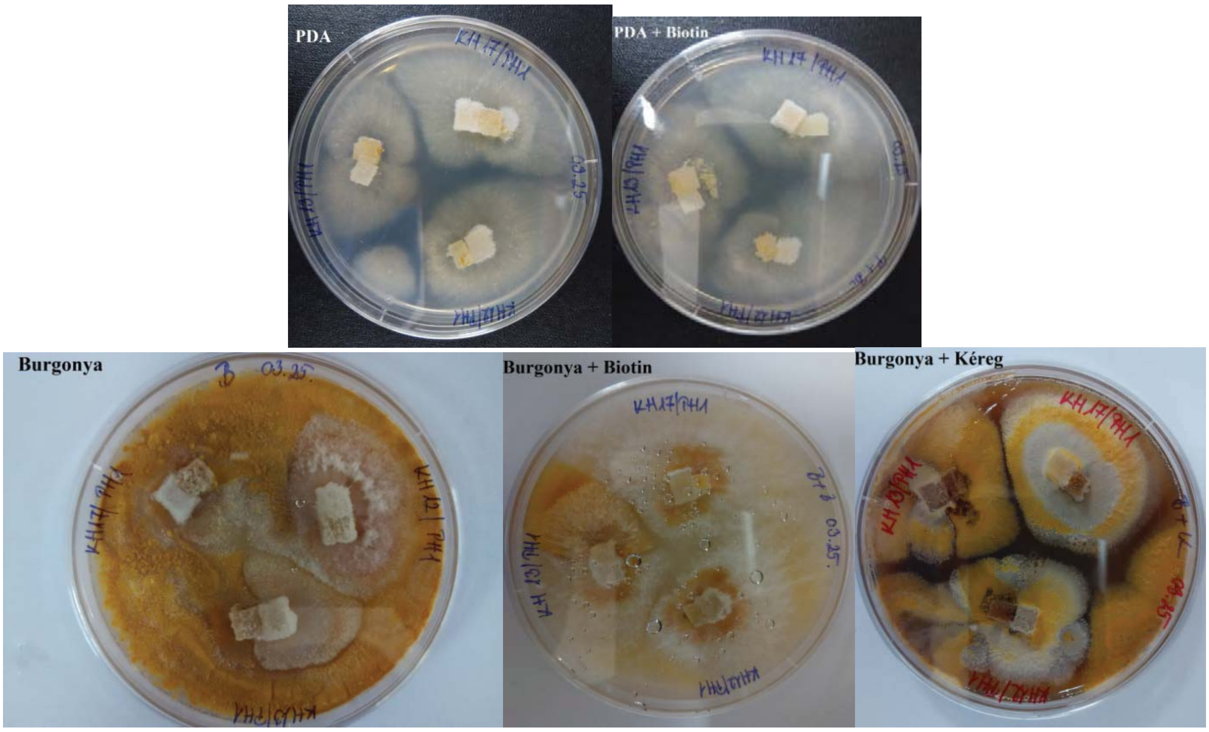
Another culture medium made from cooked fresh potato was enriched by 1mg/l biotin just before pouring into Petri dishes.

Simulating the natural spreading of the fungus, it was attempt to provide ideal circumstainces to growth. Healthy chestnut bark (5g/l) was given to the potato culture medium which guarantees the proper tannin acid amount. In parallel with this, after sterilization 1mg/liter biotin was also added to ensure the growing criteria.

RESULTS

Due to the transparent consistence of the media and the hyphae whitish colour, the hyphae textures are hardly visible on PDA and PDA+biotin media. The pigmentation of the virulent fungus strains started up on the potato medium, so the virulent (orange) and hypovirulent (white) isolates were easy to separate. However, we have not experienced significant differences in the intensity of the growth of the fungus on the media which is enriched by biotin. With the bark addition to the potato the characters of the fungus is more outstanding, and on the surface of darker, containinig bark tannin media, the pigmentation is clearly visible (*Figure 1*).

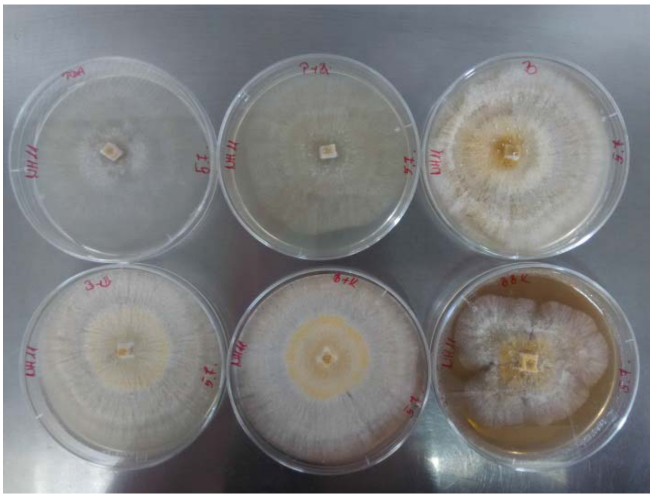
Figure 1: **Conversions of Pécsbánya hypovirulent + Pálháza virulent isolates on different media**



burgonya = fresh potato medium; kéreg = contains chestnut bark

Testing the media shown clearly that both the measured parameters and visual observation on the potato+biotin+bark type medium resulted slower growing both on virulent and hypovirulent isolates and the mycelium has not grown in concentric rings as usual (*Figure 2*).

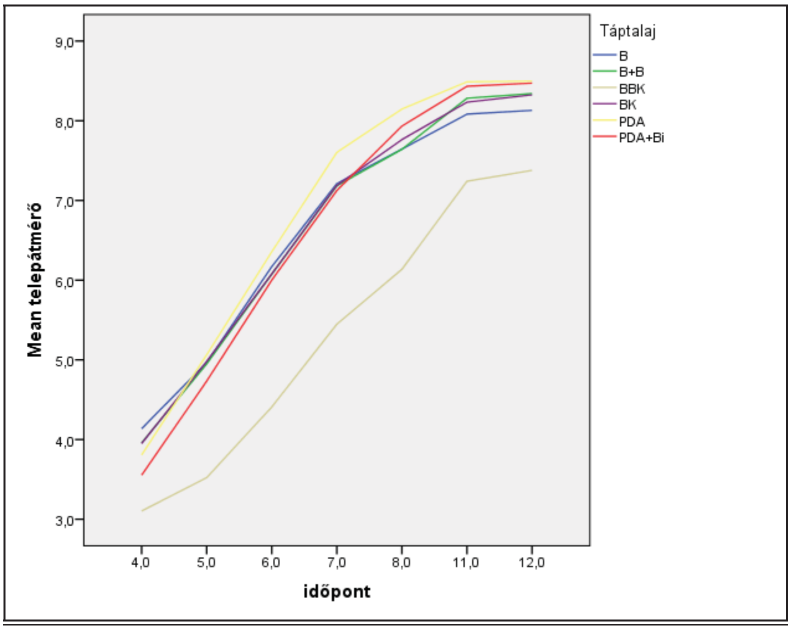
Figure 2: **Growing hypovirulent strain from Pécsbánya (NH 11)**



PDA (top left) PDA+Biotin (top middle), fresh potato (top right), fresh potato+biotin (bottom left), fresh potato+bark (bottom middle), fresh potato+biotin+bark ('BBK', bottom right) media

Using the SPSS statistical software was confirmed that the 'BBK' marked media proved the least appropriate for growth monitoring and conversion testing of *Cryphonectria parasitica* fungus due to the smaller growing intensity (*Figure 3*).

Figure 3: **Average diameter of all analysed fungal strains on different cultural media**

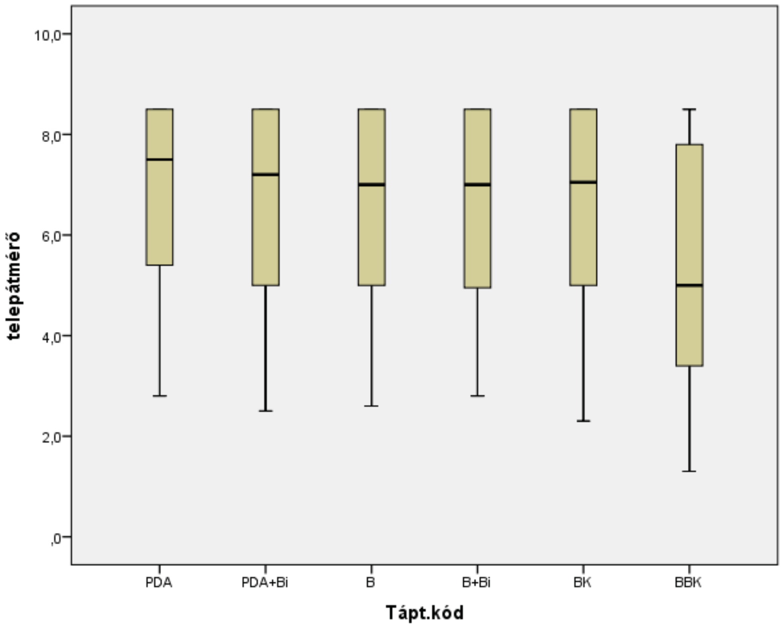


mean telepátmérő = mean colony size in diameter (cm), időpont = time (days), táptalaj = media, B = fresh potato, B+B = fresh potato + biotin, BK= fresh potato+chestnut bark, BBK = fresh potato + biotin + chestnut bark, PDA = potato dextrose agar, PDA+Bi = potato dextrose agar + biotin

It seems well on the graphs that the PDA cultural media was the best for growing the *Cryphonectria parasitica* considering the growing speed on the fifth day, and the PDA+biotin (BDA+Bi) medium on the seventh one. Because shortage of pigmentation fungal attributions are hardly visible.

On potato-based media resulted the same in all cases without significant differences (*Figure 4*).

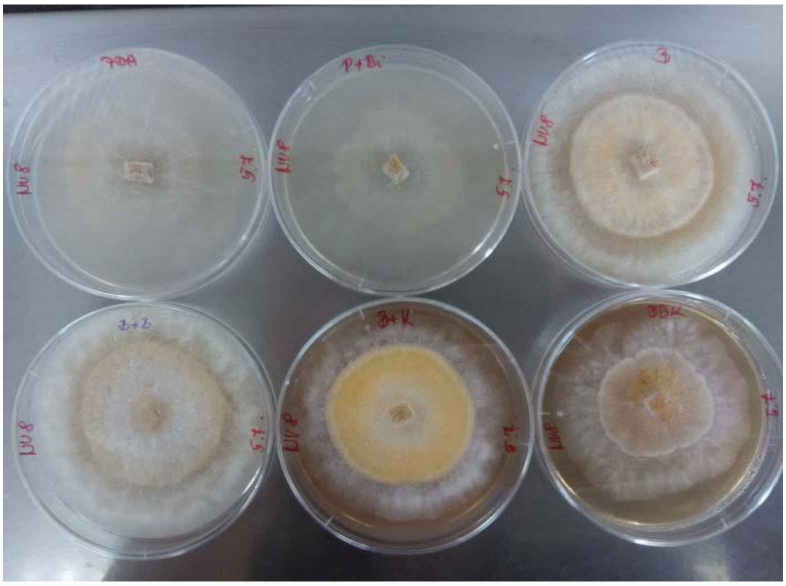
Figure 4: **Average fungal colony in diameter and standard deviations**



telepátmérő = mean colony size in diameter (cm), tápt.kód = media, PDA = potato dextrose agar, PDA+Bi = potato dextrose agar + biotin, B = fresh potato, B+Bi = fresh potato + biotin, BK= fresh potato+chestnut bark, BBK = fresh potato + biotin+chestnut bark

On the *Figure 5* the pigmentation of the virulent fungus is visible on the fresh potato media in contrast with PDA, where the mycelium is rather white. The PDA + biotin is transparent, but in the fresh potato based medium the pigmentation is clearly visible. On the fresh potato based + biotin is also sensible, and the fluffy mycelium seems somewhat more. In the middle there is the potato based and bark added cultural media, and due to its dark colour, the fungal colony is more noticeable. Biotin was added to the media on the last Petri dish as we expounded before. The fungal characteristics are clearly showed, but the fungal development was slower. However the fan-form mycelium which was described in various studies can be observed on this media clearly.

Figure 5: **Virulent isolate from Pécsbánya (NV 8)**



PDA (top left), PDA + biotin (top middle), fresh potato based (top right), fresh potato based + biotin (bottom left), fresh potato based + chestnut bark (bottom middle), fresh potato based + biotin + chestnut bark (bottom right)

CONCLUSIONS

Overall we stated that the biotin supply of media seems unnecessary because it did not resulted any advanatage in growth of the chestnut blight fungal isolates. By the coupling of virulent and hypovirulent strains on PDA medium did not result obvious, clearly visible reaction to check visible the efficacy of conversions or hyphae anastomoses.

It seems reasonable to use fresh potato based + chestnut bark medium to cultivate *Cryphonectria parasitica* isolates during conversion tests of hypovirulent and virulent strains.

REFERENCES

Anagnostakis, S.L. (1977): Vegetative incompatibility in *Endothinia parasitica*. Exp. Mycol. 1: 306-316.

Anagnostakis, S.L. (1987): Chestnut blight: The classical problem of an introduced pathogen. Mycology 79: 23-37.

Anagnostakis, S.L. (1993): Valuable chestnut germplasm in Connecticut. Annual Report of the Northern Nut Growers Association 83: 53-54.

Biraghi, A. 1(946): Il cranco del castagno causato da *Endothinia parasitica*. Agric.Ital. 7: 1-9.

Biraghi, A. (1950): Caratteri di resistence in Castanea sativa nei confronti de Endothinia parasitica. Boll. Stn.Patol.Veg., Rome. 7: 161-171.

Heiniger, U. – Rigling, D. (1994): Biological control of chestnut blight in Europe. Annual Review of Phytopathology 32: 581-599.

Merkel, H.W. (1906): A deadly fungus ont he American chestnut. N.Y.Zool.Soc.Am. Rep.10: 204-210.

Radócz L. (2010): A Nagymarosi szelídgesztenyések története, ápolása, védelme. Debreceni Egyetem Kiadó. 83 pp.

Radócz L. (2014): Az európai szelídgesztenye szaporítása, ápolása, védelme. University Press Debrecen. 165 pp.

Roane, M.K. - Griffin, G.J. – Elkins, J.R. (1986): Chestnut blight, other *Endothia* diseases, and the genus *Endothia*. The American Phytopathological Society, St. Paul, Minnesota, USA. 53 pp.

Régi-új betegség a kukorica golyvásüszög (*Ustilago maydis*)

Frommer Dóra[1] – Veres Szilvia[2] – Lévai László[2] – Radócz László[1]

[1]Debreceni Egyetem MÉK Növényvédelmi Intézet, Debrecen,
[2]Debreceni Egyetem MÉK Növénytudományi Intézet, Mezőgazdasági Növénytani, Növényélettani és Biotechnológiai Tanszék, Debrecen[2]
dorafrommer@gmail.com

ÖSSZEFOGLALÁS

*A kukorica golyvásüszög (*Ustilago maydis*) az egyik leggyakrabban előforduló kukorica betegség. Az elmúlt években jelentősége háttérbe szorult, azonban napjainkban egyre elterjedtebb és egyre nagyobb arányban fordul elő, különösen csemegekukoricában. Az ellene való védekezési paletta igen szűkös, ezért fontos felhívni a figyelmet a megelőzésen és az ellenállóságon alapuló védekezésre.*

SUMMARY

*Corn smut disease (*Ustilago maydis*) is one of the most common maize diseases. In the previous years the disease lost some from its importance, however nowadays it turns into more and more important and widespread one. The control encounters great difficulties, therefore it should be emphasized the preventive and resistance-based protection.*

Kulcsszavak: golyvásüszög, fertőzés, betegség elleni védekezés
Keywords: corn smut disease, infection, disease control

BEVEZETÉS

A kukorica golyvásüszögje (*Ustilago maydis* /DC./ Corda) az egyik leggyakoribb, legismertebb kukorica betegség (Christensen, 1963). A növény fiatal, növekedésben levő részein – leggyakrabban a szárcsomókon és csöveken, ritkábban a leveleken, címeren vagy a járulékos gyökerek eredési helyén – pár mm-estől ököl-, sőt gyermekfej nagyságúra fejlődött golyvák jelennek meg: a kórokozó spóratelepei. A golyvákat kezdetben fehér, ezüstösen fénylő burok fedi, és belsejük húsos, szivacsos, később a burok szürkésbarna, száraz lesz, belsejük pedig barnás-fekete üszögspóra porral teli (*1. ábra*).

1. ábra: **Csemegekukorica csövön kialakult golyvás daganat**

Figure 1: **Corn smut tumor on the ear of sweet corn**

A fertőzés hatására a címeren csövek jelenhetnek meg, a fertőzött csövön pedig címer. A betegség bárhol előfordulhat, ahol kukoricát termesztenek. Hazánkban a kukoricát rendszeresen fertőzi (endemikus kórokozó), kártétele azonban évjáratonként változó. A gomba proliferációjával együtt képződő daganatok energiát vonnak el a többi szemtől, jelentősen csökkentve a termés mennyiséget (Snetselaar and Mims, 1993). Az országos fertőzés a felmérések alapján több éves átlagot figyelembe véve 2-10 % körül alakul. Vizsgálatok szerint 10 %-os fertőződés esetén akár 3,5 % terméskieséssel is számolhatunk. Legsúlyosabb károkat csőfertőzés esetén okoz, ilyenkor a beteg növény termésvesztesége elérheti akár a 15-40 %-ot.

A golyvásüszög legfontosabb fertőzési forrása a talaj, ugyanis az elsődleges fertőzés a talajba került és ott áttelelt üszögspóráktól ered. A teliospórák a talajon, trágyacsomókon, trágyalében kicsíráznak, a rajtuk kialakuló sporídiumok pedig a légmozgás segítségével a növényre jutnak és ott csíratömlőt hajtanak. Fontos, hogy a teliospórák csírázása különböző talajadottságok mellett eltérő lehet. Az istállótrágyázás, a bőséges nitrogén ellátás és az öntözés fokozza a növények fogékonyságát. A talaj állapota mellett a klimatikus tényezők is befolyásolják a betegség kialakulását. A teliospórák 8 °C fölött már csíráznak, az optimuma azonban 26-34 °C között van. A sarjkonídium (sporídiumok) képződésének optimális hőmérséklete 20-26 °C (Holiday, 1961). Esős meleg nyarak, a gyakori viharkárok, jégesők is megnövelik a fertőzés valószínűségét. A szeles időjárás pedig a sarjspórák terjedésének kedvez. Általánosságban elmondható az is, hogy minden növényi sérüléssel járó mechanikai hatás, kapálás, címerezés, rovarrágás (fritlégy, kukoricamoly, kukoricabogár, gyapottok-bagolylepke), vadkár, jégeső is növeli a fertőzés valószínűségét. Kitűnő példa erre, hogy a kukorica fiatalkori megbetegedése összefüggésben van a fritlegyek fellépésével, ugyanis a fritlégytől fertőzött tövek nagyobb arányban fertőződtek golyvásüszöggel.

A kukorica golyvásüszög elleni védekezés fő iránya az ellenálló hibridek termesztése (Russel, 1978). Agrotechnikai eljárásokkal csak mérsékelni lehet a golyvásüszög kártételét. Tekintve, hogy a fertőzés elsősorban a talajból indul ki, a növények gondos betakarítása és a maradványok mély alászántása a betegség megelőzése szempontjából igen fontos. Ezen kívül elengedhetetlen a vetésváltás alkalmazása, amely nagymértékben elősegíti a kórokozó fennmaradását a talajban. Ezek mellett fontos az egyoldalú N-trágyázás kerülése, a kiegyensúlyozott tápanyag-ellátás, valamint a hibrid-specifikus állománysűrűség alkalmazása. A fungicides kezelések közül egyedül a vetőmagcsávázás adhat némi védelmet a kórokozóval szemben, a spórák vetőmaggal történő széthurcolásának veszélyét csökkentve. Ezen kívül elengedhetetlen a rovarok elleni vegyszeres védekezés is, amely a rágások okozta mechanikai sérülés nyomán kialakuló fertőzések megelőzését segíti elő (Radócz, 2013).

Az *Ustilago maydis* a kukoricatáblák állandó vámszedője (Jakucs és Vajna, 2003), mégis, az elmúlt években jelentőségét alábecsülték. Alacsony fertőzöttségnél ugyan nem okoz nagy termésveszteséget, viszont erősen fertőzött táblákon igen nagy terméskieséssel kell számolnunk. Az idei 2015-ös év szélsőséges időjárása ellenére is több területen jelent meg a kórokozó és okozott veszteségeket. Jelen munkám a 2015-ös golyvásüszög fertőzöttség alakulását mutatja be Hajdú-Bihar megyében, több kukoricatermesztés szempontjából jelentős termőhelyen.

ANYAG ÉS MÓDSZER

A vizsgálatokat 2015-ben három területen (Földes, Tetétlen, Látókép), három hibriddel (DKC 4596, PR0216, Desszert 73) végeztem. Hibridenként 1000 db kukoricát vizsgáltam. A felvételezéseket 2015 júliusában hajtottam végre. Mind a három területen meghatároztam a természetes fertőzés következtében kialakult golyvásüszög százalékos gyakorisági értékeit, illetve a rovarkártétel (kukoricamoly, kukoricabogár), a jégeső és egyéb mechanikai sérülést okozó tevékenységek (öntözés, mechanikai gyomirtás) előfordulását. A kukorica golyvás fertőzöttségét a csövön és a száron jelentkező tünetek (golyvás daganatok) alapján határoztam meg. A statisztikai értékelést MS Excel program segítségével végeztem.

EREDMÉNYEK

A 2015-ös év szélsőségesen meleg időjárása egyáltalán nem kedvezett a golyvás megbetegedést okozó *Ustilago maydis* felszaporodásának. Ennek ellenére a vizsgált területeken igen nagy arányban fordult elő.

A Földes és Tetétlen területén vizsgált DKC 4596 hibridnél 8,2 %-os fertőződés volt tapasztalható. A cső és szár fertőzés arányát az *2. ábra* mutatja.

2. ábra: **Cső és szár fertőzés aránya a DKC 4596-os hibridnél**

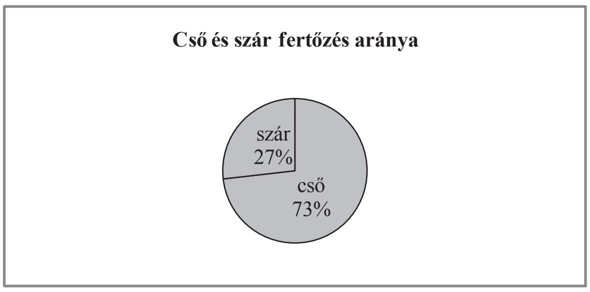


Figure 2: **The rate of ear-stem infection at DKC 4596**

szár = stem, cső = ear

Az adott területen nem volt jégeső. Kártevők közül a kukoricabogár és kukoricamoly kártétele volt jelentős. Öntözés nem volt a területen, mechanikai gyomirtás viszont igen sorközművelő kultivátorral.

A Földes-Tetétlen területén vizsgált PR0216 hibridnél 3,2 %-os volt a fertőződés. A cső- és a szárfertőzés arányát a *3. ábra* mutatja.

3. ábra: **Az *Ustilago maydis* cső- és szárfertőzés aránya a PR0216 hibridnél**

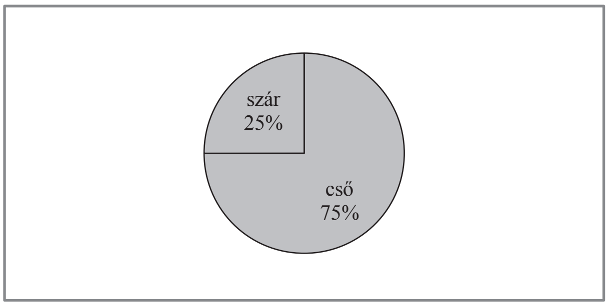


Figure 3: **The rate of ear and stem infection of Ustilago maydis at PR0216**
szár = stem, cső = ear

Ezen a területen szintén nem volt jégeső. Kártevők közül a kukoricamoly kártétele volt megfigyelhető. Öntözve nem volt a terület, a mechanikai gyomirtást sorközművelő kultivátorral végezték.

Látókép területén a vizsgált Desszert 73 csemegekukoricánál volt a legjelentősebb a fertőződés, 14,7 %. Ezen a területen nem volt jégeső, rovarkártétel elenyésző arányban volt jelen, a mechanikai gyomirtást sorközművelő kultivátorral végezték. A cső- és szárfertőzés arányát a *4. ábra* mutatja.

4. ábra: **Az *Ustilago maydis* cső- és szárfertőzés aránya Desszert 73 hibridnél**

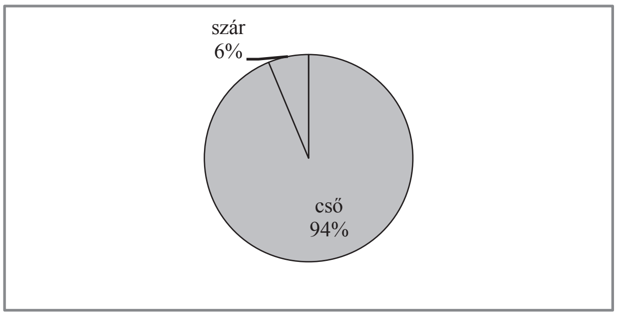


Figure 4: **The rate of ear and stem infection of Ustilago maydis at Desszert 73**
szár = stem, cső = ear

KÖVETKEZTETÉSEK

Annak ellenére, hogy az időjárási körülmények kedvezőtlenek voltak, mind a három vizsgált hibridnél nagymértékű golyvásüszög megbetegedés volt megfigyelhető *(5. ábra*), amely a kórokozó jövőbeni fontosságára hívja fel a figyelmet.

Az eredményekből egyértelműen megállapítható, hogy a csőfertőzés nagyobb, a szárfertőzés kisebb arányban fordult elő. Fontos kiemelni, hogy a vizsgált területeken a rovarkártételből adódó mechanikai sérülés jelentős volt, amely hozzájárult a csövön képződő golyvás daganatok megjelenését. Azonban a vizsgált csemegekukoricánál a rovarkártétel elenyésző volt, így itt a nagyobb mértékű megbetegedés a hibrid tulajdonságaiban keresendő.

5. ábra: **A vizsgált hibridek fertőzöttsége %-ban kifejezve**

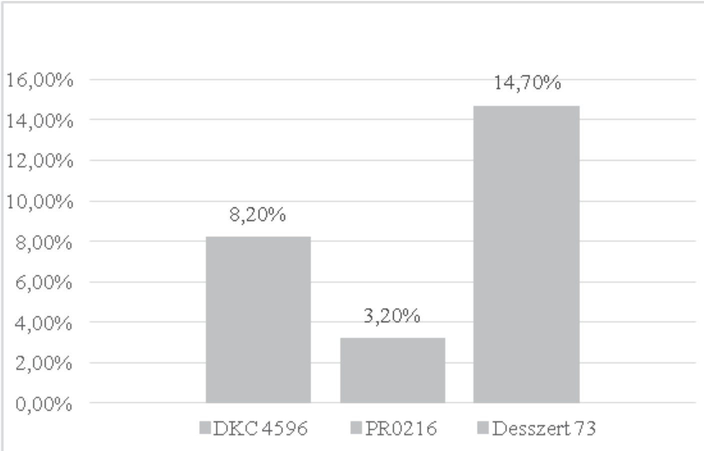


Figure 5: **The infection of investigated hibrids in percentage**

IRODALOM

Christensen, J.J. (1963): Corn smut caused by *Ustilago maydis*. Monograph No. Am Phytophatol. Soc., Saint Paul.

Holiday, R. (1961): The genetics of *Ustilago maydis*. Genet. Res. 2. 204-230.

Jakucs E. - Vajna L. (2003): Mikológia. Agroinform Kiadó, Budapest. 467.

Radócz L. (2013): Korszerű növényvédelem. Egyetemi Kiadó, Debrecen. 165.

Russel, G.E. (1978): Plant breeding for pest and disease resistance. Butterworths, London-Boston. 485.

Snetselaar, K.M. and Mims, C.W. (1993): Sporidial fusion and infection of maize seedlings by the smut fungus *Ustilago maydis*. Mycologia 84: 193-203.

Sensitivity of maize to herbicides in experiments in Martonvásár in 2015

Péter Bónis – Tamás Árendás – Csaba Szőke – Eszter Sugár – Nándor Fodor – Éva Darkó – Lajos Csaba Marton

Agricultural Institute, Centre for Agricultural Research, Martonvásár, Hungary

bonis.peter@agrar.mta.hu

SUMMARY

The phytotoxic effect of herbicides applied post-emergence was investigated in a herbicide sensitivity experiment set up on parental maize genotypes in Martonvásár. A total of 48 Martonvásár inbred lines and 12 single line crosses were included in small-plot experiments set up in two replications. Ten herbicides were applied at the normal authorised rate and at twice this quantity. Compounds intended for pre-emergence application were applied when maize was in the 3–4-leaf stage and post-emergence herbicides in the 7–8-leaf stage of development. The extent of phytotoxicity was scored two weeks after treatment. Some of the herbicides tested are not authorised for use in seed production fields, but it is important to know how the parental genotypes respond to all types of herbicides. Phytotoxic symptoms of varying intensity were only observed on a third of the 60 parental genotypes examined; the majority of the lines exhibited no reaction to any of the herbicides. Averaged over the 60 genotypes the level of phytotoxic damage was less than 10% for the single dose. When the double dose was applied somewhat more severe damage was induced by products containing Mesotrione + Nicosulfuron or Foramsulfuron + Isoxadifen-ethyl, but this was still below 15%. The herbicide dose had a three times stronger influence on the intensity of the symptoms than the type of herbicide. With the exception of Topramezone, there was a significant difference between the effects of the normal and double doses. The greatest dose effect differences, in decreasing order, were observed for Mesotrione + Nicosulfuron, Foramsulfuron + Isoxadifen-ethyl. Nicosulfuron and Mesotrione + Terbutylazine. The Mesotrione + Terbutylazine active ingredient combination only caused mild (<10%) symptoms on a total of 11 genotypes, while the Mesotrione + Nicosulfuron combination induced more severe phytotoxic symptoms on 26 lines. When Nicosulfuron was applied alone it caused milder symptoms on fewer genotypes than in combination with Mesotrione. Among compounds of the sulphonyl-urea type, the least severe symptoms on the fewest genotypes were recorded in the case of Prosulfuron.

Keywords: maize inbred lines, post-emergence herbicide, phytotoxicity

INTRODUCTION

Chemical weed control has a key importance for large-scale maize production. Only a few of the many herbicides available to maize growers can be safely used for weed control of inbred lines. Numerous studies have demonstrated the diverse levels of herbicide tolerance of maize lines (Shimabukuro *et al*., 1971, Eberlein *et al*., 1989; Harms *et al*., 1990; Kang, 1993; Widstrom and Dowler, 1995; Green and Ulrich, 1993, 1994; Green, 1998; Bónis *et al*., 2004, 2013). The interaction between herbicide and crop is influenced not only by the active ingredient - genotype relationship but also by the year and by other environmental factors (Berzsenyi *et al*., 1997; Bónis *et al*., 2011).

MATERIALS AND METHODS

A small-plot field experiment was set up in two replications in Martonvásár on chernozem soil with forest residues to investigate the herbicide tolerance of maize genotypes bred in Martonvásár.

The phytotoxic effects of ten herbicides (*Table 1*), applied post-emergence with a plot sprayer at the authorised dose and at twice this quantity, were examined for 48 Martonvásár inbred lines and 12 single line crosses. For experimental purposes, compounds intended for pre-emergence use were also applied post-emergence when the maize plants were in the 3–4-leaf stage (Treatments 1 and 2).

The post-emergence herbicides were applied when the maize was in the 7–8-leaf stage and the level of phytotoxicity was evaluated on a 0–100 scale 14 days after treatment. Each herbicide had its own untreated control. The treatments are listed in *Table 1*. Some of the herbicides tested are not authorised for use in seed production fields. These were the following: Isoxaflutole + Cyprosulfamide (Treatment 2), Nicosulfuron (7), though this active ingredient is authorised in some combinations, Topramezone + Dicamba (9) and Foramsulfuron + Isoxadifen-ethyl (10). It is important, however, to study the reactions of parental genotypes to all types of herbicides in order to prepare for the possibility of extreme cases where the level of weed infestation makes it imperative to apply them.

Table 1

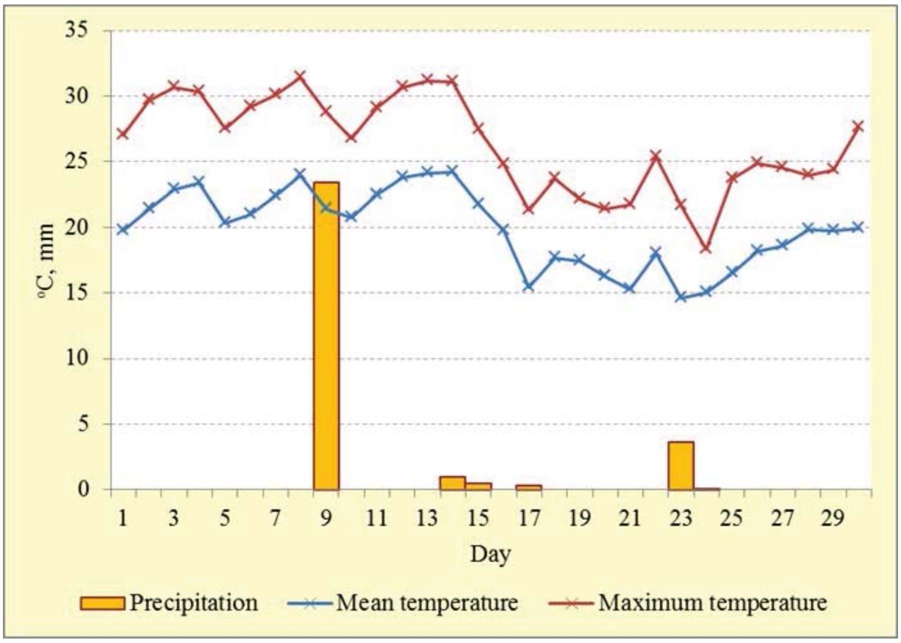
Treatments applied in the herbicide tolerance experiment, Martonvásár 2015

	Treatment	Dose (ml, g a.i. ha-1)	
		Normal	Double
	Control	-	-
1	Mesotrione + S-metolachlor + Terbutylazine	187.5 +1875 +625	375 +3750 + 1250
2	Isoxaflutole + Cyprosulfamide	105.6 + 105.6	211.2 + 211.2
3	Topramezone	50.4	100.8
4	Mesotrione + Terbutylazine	115 + 749.8	230 + 1499.6
5	Tembotrione + Isoxidifen-ethyl	99 + 47.5	198 +99
6	Mesotrione + Nicosulfuron	150 + 60	300 + 120
7	Nicosulfuron	48	96
8	Prosulfuron	15	30
9	Topramezone + Dicamba	50 + 160	100 + 320
10	Foramsulfuron + Isoxadifen-ethyl	56.25 + 56.25	112.5 +112.5

The weather in the 2015 growing season was characterised by rainfall deficiency. Up to the end of August, almost 100 mm less rain fell during the growing season than the 30-year mean. In June there was only 29 mm rainfall, which was less than half the 30-year mean (73 mm). The most important weather data for the spraying period are illustrated in *Figure 1*.

On June 3rd, when the pre-emergence herbicides were applied to maize plants in the 3–4-leaf stage, the daily mean temperature was close to 25°C, with a maximum of over 30°C. The 23 mm rain that fell within a week of the treatment facilitated the uptake of the herbicides through the roots. When the post-emergence herbicides were sprayed on June 16th and on the following days the daily mean temperature was less than 20°C and even the maximum temperatures were below 25°C (*Figure 1*).

Figure 1: **Major weather parameters at spraying and over the following days. Martonvásár, June 2015**



Scoring results were evaluated using two-factor analysis of variance (ANOVA).

RESULTS

Averaged over the 60 genotypes the extent of phytotoxic damage did not exceed 10% for the single doses, while the double doses of Treatments 6 and 10 (Mesotrione + Nicosulfuron and Foramsulfuron + Isoxadifen-ethyl) caused more severe damage, but still below 15% (*Figure 2*). Analysis of variance revealed highly significant differences (at the F=0.1% level) between both the herbicide and dose effects. Based on the MQ values (not shown) the herbicide dose influenced the intensity of the symptoms three times more than the type of herbicide (MQ=121.2 and MQ=40.71, respectively). Among the treatments, only for Treatment 3 (Topramezone) was there no significant difference between the normal and double doses (*Table 2*). The greatest differences in the dose effects were found in decreasing order for Treatments 6 (Mesotrione + Nicosulfuron, 8.81%), 10 (Foramsulfuron + Isoxadifen-ethyl, 8.80%), 7 (Nicosulfuron, 5.97%) and 4 (Mesotrione + Terbutylazine, 4.28%). Averaged over the genotypes, phytotoxic damage of below 1% was observed for the single doses of Treatments 1 (Mesotrione + S-metolachlor + Terbutylazine), 2 (Isoxaflutole + Cyprosulfamide), 3 (Topramezone), 8 (Prosulfuron) and 9 (Topramezone + Dicamba). The level of phytotoxicity was between 1 and 3% for Treatments 4 (Mesotrione + Terbutylazine), 5 (Tembotrione + Isoxadifen-ethyl) and 7 (Nicosulfuron), and above 3% for Treatments 6 (Mesotrione + Nicosulfuron) and 10 (Foramsulfuron + Isoxadifen-ethyl).

Figure 2: **Visible phytotoxic effects (%) of normal and double doses of herbicides two weeks after treatment in a maize herbicide tolerance experiment, averaged over 60 genotypes. Martonvásár, 2015**

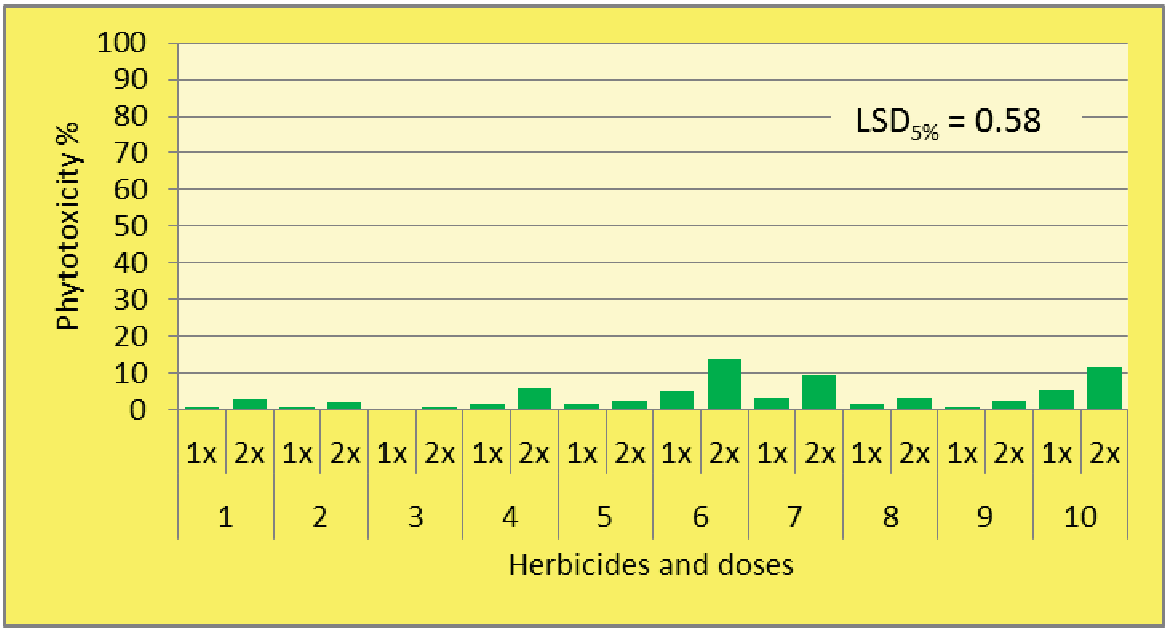


Table 2

Variance table for the herbicide tolerance experiment, Martonvásár, 2015

Herbicide	Dose		Mean	$LSD_{5\%}$
	1x	2x		
1	0.60	2.31	1.46	0.39
2	0.56	2.27	1.41	
3	0.00	0.55	0.28	
4	1.48	5.76	3.62	
5	1.27	2.33	1.80	
6	5.00	13.81	9.41	
7	2.75	8.73	5.74	
8	0.97	2.92	1.95	
9	0.25	2.22	1.24	
10	4.83	11.62	8.23	
Mean	1.77	5.25	3.51	0.23
$LSD_{5\%\ \text{between any treatments}}$	0.58			

The genotypes on which the normal herbicide doses exerted phytotoxic effects are shown in *Figures 3–9*. As can be seen in *Figures 3 and 4*, the two pre-emergence herbicides (Mesotrione + S-metolachlor + Terbutylazine and Isoxaflutole + Cyprosulfamide), applied when maize was in the 3–4-leaf stage, both caused mild yellowing symptoms on five different genotypes, but these disappeared later as the maize plants developed.

Figure 3: **Effect of treatment with the normal dose of the pre-emergence herbicide Mesotrione + S-metolachlor + Terbutylazine in the 3–4-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**

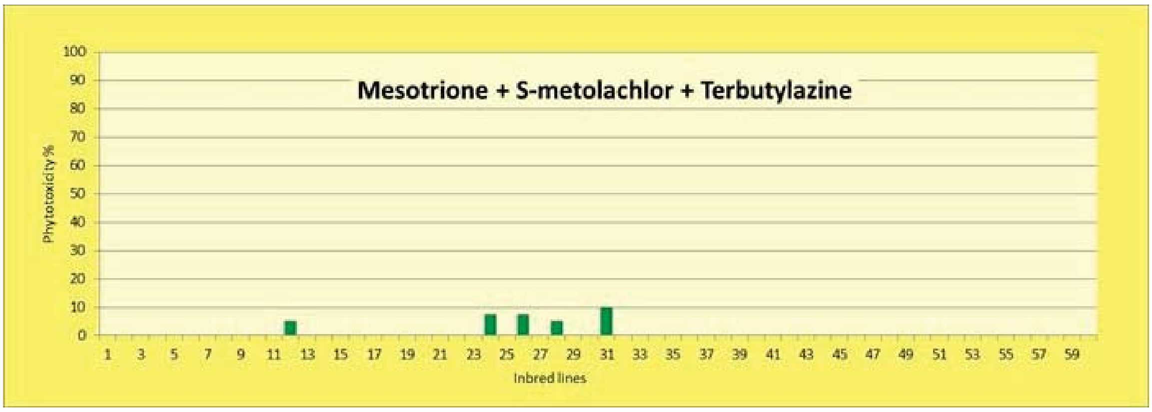
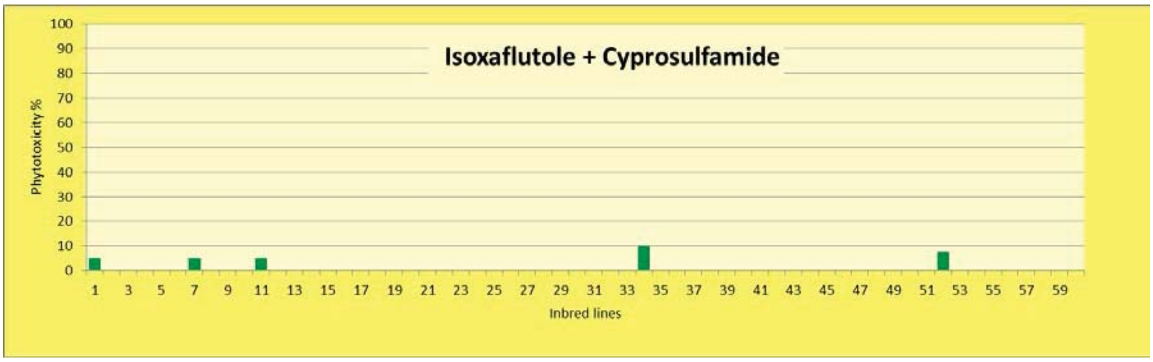


Figure 4: **Effect of treatment with the normal dose of the pre-emergence herbicide Isoxaflutole + Cyprosulfamide in the 3–4-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**



Among the post-emergence herbicides sprayed in the 7–8-leaf stage, Topramezone (Treatment 3) caused no symptoms on any of the lines, while Topramezone + Dicamba (Treatment 9) only led to very mild initial damage on two genotypes and Tembotrione + Isoxadifen-ethyl (Treatment 5) only produced intensive symptoms (around 40%) on two extremely herbicide-sensitive lines. (These results are not presented in separate figures.)

The active ingredient Mesotrione, a component in one of the pre-emergence herbicides, was also included in the experiment in two post-emergence combinations, the results of which are illustrated in *Figures 5 and 6*.

Figure 5: **Effect of the normal dose of Mesotrione + Terbutylazine applied in the 7–8-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**

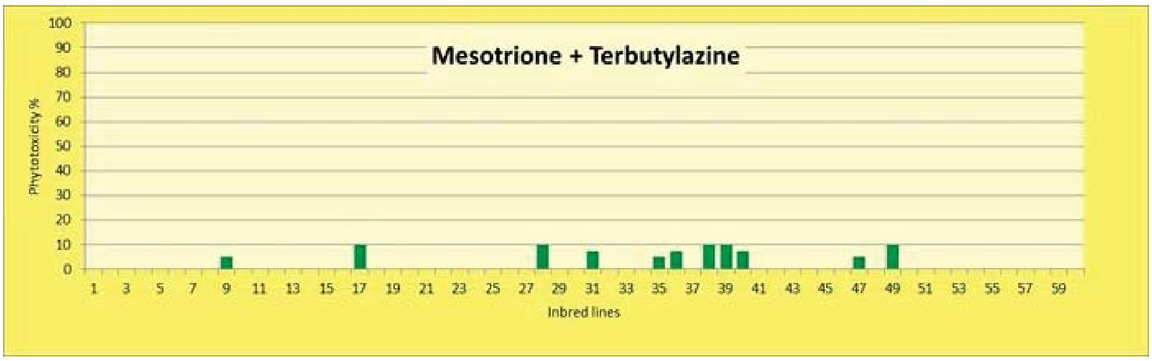
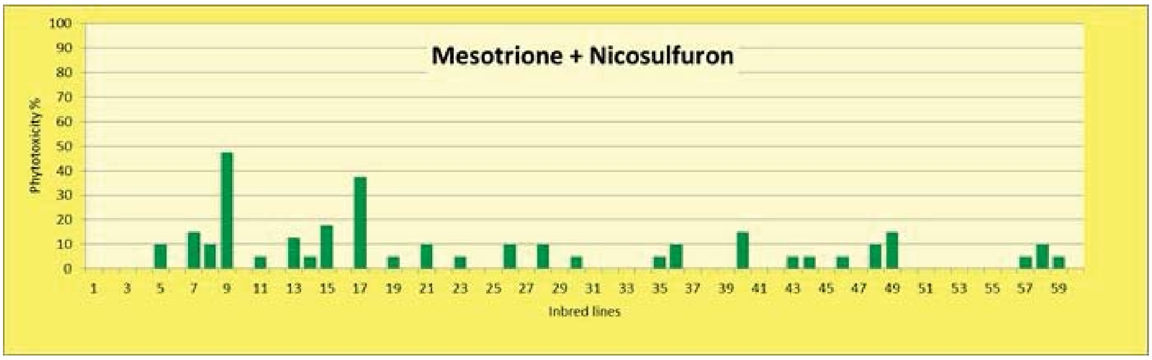
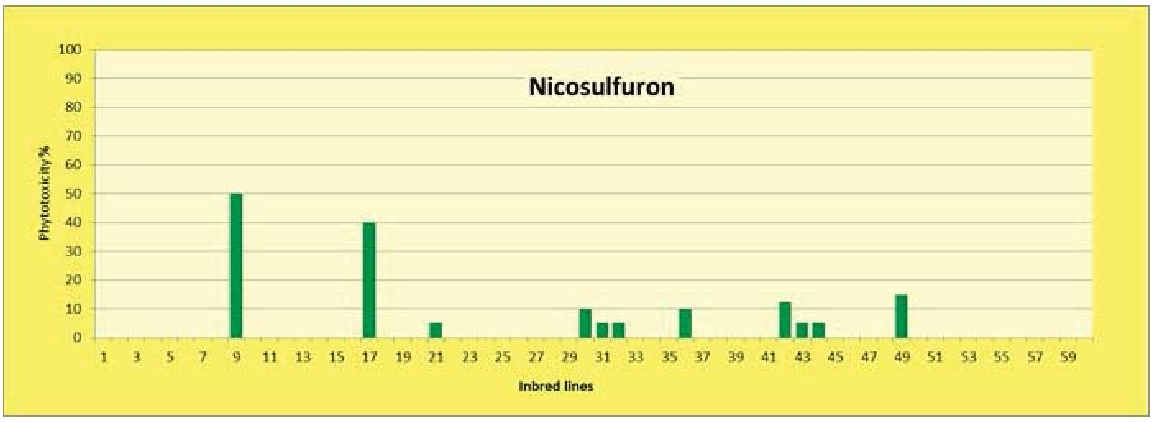


Figure 6: **Effect of the normal dose of Mesotrione + Nicosulfuron applied in the 7–8-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**



The Mesotrione + Terbutylazine combination only caused mild symptoms on a total of 11 genotypes, while the effect of the Mesotrione + Nicosulfuron could be observed as more severe phytotoxic symptoms on 26 of the lines. When Nicosulfuron was applied alone (Treatment 7) it produced milder symptoms on fewer genotypes than when combined with Mesotrione (*Figure 6* and *7*).

Figure 7: **Effect of the normal dose of Nicosulfuron applied in the 7–8-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**



Among the compounds of the sulphonamide-urea type (Nicosulfuron, Prosulfuron, Foramsulfuron + Isoxadifen-ethyl), Prosulfuron produced the least damage on the lowest number of genotypes. Altogether, Foramsulfuron + Isoxadifen-ethyl caused visible phytotoxic symptoms of varying intensity on 23 genotypes, Nicosulfuron on 11 and Prosulfuron on four (*Figure 7-9*).

Figure 8: **Effect of the normal dose of Prosulfuron applied in the 7–8-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**

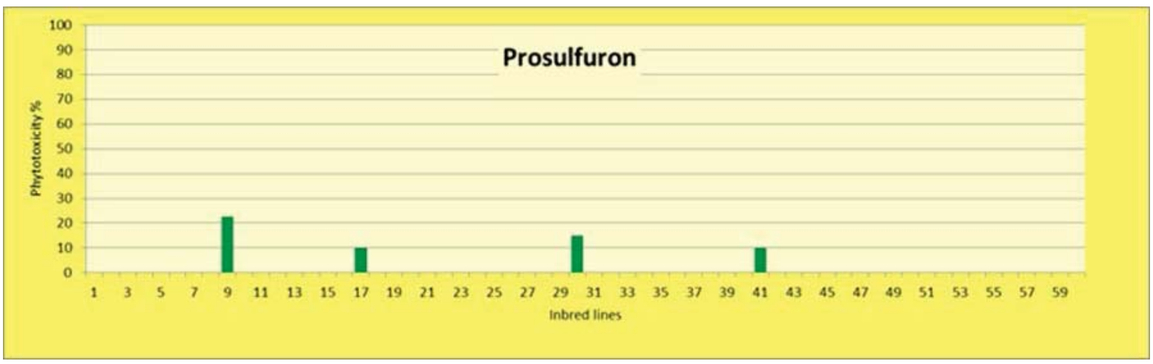
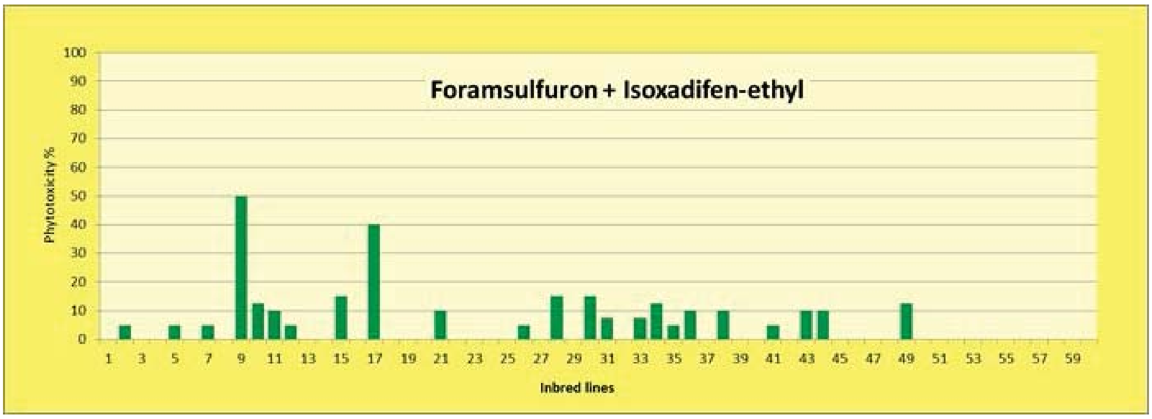


Figure 9: **Effect of the normal dose of Foramsulfuron + Isoxadifen-ethyl applied in the 7–8-leaf stage of maize, averaged over 60 parental genotypes from Martonvásár**



DISCUSSION

Only a third of the 60 parental genotypes from Martonvásár exhibited symptoms of varying intensity, while the majority did not react to any of the herbicide treatments. Averaged over the 60 genotypes, the phytotoxic damage did not exceed 10% in the case of the single dose, while the double quantity only caused more severe symptoms in the case of Mesotrione + Nicosulfuron and Foramsulfuron + Isoxadifen-ethyl, but even then the damage level was below 15%.

Analysis of variance indicated that the herbicide dose had three times as strong an influence on the severity of the symptoms as the type of herbicide. Among the treatments, only for Treatment 3 (Topramezone) was there no significant difference between the effects of the normal and double doses. The greatest dose effect differences were recorded in decreasing order for Mesotrione + Nicosulfuron, Foramsulfuron + Isoxadifen-ethyl, Nicosulfuron and Mesotrione + Terbutylazine.

The Mesotrione + Terbutylazine combination only caused mild (<10%) symptoms on a total of 11 genotypes, while the Mesotrione + Nicosulfuron combination caused more severe phytotoxicity on 26 lines. When applied alone, Nicosulfuron induced milder symptoms on fewer genotypes than in combination with Mesotrione.

Among the compounds of the sulphonamide-urea type, Prosulfuron caused the least damage on the lowest number of genotypes.

REFERENCES

Berzsenyi, Z. - Győrffy, B. - Árendás, T. - Bónis, P. - Lap, D. Q. (1997): Studies on the phytotoxicity of herbicides in maize (*Zea mays* L.) as affected by temperature and antidotes. Acta Agron. Hung. 45, 443-448.

Bónis, P. - Árendás, T. - Berzsenyi, Z. - Marton, L. C. (2004): Herbicide tolerance studies on maize inbred lines. Z. PflKrankh. PlfSchutz, Sonderh. 19, 901–907.

Bónis, P. – Árendás, T. – Berzsenyi, Z. - Marton L. C. (2011): Kukorica genotípusok herbicid toleranciájának változása aszályos és csapadékos évjáratokban. Changes in the herbicide tolerance of maize genotypes in wet and dry years. Acta Agraria Debreceniensis 43, 124-127.

Bónis, P. - Árendás, T. - Szőke, C. - Micskei G. - Marton L. C. (2013): Posztemergens kukorica gyomirtó szerek fitotoxikus hatása kukorica törzsekre rendkívül aszályos évjáratban. (Phytotoxic effect of post-emergence herbicides on maize line sin an extremely dry year.) Agrártudományi Közlemények 53, 71-74.

Eberlein, C.V. - Rosow, K. M. - Geadelmann, J. L. - Openshaw, S. J. (1989): Differential tolerance of corn genotypes to DPX-M6316. Weed Sci. 37, 651-657.

Green, J. M. (1998): Differential tolerance of corn (*Zea mays*) inbreds to four sulfonylurea herbicides and bentazon. Weed Technology 12, 474–477.

Green, J. M. - Ulrich, J. F. (1993): Response of corn (*Zea mays*) inbreds and hybrids to sulfonylurea herbicides. Weed Science 41, 508–516.

Green, J. M. - Ulrich, J. F. (1994): Response of maize (*Zea mays*) inbreds and hybrids to rimsulfuron. Pestic. Science 40, 187-191.

Harms, C. T. - Montoya, A. L. - Privalle, L. S. - Riggs, R. W. (1990): Genetic and biochemical characterization of corn inbred lines tolerant to sulfonylurea herbicide primisulfuron. Theor. Appl. Genet. 80, 353-358.

Kang, M. S. (1993): Inheritance of susceptibility of nicosulfuron herbicide in maize. J. Heredity 84, 216-217.

Shimabukuro, R. H. - Frear, D. S. - Swanson, H. R. - Walsh, W. C. (1971): Glutathione conjugation - an enzymatic basis for atrazine resistance in corn. Plant Physiology 47, 10-14.

Widstrom, N. W. - Dowler C. D. (1995): Sensitivity of selected field corn (*Zea mays*) to nicosulfuron. Weed Technology 9, 779-782.

Woolly cupgrass (*Eriochloa villosa* /Thunb./ Kunth), a recently occured invasive weed in Trans-Tisza Region and a trial for control in maize

Arnold Szilágyi[1] – Zoltán Balogh[2] – István Dávid[1] – László Szabó[3] – László Radócz[1]

[1]University of Debrecen, Plant Protection Institute, Debrecen, Hungary
[2]Hungarian Plant Protection Service of the Ministry of Agriculture, Miskolc, Hungary
[3]Hungarian Plant Protection Service of the Ministry of Agriculture, Debrecen, Hungary
szilagyi.arnold@agr.unideb.hu

Summary:

*To the effective control of invasive weeds are essential to prevent establish, if has already happened obstacle to massive accumulation, and promoting the efficient and rapid eradication, if it is possible. The Woolly cupgrass (*Eriochloa villosa */Thunb./ Kunth) belongs to weeds which "hard to control" especially in corn. One of the difficulties of effective control is the prolonged emergence causing avoidance of several individuals the contact with pre-emergent herbicides. Another problem arises due to the intensive use of post-emergence herbicide products with short duration of action. To optimalize of timing of treatment is essential for successful control of later emerging weeds. The recently established Woolly cupgrass in Hungary shows resistance or reduced susceptibility to substantial portion of herbicides used in corn. The data collected from small-plot trials demonstrates that application of sulfonylurea or selective monoctyledonous herbicides can be effective against the Woolly cupgrass.*

Keywords: Wooly cupgrass, *Eriochloa villosa*, weed control, selective herbicides, maize, corn

Introduction

The number of weed species affect agricultural production is around 6700. About 200 weed species cause significant problems for crop production worldwide. The accumulation and spread of weeds highly affected by the effectiveness of applied weed control technology in a certain area. Increasing number of new weed species have appeared in Hungary such as Woolly cupgrass (*Eriochloa villosa* /Thunb./ Kunth). Changes in weed flora elements, appearance of new species can be influenced by:

- changes in farming systems and tillage depth. These can highlight those weed species which are less tolerant for disturbances.
- introduction of non native species by seed, feed, and food trade, transport, stuck in vehicles etc).
- climate change contribution to increase frost-free periods resulting extension of growing season especially for the warm-loving weeds (Szőke, 2001).

The Woolly cupgrass (*Eriochloa villosa* /Thunb./ Kunth) is widespread in Eastern Europe. Its propsed Hungarian name is 'ázsiai gyapjúfű'. The plant distribution in the temperate zones of Asia, Caucasus, Russia's Far Eastern region, Iran, Japan, China, Taiwan, Korea and Vietnam is common (Tsvelev, 1984). In several states of the United States and Canada was also released. The species has been found in France, Ukraine, Romania and Hungary (*Figure 1*). The first report about observations was made by János Madarász and Péter Partosfalvi on the 5th (Hungarian) National Weed Surveys in 2007. Partosfalvi *et al.* (2008) gave an account of occurence of Woolly cupgrass on 25 July 2007, near Gesztely village (North Hungary). Balogh and Novák (2014) shortly reported about spreading of Wooly cupgrass in the northern region and about a herbicide control trial. It is suggested to control in sunflower culture by cycloxydim, a special monocot herbicide which proved proper effectiveness. The Wooly cupgrass plants were also observed in Debrecen (East Hungary) in 2011 on agricultural fields (*Figure 2* and *Table 1*) by László Szabó and István Dávid (unpublished), too.

The proper identification of *Eriochloa villosa* was confirmed by a grass weed specialist, Prof. Hildemar Scholz (1928-2012).

The Woolly cupgrass belongs to the well adaptable plant species. The Hungarian climate elements provide good conditions for this recently appeared weed. Its favourable conditions are 10-11°C average annual temperature, 550-600 mm average annual rainfall, and an average of 5.5-6.5 soil pH (Fărcăşescu *et al.*, 2008). The optimum germination temperature for most of the weeds is between 20-35°C (Bello *et al.*, 2000). The germination of Woolly cupgrass starts in mid-April in Hungary. The mass hatching period is followed by a second minor germination peak. Hence, the emergence fully extended, which makes it difficult to control. The ripening of grain yield starts in August and begin to achieve its distribution by animals and human activities. The Woolly cupgrass is classified as a T4 group plant according to the Ujvárosi' weed plant life system.

Woolly cupgrass gets its name from the hairs covering many parts of the plant. It is a 30-200 cm annual grass with dark green and densely hairy leaves that have a velvety feel. Only one edge of the leaf blade is typically crinkled, and the flowering branches are also one-sided (*Figure 3*). The Woolly cupgrass impairs corn, sunflower, soybean areas and stubble-fields.

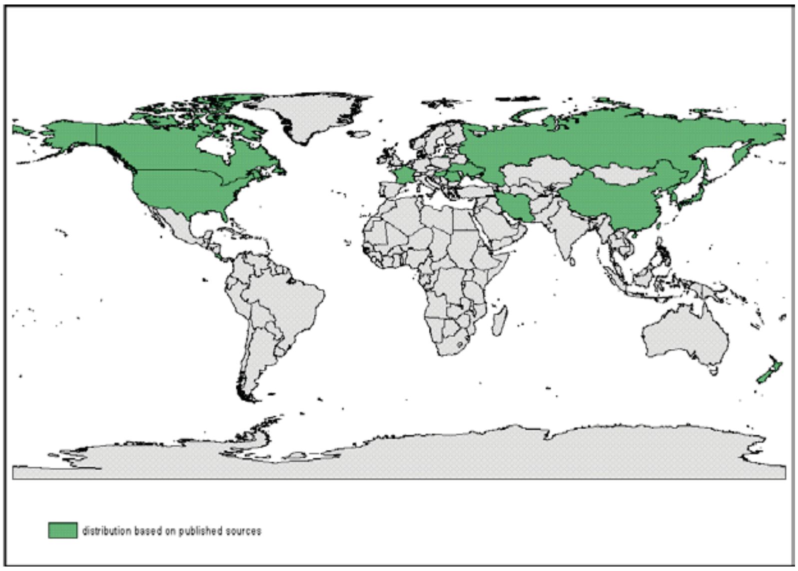


Figure 1: **Distribution of Woolly cup grass worldwide** (Source: http://www.q-bank.eu/Plants/BioloMICS.aspx?Table=Plants%20-%20Species& Rec=971&Fields=All)

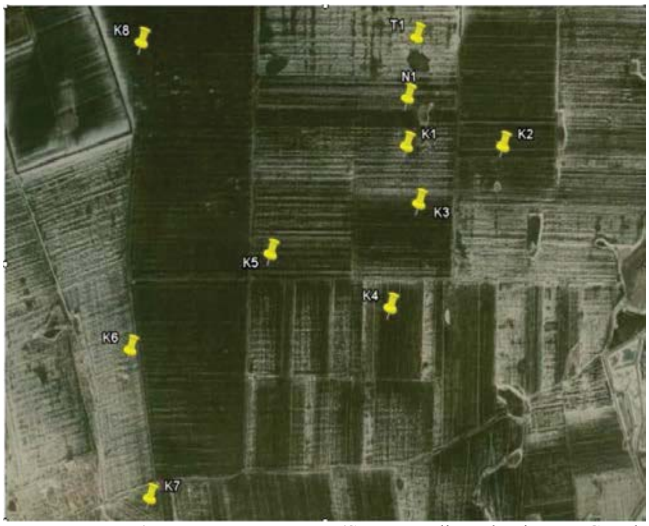


Figure 2: **The Woolly cupgrass has been sprading around Debrecen** (Source: Indicated points on Google-Earth picture by Somogyi *et al*., 2011)

K1 – Maize 1, K2 – Maize 2, K3 – Maize 3, K4 – Maize 4, K5 – Maize 5, K5 – Maize 6, K7 – Maize 7, K8 – Maize 8,
N1 – Sunflower 1, T1 – Stubble-field 1

Table 1

The dense of Wooly cupgrass on surrounding arable areas of Debrecen, 2011

	Wooly cupgrass observations on maize fields, Debrecen district, and its proportion in weeds (%)							
	K1	K2	K3	K4	K5	K6	K7	K8
Infection of *Eriochloa villosa* on the maize field	71	0	2.3	0	0.2	0	0.5	0
Infection of *Eriochloa villosa* on ruderal areas	71	2	3	4	2	0.5	0.5	0.5

(Source: Somogyi *et al*., 2011)

B/

A/

Figure 3: **Woolly cupgrass inflorescence branch (A/), infesting the edge of a corn field (B/)** (Sources: A: Szilágyi, 2015; B: http://www.inspection.gc.ca/plants/plant-protection/invasive-plants/fact-sheets/woolly-cupgrass/eng/1331822413731/1331822996178)

MATERIALS AND METHODS

A small-plot herbicide experiment was performed at Gesztely outskirts in 2015. The measurements of the plots: 2 m wide and 10 m long. The plots of nine post-emergent herbicide treatments and untreatment ones were designed in randomized block in 4 repetitions. The maize field was totally infested by Wooly cupgrass. The coordinates of trial the follows in UTM system:

1. 48^{o}12’80.63” 20^{o}99’34.63”
2. 48^{o}12’80.92” 20^{o}99’36.78”
3. 48^{o}12’65.81” 20^{o}99’38.92”
4. 48^{o}12’65.95” 20^{o}99’40.86” (*Figure 4*).

The maize hybrid was the Focus Ultra (cycloxydim) resistant, calls Duo System. The spraying of plots was made on 08 June 2015 by a special plot sprayer.

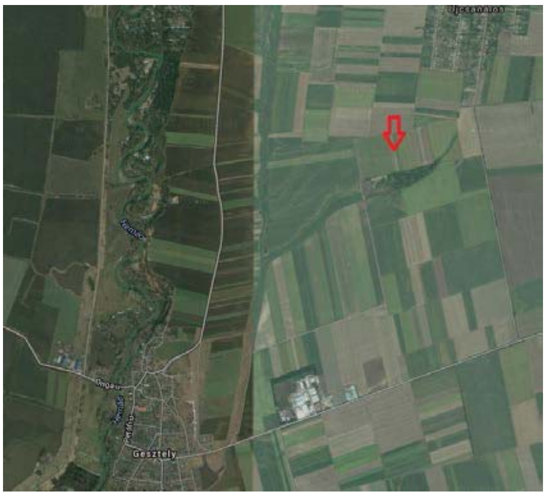


Figure 4: Place of small plot trial next to Gesztely, 2015 (Source: Google Earth)

RESULTS

The effectiveness of post-emergent herbicide treatments is shown in the *Table 2*. The most of herbicides which generally used in maize production reached weak or very poor rating. So those areas, which heavy infested by Wolly cupgrass, there are very important to apply a wide range of weed control. Because of weak effectiveness of post-emergent herbicides, it sholud be reasonable to find effective pre-emergence herbicides, which could suppress the emergence of the first wave of weeds including Wooly cupgrass. The post-emergent herbicides can push back the late germinating Wolly cupgrass with weak effectiveness only.

Table 2

Effectiveness of herbicide treatment in maize (Gesztely, 2015)

Treatments (Number)	Active substances	Dose	Effectiveness	
		(kg/ha, l/ha, %)	%	Textually
1	***nicosulfuron*** dicamba	1.5 0.6	71	weak
2	***nicosulfuron*** dicamba ethoxylated isodecyl alcohol	1.5 0.6 0.3	83	weak
3	***nicosulfuron*** + rimsulfuron dicamba ethoxylated isodecyl alcohol	0.09 0.6 0.3	65	very weak
4	mesotrione + nicosulfuron+ prosulfuron dicamba modified trisiloxane + polyester	2 0.017 0.6 0.2	85	weak
5	nicosulfuron dicamba plant oil fatty acid methyl ester (FAME) + etoxylated alcohols + alkyl polyglykoside citrate	0.25 0.6 0.6	67	very weak
6	foramsulfuron + thiencarbazone-methyl + ciprosulfamid dicamba	2.0 0.6	50	very weak
7	topramezon dicamba methyil oleate+ methyl palmitate	0.15 0.6 1.2	56	very weak
8	tembotrion + thiencarbazone-methyl + izoxadifen-ethyl dicamba demetilated rape oil	0.44 0.6 2.0	62	very weak
9	sulcotrione dicamba	2 0.6	45	very weak

CONCLUSIONS

The Wooly cupgrass is a new invasive weed species in Hungary, which was detected at the first time in Gesztely (North-Hungary) in 2007, then it occurred the outskirts of Debrecen (East-Hungary) in 2011. The main objective of the herbicide trial was to find an effective herbicide against Woolly cupgrass in maize culture. On the base of foreign literature the use of sulphonylureas, including nicosulfuron proved to be weak but acceptable effectiveness (65-85%). The mesotrione + nicosulfuron + prosulfuron + dicamba + trisiloxane added with modified polyester herbicide mixture achieved the best results with a 85% efficiency. The most effective defense preemergence and postemergence according to a combination only defense, because of the delayed emergence.

By avoidance of monocultural maize production practice and keeping a four-five-year crop rotation successfully can be avoid the Woolly cupgrass accumulation in soils. In dicotyledonous cultures the application of cycloxydim active substance can also be effective that inhibits the acetylcoenzyme A carboxylase (ACCase) in chloroplasts of sensitive weeds.

The ruderal areas play role in the maintenance of Woolly cupgrass producing many seeds to survive and spread.

REFERENCES

Balogh, Z. and Novák, R. (2014): Adatok az ázsiai gyapjúfű (*Eriochloa villosa*) Borsod-Abaúj-Zemplén Megyei terjedéséhez és az ellene való védekezés lehetőségeihez. NTN 2014, Abstracts 79.

Bello, I.A. - Hatterman-Valenthi, H. – Owen, M.D.K.(2000): Factors affecting germination and seed production of *Eriochloa villosa*. Weed Science 48: 749-754.

Ciocarlan, V. – Sike, M. (2006): *Eriochloa villosa* (Thunb.) Kunth (Poaceae) in the Romanian flora. Journal of Plant Development 13: 105-107.

Fărcăşescu, A.M. – Arsene, G.G. – Neacsu, A.G. (2008): *Eriochloa villosa* (Thunb.) Khunt - a new invasive weed in Romania. Journal of Plant Diseases and Protection, Special Issue 21: 333-334.

Hinz, J.R.R. – Owen, M.D.K. – Barrett, M. (1997): Nicosulfuron, primisulfuron, and bentazon hydroxylation by corn (*Zea mays*), woolly cupgrass (*Eriochloa villosa*), and shattercane (*Sorghum bicolor*) cytochrome P-450. Weed Science 45: 474-480.

Mickelson, J.A. - Midhtun-Hensen, A. - Harvey, R.G. (2004): Fate and persistence of woolly cupgrass (*Eriochloa villosa*) seed banks. Weed Science 52: 346-351.

Partosfalvi, P. - Madarász, J. - Dancza, I. (2008): Occurrence of *Eriochloa villosa* (Thunb.) Kunth in Hungary. Növényvédelem 44(6): 304.

Somogyi N. - Szabó L. - Dávid I. (2011): Az ázsiai gyapjúfű (*Eriochloa villosa* /Thunb./ Kunth) megjelenése Hajdú-Bihar megyében. Agrártudományi Közlemények 2011/43: 119-123.

Szőke, L. (2001): A melegigényes gyomfajok gyors terjedése és a klímaváltozás összefüggése. Növényvédelem 37(1): 10–12.

Tsvelev, N.N. (1984): Grasses of the Soviet Union. Vol –II. transl. Balkema, A.A., Rotterdam. (Russian translations series No. 8) pp. 1196.

Pest species of Macrolepidoptera in the Game Reserve of Velyka Dobron' (Transcarpathia, Ukraine)

Szabolcs Szanyi[1] **– Antal Nagy**[2] **– Attila Molnár**[3] – Miklós **Tóth**[4] **– Zoltán Varga**[1]
[1]Department of Evolutionary Zoology, University of Debrecen, Hungary
[2]Institute of Plant Protection, University of Debrecen, Hungary
[3]Department of Biology and Chemistry, Ferenc Rákóczi II. Transcarpathian Hungarian Institute, Beregszász, Ukraine
[4]Plant Protection Institute, CAR HAS, Budapest, Hungary
szanyiszabolcs@gmail.com

SUMMARY

The Game Reserve of Nagydobrony extends on a marginal area of a former peatland and is covered with extended hardwood gallery forests and oak-hornbeam forests and is surrounded by a mosaic-like agricultural landscape. Due to its richness of nature-like and semi-natural habitats it supports a diverse insect assemblage. By light and bait trapping 383 species of macro-moths were recorded from which larvae of 85 species are feeding either on forest trees and scrubs or on cultivated plants thus these can be considered as potential pest species. Thirteen species (mostly Geometridae and Erebidae: Lymantriinae) have a special significance for forestry due to defoliating activity in gradation periods. Considering the habitat connections, the composition of moth assemblage is dominated by generalist species with broad spectrum of ecological tolerance but the species connected with humid forested habitats are also richly represented. The bulk of species consists of widely distributed Euro-Siberian species, but also some Holo-Mediterranean species with more southern character and Mediterranean-Subtropical migrant species were registered. The bait trapping provided significant results on the phenology of the dominant species. The faunistically significant and/or protected species were observed in a low number of individuals only, thus the applied trapping methods did not damage the faunal composition.

Keywords: Macrolepidoptera, light trapping, bait traps, pest species, ecological spectrum, phenology

INTRODUCTION

The Bereg plain is located on the north-eastern edge of the Hungarian Great Plain. It is crossed by the Hungarian-Ukrainian border, and joining to the Transcarpathian lowland through the Chop-Munkachevo basin. Because of the traditional agriculture, a typical mosaic pattern of landscape structure was formed here. Some parts of the lowland are still rich in forests and wetlands (Simon, 1952). Owing to the position within the Carpathian basin, the region forms biogeography a transition between the Pannonicum and Carpathicum (Deli *et al.*, 1997; Magura *et al.*, 1997; Ködöböcz and Magura, 1999; Varga, 2003). Transcarpathia is one of the richest areas in Ukraine in terms of natural resources. Half of the vascular plants of Ukraine can be found there (Hrihora-Szolomaha, 2005). The entomofauna of the Hungarian part of the plain is relatively well studied, but most of the Ukrainian part was never surveyed by entomologists. Therefore our surveys are somewhat pioneering, even if these are aimed to well-known insect groups.

The area has the lowest temperature (the annual average: 8-9ºC), and highest amount of precipitation (609 mm in average) on the Great Plain, and simultaneously one of the most continental climate regions of the Carpathian basin (Simon, 1952). The relatively humid continental climate has allowed a nearly continuous afforestation of the Bereg lowland, dominated by pedunculate oak, hornbeam-oak and hardwood (oak-ash-elm) gallery forests. However, the percent of forest cover seriously declined to about 15% due to deforestation. These forests were mostly replaced by extended agricultural lands. The livelihood of majority of the human population is based on the agricultural production. The remaining forest areas were also increasingly used by logging and plantation of non indigenous trees, therefore most of these forest aren't in their natural state, but some of them is nearly natural. This mosaic landscape structure leads to very rich vegetation, which supports the high diversity of local insect fauna. The insect assemblages also include a lot of pest species too.

The Game Reserve of Nagydobrony (Velyka Dobron') belongs to the most valuable ones among the natural forests of Bereg plain, although its environmental condition should be regularly monitored with appropriate methods. The identification of forestry pest species is one of these primary tasks, including the surveillance of their population dynamics. Among the insect groups which can be collected by light, the nocturnal macro-moths are the richest in species, and also the most suitable herbivore group for the characterization of the condition of forest habitats (Kitching *et al.*, 2000; Truxa, 2013). The long term data set (2009-2014) of light-trap surveys was used for this study, supplemented by bait trap results (in the summer of 2014), carried out in Game Reserve of Nagydobrony (Velyka Dobron'). All species were characterized by their zoogeographical character (faunal elements) and connection to habitat and food plant type (as faunal components). The observed species were also characterised according to their phenological character (voltinism, swarming period of moths).

MATERIALS AND METHODS

The description of the study area

The Game Reserve of Nagydobrony (Velyka Dobron') is located on the marginal area of the former Szernye-bog. Although the ancient vegetation and flora of the bog was very rich and valuable, the most important relict habitats and species became extinct. There are some fragments which still keep some species typical for marshy-boggy habitats. The most extended habitat type of the reserve is the oak-ash-elm hardwood gallery forest (Fraxino-pannonicae-Ulmentum) with closed canopy layer. The canopy coverage is between 70-100%. The dominant tree species of these habitats are: *Quercus robur, Fraxinus angustifolia* subsp. *pannonica, Ulmus laevis, Populus canescens*, etc. The lowland pedunculate oak-hornbeam forest (Circaeo-Carpinetum) is considered as the climax association of the region, which is zonal association in the higher regions. Other components of the nature-like and semi-natural vegetation are the more xerophilous silver lime – oak forests and forest fringes, the mesic and humid forest clearings and willow scrubs. The reserve is surrounded by extended agricultural areas and dissected by drainage channels of the former peatland.

Methods

The investigation of nocturnal macrolepidoptera species was started in 2009. The samplings were carried out by light-trapping, which is the most commonly used method for similar purposes. This method is based on the positive phototaxis of the target group. A mercury vapour lamp (250 W) combined with a large white sheet (4x3 m, in 1.5 m elevation) was used for collecting the moths.

Because the light trapping was highly affected by external environmental factors, bait traps were placed out, which contained different scent baits. These investigations were conducted in 2014. CSALOMON® VARL+ funnel traps (MTA ATK Plant Protection Institute, Budapest Hungary) were placed out baited with synthetic compounds previously isolated and identified from fermenting bait liquids (= FERM) (Landolt, 2000) or with synthetic floral compounds (= FLORAL), which was previously isolated and identified from the flower scent of several plants (for a review refer to Knudsen *et al*, 1993). Traps without baits were also set out for control.

Polypropylene tubes with 4 ml capacity were used as dispensers for the FERM bait (Tóth *et al*., 2015). The synthetic compounds were administered on the dental rolls inside the tubes. The upper, larger opening of the tube was closed. The bait mixture could evaporate across the smaller opening with 4 mm diameter, which was opened when setting out in the field. The attractant contained iso-amyl alcohol, acetic acid and red wine (1: 1: 1; 3 ml). The wine was prepared (cellary of Dr. G. Vörös) by processing of different grape sorts: Bluefrankish (70%), Merlot (15%), Kadarka (7,5%) and Blauburger (7,5%). Its alcohol content was 13.6-13.8 %, the volatile acid (acetic acid) content was 0.4-0.6 g/l. Traps with the FLORAL lure were baited with two separate polyethylene bag dispensers (Tóth *et al*., 2002). One of the dispensers contained the mixture (1:1:1, 0.6 ml) of phenylacetaldehyde, eugenol and benzyl acetate, while the second dispenser contained a mixture (1:1, 0,4 ml) of phenylacetaldehyde and trans-anethol.

All bait trap types were exposed in four repetitions, i.e. 4*3 traps were placed in the survey area on trees, in 20 m distance from each other, at 1.8-2 m elevations. The traps were placed to trees which were situated in the edge of a sampling site. To avoid positional effects of different trap positions, the traps were rotated between locations at each inspection. The traps were operated between 20th July and 19th October. The trapped moths were killed by an insecticide strip. They were emptied once in a week. The collected material was stored deep-frozen until identification.

The Noctuoidea taxa were identified according to the works of Kádár *et al*. (2010), Mészáros and Szabóky (2012), but mostly Varga *et al*. (2011). For the nomenclature and characterization of species the book „Magyarország Nagylepkéi" (Varga /ed./ 2011) was used. For the selection of pest species the publications of Szabóky and Leskó (1999) and Both *et al*. (2012) were used. For the fauna element and component information the 3rd volume of „A Magyar Állatvilág Fajjegyzéke" (Varga *et al*. 2004, Macrolepidoptera) was used.

RESULTS AND DISCUSSION

During the investigation 383 nocturnal macrolepidoptera species were identified. Within that there were 85 potential forestry and agricultural pest species (65 were collected by light trapping only, 18 with both methods, and 2 just with bait trapping) (*Table 1*). Among them there were 13 species (bold) which already caused serious damages in some forests of the Bereg lowland.

The quantitative information coming from bait trapping is very preliminary only, thus it may not represent fully the ratio of potential pest species.

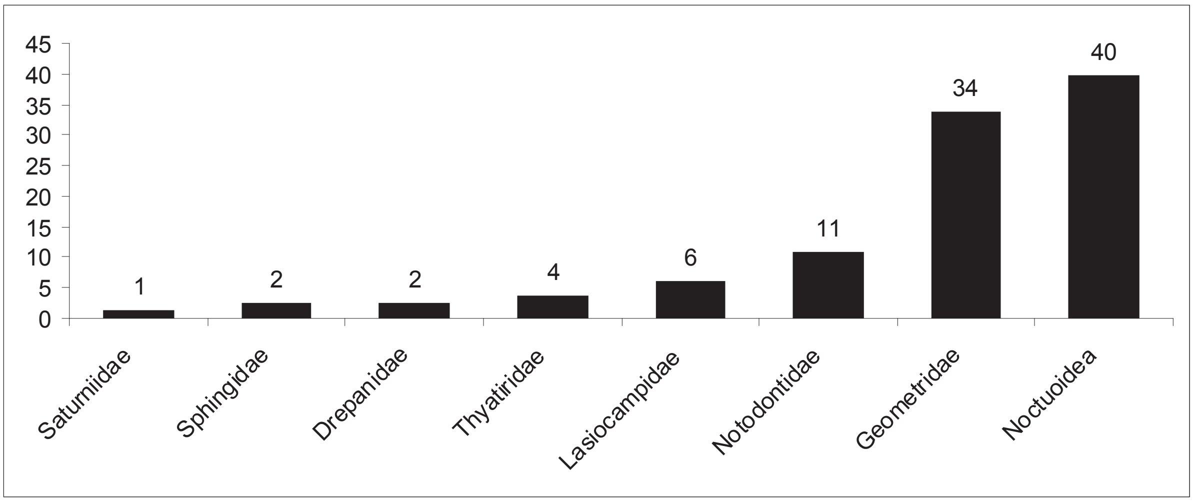
Table 1

The list of pest species (A – light trap; B – bait trap with semisynthetic and synthetic attractants)

SPECIES	A	B	SPECIES	A	B
LASIOCAMPIDAE			NOTODONTINAE		
Malacosoma neustrium (Linnaeus, 1758)	+		*Furcula bifida* (Brahm, 1787)	+	
Poecilocampa populi (Linnaeus, 1758)	+		*Stauropus fagi* (Linnaeus, 1758)	+	
Trichiura crataegi (Linnaeus, 1758)	+		*Drymonia ruficornis* (Hufnagel, 1767)	+	
Lasiocampa quercus (Linnaeus, 1758)	+		*Pheosia tremula* (Clerck, 1759)	+	
Gastropacha quercifolia (Linnaeus, 1758)	+		*Spatalia argentina* ([Den. et Schiff.], 1775)	+	
SPHINGIDAE			*Ptilodon capucina* (Linnaeus, 1758)	+	
Laothoe populi (Linnaeus, 1758)	+		*Ptilophora plumigera* ([Den. et Schiff.], 1775)	+	
Mimas tiliae (Linnaeus, 1758).	+		*Phalera bucephala* (Linnaeus, 1758)	+	
SATURNIIDAE			***Clostera anastomosis*** (Linnaeus, 1758)	+	
Saturnia pyri ([Den. et Schiff.], 1775)*	+		EREBIDAE		
DREPANIDAE			*Scoliopteryx libatrix* (Linnaeus, 1758)	+	+
Drepana falcataria (Linnaeus, 1758)	+		***Lymantria dispar*** (Linnaeus, 1758)	+	
Watsonalla binaria (Hufnagel, 1767)	+		*Lymantria monacha*(Linnaeus, 1758)	+	
THYATIRIDAE			***Euproctis chrysorrhoea*** (Linnaeus, 1758)	+	
Thyatira batis (Linnaeus, 1758)	+	+	***Sphrageidus similis*** (Fuessly, 1775)	+	
Tethea or ([Den. et Schiff.], 1775)	+	+	*Orgyia antiqua* (Linnaeus, 1758)	+	
Habrosyne pyrithoides (Hufnagel, 1766)	+	+	*Arctornis l-nigrum* (Müller, 1764)	+	
GEOMETRIDAE			***Leucoma salicis*** (Linnaeus, 1758)	+	
Cyclophora linearia (Hübner, 1799)	+		*Spilarctia lutea* (Hufnagel, 1766)	+	
Chlorochlysta siterata (Hufnagel, 1767)	+		*Spilosoma lubricipedum* (Linnaeus, 1758)	+	
Dysstroma truncata (Hufnagel, 1767)	+		***Hyphantria cunea*** (Drury, 1773)	+	
Epirrita dilutata ([Den. et Schiff.], 1775)	+		*Arctia caja* (Linnaeus, 1758)	+	
Operophtera brumata (Linnaeus, 1758)	+		*Lithosia quadra* (Linnaeus, 1758	+	+
Chloroclystis v-ata (Haworth, 1809)	+		*Catocala fraxini* (Linnaeus, 1758)		+
Abraxas grossulariata (Linnaeus, 1758)	+		*Nycteola asiatica* (Krulikovsky, 1904)	+	
			NOCTUIDAE		
Lomaspilis marginata (Linnaeus, 1758)	+		*Autographa gamma* (Linnaeus, 1758)	+	+
Macaria liturata (Clerck, 1759)	+		*Colocasia coryli* (Linnaeus, 1758)	+	
Chiasmia chlathrata (Linnaeus, 1758)	+		*Acronicta megacephala* ([Den. et Schiff.], 1775)		+
Plagodis dolabraria (Linnaeus, 1767)	+		*Acronycta rumicis* (Linnaeus, 1758)	+	+
Epione repandaria (Hufnagel, 1767)	+		*Heliothis peltigera* ([Den. et Schiff.], 1775)	+	
Ennomos quercinaria (Hufnagel, 1767)	+		*Helicoverpa armigera* (Hübner, 1808)	+	+
Selenia dentaria (Fabricius, 1775)	+		*Phlogophora meticulosa* (Linnaeus, 1758)	+	+
Colotois pennaria (Linnaeus, 1761)	+		***Cosmia trapezina*** (Linnaeus, 1758)	+	+
Apocheima hispidaria ([Den. et Schiff.], 1775)	+		*Conistra vaccinii* (Linnaeus, 1761)	+	+
Lycia hirtaria (Clerck, 1759)	+		*Agrochola circellaris* (Hufnagel, 1766)	+	+
Biston betularius (Linnaeus, 1758)	+		*Mamestra brassicae* (Linnaeus, 1758)	+	
Biston strataria (Hufnagel, 1767)	+		*Lacanobia suasa* ([Den. et Schiff.], 1775)	+	+
Agriopis marginaria (Borkhausen, 1777)	+		*Lacanobia oleracea* (Linnaeus, 1758)	+	+
Agriopis aurantiaria (Hübner, 1799)	+		***Orthosia cruda*** ([Den. et Schiff.], 1775)	+	
Erannis defoliaria (Clerck, 1759)	+		*Orthosia gothica* (Linnaeus, 1758)	+	
Peribatodes rhomboidaria ([Den. et Schiff.], 1775)	+		*Agrotis exclamationis* (Linnaeus, 1758)	+	+
Hypomecis roboraria ([Den. et Schiff.], 1775)	+		*Agrotis segetum* ([Den. et Schiff.], 1775)	+	+
Hypomecis punctinalis (Scopoli, 1763)	+		*Agrotis ipsilon* (Hufnagel, 1766)	+	
Ectropis crepuscularia ([Den. et Schiff.], 1775)	+		*Noctua pronuba* (Linnaeus, 1758)	+	+
Cabera pusaria (Linnaeus, 1758)	+		*Xestia c-nigrum* (Linnaeus, 1758)	+	+
Campaea margaritata (Linnaeus, 1767)	+				

[*Den. et Schiff. = Denis and Schiffermüller]

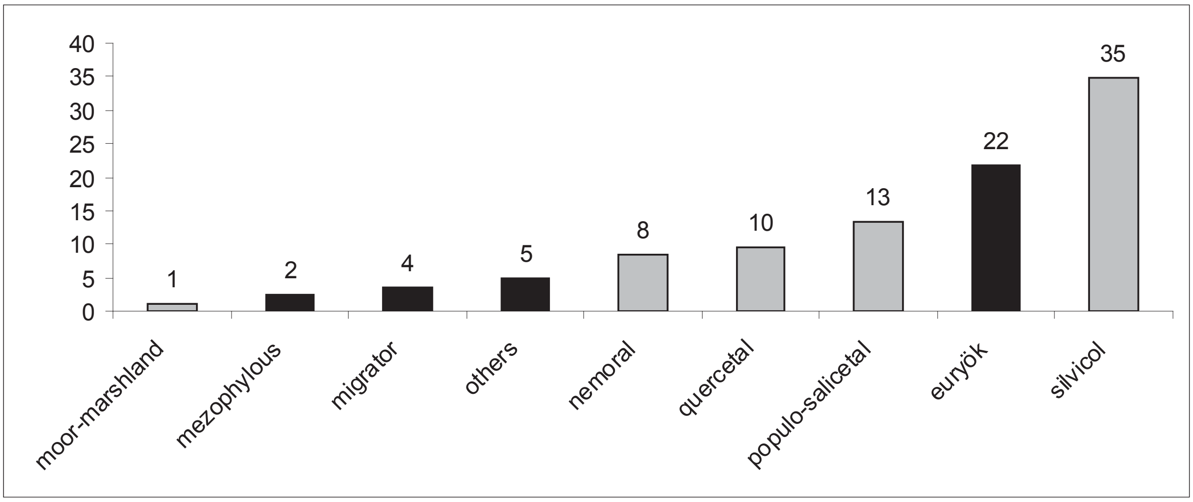
Figure 1: **The composition (%) of potential pest species in the surveyed material by families**



The greatest threat was caused until yet by the gypsy moths (Erebidae: Lymantriinae), which belongs to the Noctuoidea superfamily, and also from the early spring or late autumn Geometridae (*Figure 1*), of which caterpillars are hatching before leafing out. It has to be mentioned, that all of the important Hungarian forestry pest gypsy moth species were recorded: *Lymantria dispar* (Linnaeus, 1758), *L. monacha* (Linnaeus, 1758), *Euproctis chrysorrhoea* (Linnaeus, 1758), *Sphrageidus similis* (Fuessly, 1775) and *Leucoma salicis* (Linnaeus, 1758).

The distribution of different faunal components reflect to the linkage of species to the habitat types (*Figure 2*).

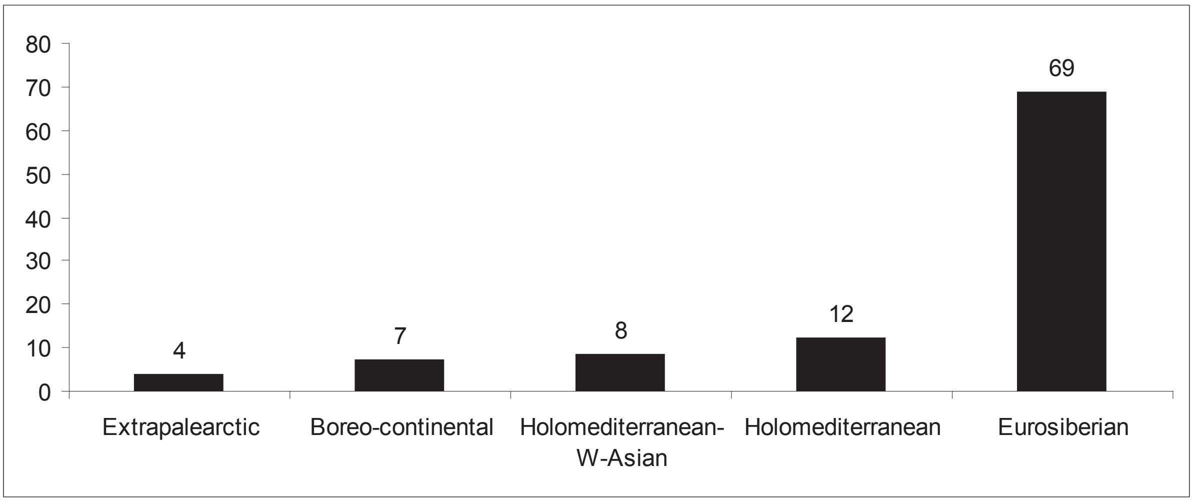
Figure 2: **Proportion of the ecological groups (faunal components) (%)**



Considering the composition of the vegetation of the area, it was expectable that the euryoecious species are dominating. The bulk of species linked to forest habitats belong to the generalist forest species (silvicolous), but also the softwood (populo-salicetal), and oak-wood (quercetal) etc. species (grey columns) are abundantly represented. Between these species, which are linked to the forest habitats, there were several which can cause the mass defoliattion of pedunculate oak forests, e.g. *Operophtera brumata* (Linnaeus, 1758), *Agriopis aurantiaria* (Hübner, 1799), *Colotois pennaria* (Linnaeus, 1761) and *Erannis defoliaria* (Clerck, 1759) from the Geometridae family. All of these species are prone to gradation, which repeat periodically in every 9-12 years (Szontagh, 1985).

The collected species can also be characterized zoogeographically as faunal elements. It is clear that most of the species belong to Euro-Siberian faunal elements (*Figure 3*).

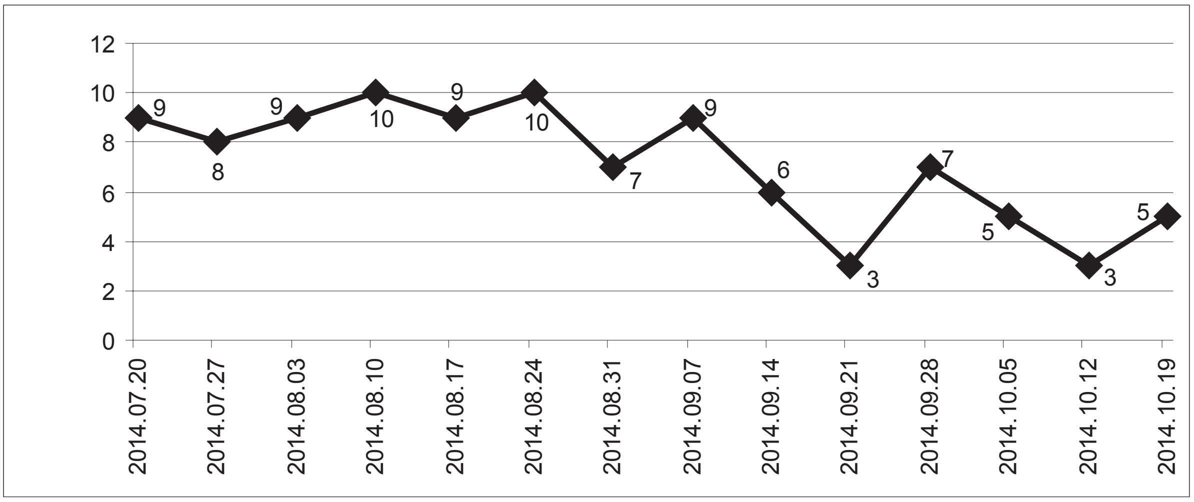
Figure 3: **Zoogeographic divergence of species (%)**



Most of these show a wide spectrum of tolerance and thus they are widespread and frequent species in the Carpathian basin. Most of these can live in disturbed, secondary habitats, too. They can find favorable conditions since the sampling sites are surrounded by fields used for agriculture, or they are partially abandoned areas. There are also some species, which have southern connections e.g. the Holo-Mediterranean *Drymonia ruficornis* (Hufnagel, 1767), *Biston strataria* (Hufnagel, 1767), *Heliothis peltigera* ([Denis et Schiffermüller], 1775), etc. The northern component is composed by some few boreo-continental species, as *Catocala fraxini* (Linnaeus, 1758), *Lymantria monacha* (Linnaeus, 1758), *Dysstroma truncata* (Hufnagel, 1767), etc.

The bait traps have shown that the first peak of the collected species appears in mid-summer. It is gradually decreasing to the direction of autumn. However it is followed by a smooth increase (*Figure 4*).

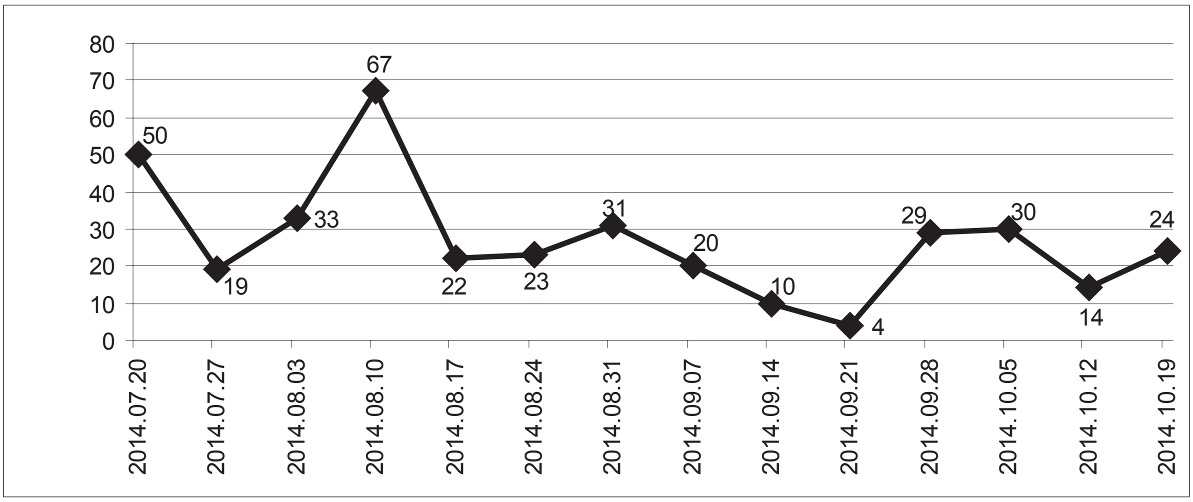
Figure 4: **The number of species collected by the bait traps in weekly subdivision**



This first peak is connected with appearance of polyphagous species feeding on herbaceous plant species. Their summer (second!) generation flies in mid-late summer period until the early autumn. This period is followed by a faunal change, when the species connected to herbaceous plants are replaced by univoltine species feeding on forest trees or scrubs. It has to be mentioned, that the bait traps did not collect those pest species from which the imagoes do not feed (e.g. autumnal Geometridae).

The number of individuals shows a similar general picture as number of species (*Figure 5*) although in contrast with the species number, the number of individuals displays a stronger increase in the autumn period.

Figure 5: **The number of individuals collected by the bait traps in weekly subdivision**



Here is the place to note that despite the large number of species and individuals, the faunistically significant and/or protected species were observed in rather low number of individuals only. Therefore the applied sampling methods did not damage the faunal composition but signalised the potential threats for the forestry in this biogeographically significant transitional region.

ACKNOWLEDGEMENTS

We are grateful to Krisztián Katona for his collaboration in the field work. Szabolcs Szanyi was supported by the Collegium Talentum grant of the Edutus High School.

REFERENCES

Deli, T. - Sümegi, P. - Kiss, J. (1997): Biogeographical characterisation of the Mollusc fauna on Szatmár-Bereg Plain. – In: Tóth, E. - Horváth, R. (eds): Proceedings of the „Research Conservation, Management” Conference (Aggtelek) 1–5 May 1966. - ANP Füzetek Aggtelek Vol I. pp. 123–129.

Hrihora, I. M. - Szolomaha, V. A. (Григора, І. М. - Соломаха В. А.) (2005): Рослинність України. Киев, Український фітосоціологічний центр.

Kádár M. - Petrányi G. - Ronkay G. - Ronkay, L. (2010): A magyarországi bagolylepkék (Lepidoptera, Noctuidae) fényképes határozója. (Photographic identification guide to the noctuids (Lepidoptera, Noctuidae) of Hungary). Szalkay József Magyar Lepkészeti Egyesület. Budapest.

Kitching, R. L. - Orr, A. G. - Thalib, L. - Mitchell, H. - Hopkins, M. S. - Graham, A. W. (2000): Moth assemblages as indicators of environmental quality in remnants of upland Australian rain forest. Journal of Applied Ecology 37: 284–297.

Knudsen J.T. - Tollsten L. - Bergström L.G.(1993): Floral scents - a checklist of volatile compounds isolated by head-space techniques. Phytochemistry, 33:253-280.

Ködöböcz, V. - Magura, T. (1999): Biogeographical connections of the carabid fauna (Coleoptera) of the Beregi-síkság to the Carpathians. Folia entomologica hungarica 60: 195–203.

Landolt, P. J.(2000): New chemical attractants for trapping *Lacanobia subjuncta, Mamestra configurata*, and *Xestia c-nigrum* (Lepidoptera: Noctuidae). *Journal of Economical Entomology* 93: 101–106.

Magura, T. - Ködöböcz, V. - Tóthmérész, B. - Molnár, T. - Elek, Z. - Szilágyi, G. - Hegyessy, G. (1997): Carabid fauna of the Beregi-síkság and its biogeographical relations (Coleoptera Carabidae). Folia Entomologica Hungarica 58: 73–82.

Mészáros Z. - Szabóky, Cs. (2012): A magyarországi nagylepkék gyakorlati albuma. Szalkay József Magyar Lepkészeti Egyesület. Budapest, 185 pp.

Simon, T. (1952): Mountain elements in the flora and vegetation of the Northern Lowland [Montán elemek az Észak-Alföld flórájában és növénytakarójában. In Hung.] Annales Biologicae Universitatis Debreceniensis 1:146-174.

Szabóky, Cs. - Leskó, K. (1999): Lepidoptera – lepkék. 354 – 409. In: Tóth, J. (Szerk.): Erdészeti rovartan. Agroinform kiadó. Budapest.

Szontagh P. (1985) Tölgy nagylepke károsítóinak populációdinamikája és a másodlagos károsító rovarok okozta kárláncolat. Erdészeti Kutatások 1985. 76–77: 305–314.

Tóth, M. - Répási, V. - Szőcs, G. (2002) Chemical attractants for females of pest pyralids and phycitids (Lepidoptera: Pyralidae, Phycitidae). Acta Phytopath. Entomol. Hung. 37:375-384.

Tóth, M. - Szarukán, I. - Nagy, A. - Gém, F. - Nyitrai, R. - Kecskés, Zs. - Krakkó, L. - Jósvai, J. - Bélai, I (2015): Félszintetikus "biszex" csalétkek kártevő rovarok nőstényeinek és hímjeinek fogására. Növényvédelem 51:197-205.

Truxa, Ch. (2013): Community ecology of moths in floodplain forests of Eastern Austria. Ph.D. Dissertation, Universität Wien, pp. 112.

Varga, Z. (2003): Zoogeography of the Carpathian Basin. [A Kárpát-medence állatföldrajza in Hung.]. In: Láng, I., Bedő, Z., Csete, L. (eds.): Növény, állat, élőhely. Magyar Tudománytár III pp. 89-119.

Varga, Z. - Ronkay, L. - Bálint, Zs. - Gyula, L. M. - Peregovits, L. (2004): Checklist of the fauna of Hungary. Volume 3. Macrolepidoptera. – Hungarian Natural History Museum, Budapest, 106 pp.
Varga, Z. (Ed.) (2011): Magyarország nagylepkéi – Macrolepidoptera of Hungary. Heterocera Press, Budapest, pp. 354.

Slight damage of the great green bush-cricket (*Tettigonia viridissima*) (Orthoptera: Tettigoniidae) in some Hungarian maize fields

András Bozsik
University of Debrecen, Institute of Plant Protection, Debrecen, Hungary
bozsik@agr.unideb.hu

SUMMARY

Characteristic cricket damage was observed in two maize fields in northern Hungary, at Máriabesnyő, a district of Gödöllő. The damage level of the two fields did not differ significantly and continual monitoring of field1 showed also a stable infestation level. T. viridissima *nymphs and a female were found and observed as feeding on maize plants. The crickets must have disappeared after 18.07. because no more fresh damage was observed after this date. The chewing's number about on one and two % of the examined plants amounted one and six a plant and their size was between one and eight cm^2. This infestation was quite little and might have caused apparently no yield loss. Compared this damage of* T. viridissima *with former Hungarian experience, this was the usual negligible damage despite the explicit draught in July and August 2015. As regards the global warming, orthopteran damage may be more obvious in the future.*

Keywords: *Tettigonia viridissima*, Tettigoniidae, maize, damage, Hungary

INTRODUCTION

Orthoptera are well known and important pests at many parts of the world but especially in terrestrial habitats of warmer regions. Their consumption in temperate grasslands may be annually 3–5% of the plant production (Ingrisch and Köhler, 1998 in Antonatos *et al*., 2013). In most cases, they are polyphagous and relating to the climatic and vegetation conditions can cause significant economic damage in various crops. Generally, cereals, vegetables, industrial crops, fruit trees and fabaceous vegetation and crops are their host plants (Smith and Holmes, 1977 in Antonatos *et al*., 2013; Jonson and Mündel, 1987 in Antonatos *et al*., 2013; Blanchet *et al*., 2012; Ovsyannikova and Grichanov 2015). Although, the diversity of Orthopterans is considerable, merely few species can attain the pest status. Regarding Mediterranean countries, economically important species are *Dociostaurus maroccanus* (Thunberg, 1815), some *Calliptamus* spp. and *Tettigonia viridissima* (Linnaeus, 1758) (Pelekasis, 1976 in Antonatos *et al*., 2013; Latchininsky, 1998 in Antonatos *et al*., 2013; Blanchet *et al*., 2012). In Central and Western Europe both, their diversity and the caused damage are less (Nagy, 1988) even some species – because of the habitat destruction – are in vulnerable situation (Cooper *et al*., 2012; Anonymous, 2015). Regarding their feeding habits, not each Orthoptera are herbivorous. Species of the family Tettigoniidae are omnivorous with predaceous preference but they consume also plants (Nagy, 1988; Ovsyannikova and Grichanov, 2015).

Great green bush-cricket (= GGBC), *T. viridissima* is a serious pest of cereals, potatoes, grapevines and other annual crops (Gentry, 1965 in Antonatos *et al*., 2013; Pelekasis, 1976 in Antonatos *et al*., 2013). According to recent Greek data, its damage was important in vines, cottons and potatoes but the last crop suffered the most loss (Antonatos *et al*., 2013). In the following, this species is briefly described.

Distribution and habitats

The species lives in Europe, Northern Africa, Middle East, Russia, Afghanistan, Northern India, Pakistan, Mongolia, and Western China (Kaltenbach, 1964; Nagy, 1988; Szövényi, 2002; Ovsyannikova and Grichanov, 2015).

Its habitats include shrubs, woodland, heath, brambles, grassy margins of wet woodland, humid and semi-humid pasture, meadow, riverside and marshy grasslands, cultivated land, fallow and cereal field edge. At forest margins, it prefers the lower part of crones. It can be occur above 15 m up to 1830 m above sea-level. (Nagy, 1988; Szövényi, 2002; Antonatos *et al*., 2013; Ovsyannikova and Grichanov, 2015).

Morphology

Adults' body length is 27-39 mm, their colour is grass green, sometimes with some brownish shade. Dorsally on head, pronotum and elytra a sometimes indefinite light-brown, reddish or black stripe runs longitudinally. Legs are green, on hind femora black spines, some green at base. Male cercus has a large pointed inner tooth and its subgenital plate is posteriorly broadly emarginated. Ovipositor curved slightly towards the tip, its length does not exceed that of elytra (Nagy, 1988; Holst, 1997; Roques and Jourde, 2013; Ovsyannikova and Grichanov, 2015).

Life history

Postembryonic development is epimorphosis (monometabolia). The species has one generation a year and overwinters in the soil as an egg. Female lays eggs - stuck to each other by two and four - in the soil at a depth of two cm. Total number of eggs is 70-100. Nymphs appear in spring, developing time is 50-70 days with 5-7 instars. The nymphs are green, with a brown or reddish dorsal stripe, differing from adult as being wingless (Nagy, 1988; Holst, 1997; Ovsyannikova and Grichanov, 2015).

Damage and economic significance

T. viridissima is omnivorous. Its damage area includes commonly the southern perhaps central region of Europe where field cultures mainly wheat, barley, cotton, hemp, maize, millet, Italian millet, soya, alfalfa, various leguminous cultures, sunflower, sesame, poppy, potato, tobacco are attacked. It feeds on leaves, shoots, unripe grains and bolls. GGBC prefers fruit and ornamental cultures such as peach, plum, walnut, melon, roses and *Lilium* sp., damaging buds, leaves, and ripe fruits. It harms leaves and young shoots on grapevine and blackberry and also leaves of oak and other deciduous trees can be damaged. The observed damage is more significant in drought-stricken years. It can feed also on various small insects (flies, minor caterpillars, etc.) and mites. In custody, also cannibalism was observed as it fed on weaker individuals and nymphs (Zacher, 1949 in Nagy, 1988; Nagy, 1988; Schiemenz, 1989; Bistrichanov *et al*., 2010; Atanasova *et al*., 2013; Ovsyannikova and Grichanov, 2015).

Control

Control measures involve mainly insecticide treatments before oviposition if necessary (Anonymous2, 2015; Ovsyannikova and Grichanov, 2015. If pest population is high early season chemical treatment of field margins may be advisable depending on the economic threshold (ET). If crops are under drought stress, the ET value may need to be lowered (Deneke and Keyser, 2011). In the US, beta-cyfluthrin, lambda-cyhalothrin, gamma-cyhalothrin, zeta-cypermethrin and carbaryl were suggested against grasshoppers (locusts) in pastures and forage crops in 2015 (Anonymous2, 2015). Also cultural and mechanical control can be practiced. It is advisable to modify the environment to take advantage of the vulnerable timing of the grasshopper's life cycle to reduce or eliminate pest populations. Tillage of summer fallows may discourage pest's egg laying in the autumn.
The red-footed falcon (*Falco vespertinus* (Linnaeus, 1766) consumes *T. viridissima* mainly in the breeding period. GGBC is the 11th most frequent prey in the diet of *F. vespertinus* in Hungary (Haraszthy *et al*., 1994).

The objective of this study was to assess the observed *T. viridissima* damage in maize and to conclude to the agricultural consequences.

MATERIALS AND METHODS

The surveyed sites were found at Máriabesnyő about 25 km from Budapest. Both fields belonged to the Szent István University and localised near the railway line running towards Budapest. Field1 was surrounded by dense hedges and a field path along a tree row of *Robinia pseudoacacia* L. Field2 was localised at the other side of the path and bordered by two hedges, another path and a row of deciduous trees consisted of *Acer campestre* L., *Acer pseudoplatanus* L., *Acer platanoides* L., *Celtis occidentalis* L., *Cornus sanguinea* L., *Juglans regia* L., *Fraxinus ornus* L., *Malus domestica* L., *Prunus serotina* Erh., *Populus nigra* L., *R. pseudoacacia* L., and *Rosa canina* L. Across the tree row, there was a 7.7 ha alfalfa field.

Information on the localities and the survey are showed in *Table 1*.

Table 1

Characteristics of the sites and the maize stands in Máriabesnyő (2015)

Sites	Geographical position and altitude (m)	Field size (ha)	Time of survey	Average plant height (cm)
Field1	47°35´51˝ N 19°22´28˝ E 207	2,7	06.15.	175.4
Field2	47°35´53˝ N 19°22´05˝ E 212	10,7	06.15.	178.7

Survey method: Four times 25 plants were examined from the field border diagonally, along a transect line. Plants were chosen randomly after making five steps. There were 30 steps between repetitions. Number of cricket's chewing as well as that of GGBC individuals was noted. Field1 was monitored until the harvest in the late of August (22.08.) (*Figure 1*).

Both fields were overgrown with weeds such as *Artemisia vulgaris* L., *Ambrosia artemisiifolia* L., *Cannabis sativa* var. *spontanea* L., *Chenopodium album* L. and *Atriplex tatarica* L. The weeds hampered even the moving in the fields. No pesticides were applied.

Evaluation: *T. viridissima* infestation of the fields was compared on the basis of the number of damaged plants. Data were examined by two-sample t-test and one way ANOVA of correlated samples (http://vassarstats.net/).

Figure 1: **Field1 Máriabesnyő (2015)**

RESULTS AND DISCUSSION

Results are presented in the *Table 2* and *3*. According to the results, occurrence and damage of *T. viridissima* were slight at both sites.

Table 2

Number of damaged plants (Máriabesnyő, 2015)

Sites	Average number of damaged plants (%)	Confidence interval P = 0.95
Field1	1.25 (1.25)	2.00
Field2	5.25 (5.25)	5.41

Two-sample t-test did not showed significant difference between values at p = 0.05, t = -2.2, df = 6. (http://vassarstats.net/).

Table 3

Number of damaged plants at field1 during the season (Máriabesnyő, 2015)

Date	Average number of damaged plants (%)	Standard deviation
06.21.	2.00 (2.00)	0.00
06.27.	2.75 (2.75)	1.89
07.04.	1.75 (1.75)	1.50
07.11.	2.25 (2.25)	1.26
07.18.	0.75 (0.75)	0.50

One way ANOVA computed no significant difference among values at p = 0.05, df = 4, F = 1.83. (http://vassarstats.net/).

During the season two nymphs and a female *T. viridissima* were observed at field1 on 15.06. and 27.06., respectively (*Figure 2* and *3*).

The number of chewing on one injured plant varied between one and six and its size between one and eight cm^2. However, the damage was not of importance and did not influence either the yield or the survival of crops involved. Continual monitoring at field1 showed a low and stable infestation level until 18.07. After this date no more fresh damage was detected (*Figures 4 - 6*).

The number of objective investigations on yield losses caused by Orthoptera is not high. Antonatos *et al*. (2013) assessed the leaf area (cm^2) consumption of three species, viz. *Calliptamus barbarous* (Costa, 1836), *Dociostaurus maroccanus* (Thunberg, 1815), and *T. viridissima*. Females consumed more than males in case of all species and *T. viridissima* females ingested at 25 ^{o}C the utmost quantity – compared to the other orthopteran species – of vine, cotton and potato 24, 23 and 60 cm^2 leaf area, respectively.

Figure 2: ***Tettigonia viridissima*** **nymph at field1 (Máriabesnyő, 2015)**

Figure 3: ***Tettigonia viridissima*** **female at field1 (Máriabesnyő, 2015)**

Rising temperature (30 ^{o}C) increased significantly the leaf area consumption which was about 25-40% higher than the former data (Antonatos *et al*., 2013). This shows clearly that higher temperature increases the quantity of consumed plant tissue and so the yield loss. Thus, damage of Orthoptera is higher in Mediterranean or subtropical areas than in the Central European or more northern regions. This phenomenon can be observed also in size variables of *T. viridissima* males collected in four European regions (Spain, Southern France, Central France and UK). Body length, wing length and width of GGBC males continually decreased from south towards north and the difference among the values often was significant (Cooper *et al*., 2012).

In Bulgaria, *T. viridissima* attacked the green plant parts, flowers and seeds of coriander (Atanasova *et al*., 2013) and bit off the handle of flowers of *Lilium rhodopaeum* (Bistrichanov *et al*., 2010). The severity of the damage has not been commented. In Hungary, slight damage in vines, tobaccos, cereals, fruit trees, melons, roses (Zacher, 1949 in Nagy, 1988) and in maize, alfalfa and clover stands (Nagy, 1988) were observed however it was stressed that mass outbreak or explicit damage of GGBC have not been perceived (Nagy, 1988). Regarding the continual warming impact of climate change, damage and yield loss of *T. viridissima* could be more severe in the future.

Figure 4: **Chewing damage at field1 (Máriabesnyő, 2015)**

Figure 5: **Chewing damage at field1 (Máriabesnyő, 2015)**

Figure 6: **Chewing damage at field1 (Máriabesnyő, 2015)**

REFERENCES

Anonymous (2015): Heuschrecken in Hamburg. Rote Liste und Artenverzeichnis. http://www.hamburg.de/contentblob/135208/data/heuschrecken.pdf

Anonymous2 (2015): Pastures and forage crops. Insect and weed control recommendations for 2015. Alabama A & M and Auburn Universities, http://www.aces.edu/pubs/docs/I/IPM-0028/IPM-0028.pdf

Atanasova, D., Maneva, V., Dacheva, S., Atanassov, A.(2013): Phytosanitary monitoring of coriander crops in south -east Bulgaria. Povrćarstvo, ukrasno, aromatično i ljekovito bilje. 48. hrvatski i 8. međunarodni simpozij agronoma | Dubrovnik | Hrvatska http://sa.agr.hr/pdf/2013/sa2013_p0413.pdf semmi adat nincs a kárról

Antonatos, S.A., Emmanuel, N.G. and Fantinou, A.A. (2013): Effect of temperature and species of plant on the consumption of leaves by three species of Orthoptera under laboratory conditions. Eur. J. Entomol. 110 (4): 605-610.

Bistrichanov, S., Ivanova, I., Kaninski, A., Kadhum, E. (2010): Phytosanitary monitoring of Lilium rhodopaeum Delip. in Bulgaria. Journal of Environmental Studies [JES] 4:15-17. http://www.jes.sohag.edu.eg/VOL.IV/3.pdf

Blanchet, E., Lecoq, M., Sword, G.A., Pages, C., Blondin, L., Billot, C., Rivallan, R., Foucart, A., Vassal J.M., Risterucci, A.M. & Chapuis, M.P. (2012): Population structures of three Calliptamus spp. (Orthoptera: Acrididae) across the Western Mediterranean Basin. Eur. J. Entomol. 109 : 445–455.

Cooper, E.M., Lunt, P.H., Ellis, J.S., Knight, M.E. (2012): Biogeographical patterns of variation in Western European populations of the great green bush-cricket (Tettigonia viridissima; Orthoptera Tettigoniidae). J. Insect. Conserv. https://www.researchgate.net/publication/257580225_Biogeographical_patterns_of_variation_in_Western_European_populations_of_the_great_green_bush-cricket_(Tettigonia_viridissima_Orthoptera_Tettigoniidae)

Deneke, D.L. and Keyser, J. (2011): Integrated pest management strategies for grasshopper management in South Dakota. South Dakota State University/USDA, Extension Extra 8131, pp. 4. http://pubstorage.sdstate.edu/AgBio_Publications/articles/ExEx8131.pdf

Haraszthy L., Rékási J., Bagyura J. (1994): Food of the red-footed falcon (*Falco vespertinus*) in the breeding period. Aquila 101: 93-110.

Holst, K.Th. (1997): The Saltatoria (Bush-crickets, crickets and grasshoppers) of northern Scandinavia. (Fauna Entomologica Scandinavica) E.J. Brill / Scandinavian Science Press Ltd. Leiden-Copenhagen, 9-127.

Kaltenbach, A. (1964): Die Mantidea und Ensifera der Österreichischer Karakorum Expedition 1958. Ann. Naturhistor. Mus. Wien. 67, 443-445.

Ovsyannikova, E.I., Grichanov, I.Ya. (2015): Tettigonia viridissima. Interactive Agricultural Ecological Atlas of Russia and neighbouring countries. Economic plants and their diseases, pests and weeds. http://www.agroatlas.ru/en/content/pests/Tettigonia_viridissima/

Nagy B. (1988): Zöld lombszöcske (*Tettigonia viridissima* Linné). In: Jermy T. and Balázs K. (eds): A Növényvédelmi állattan kézikönyve. 1. Akadémiai Kiadó, Budapest, pp. 215-216.

Roques, O. et Jourde, P. (2013): Clé des Orthoptères de Poitou-Charentes. Poitou-Charentes Nature, Fontaine-le-Comte, pp. 92.
http://www.poitou-charentes-nature.asso.fr/IMG/pdf_Cle_Orthopteres_PCNV1-1.pdf

Schiemenz, H. (1989): Tettigoniidae. In: Stresemann, R., Hannemann, H-J., Klausnitzer, B. and Senglaub, K. (editors): Excursionsfauna für die Gebiete der DDR und der BRD. Band 2/1, Wirbellose, Insekten – Erster Teil. 8. Auflage, Volk und Wissenschaft Vokseigener Verlag, Berlin. p. 109-110.

Szövényi G. (2002): Qualification of grassland habitats based on their Orthoptera assemblages in the Köszeg Mountains (W-Hungary). Entomol. Exp. Appl. 104: 159–163.

VassarStats 2014. Website for Statistical Computation: http://vassarstats.net/

András Bozsik: *Tettigonia viridisssima* nymph on maize (aquarelle)

Preliminary data on the effect of semi-synthetic baits for Noctuidae (Lepidoptera) on the non-target Lepidoptera species

Antal Nagy[1] – István Szarukán[1] – Ferenc Gém[1] – Rita Nyitrai[1] – Bence Füsti-Molnár[1] – Attila Némerth[1] – Lajos Kozák[2] – Attila Molnár[3] – Krisztián Katona[4] – Szabolcs Szanyi[5] – Zoltán Varga[5] – Miklós Tóth[6]

[1]Institute of Plant Protection, University of Debrecen, Hungary

[2]Department of Nature Conservation Zoology and Game Management, University of Debrecen, Hungary

[3]Department of Biology and Chemistry, Ferenc Rákóczi II. Transcarpathian Hungarian Institute, Beregszász, Ukraine

[4]Faculty of Biology, Uzhhorod National University, Uzhhorod, Ukraine

[5]Department of Evolutionary Zoology, University of Debrecen, Hungary

[6]Plant Protection Institute, CAR HAS, Budapest, Hungary

nagyanti@agr.unideb.hu

SUMMARY

Noctuidae are one of the most important Lepidoptera groups containing dangerous pest species. Monitoring and detection of these pest species is routinely performed by traps baited with sex-pheromones. Baits that attract both males and females were developed for improved pest management. First the effectiveness of different synthetic compounds was evaluated. We also tested semi-synthetic baits that contained both synthetic and natural components (wine and beer). These were more attractive for moths considering species richness and abundance. Disadvantage of this increased effectiveness is that the traps catch more non target, rare and even protected species. In this study we analysed the effect of semi-synthetic baits developed for Noctuid moths containing wine on other non-target Lepidopterans. In the six sampling sites traps caught 17158 individuals of 183 Lepidoptera species. The number of Noctuidae species was 124, while their proportion was 84.4%. The traps caught 813 individuals of 9 protected and 20 valuable species, which was only 4.7% of all Lepidopterans. In contrast the mean proportion of 33 dangerous and potential pest species was 31.3% (5375 individuals). Number and abundance of both protected and pest species were affected by landscape structure. The risks of catching non-target species was higher in species rich natural and semi-natural landscape. In homogenous arable lands the number and proportion of valuable Lepidopterans was not significant.

Keywords: pest monitoring, food attractants, loss of biodiversity, semi-synthetic baits

INTRODUCTION

Noctuidae is one of the most important families of Lepidoptera because of several dangerous and economically important pest species. The monitoring of these pests, which is an important part of the IPM (Integrated Pest Management) strategy against them, is generally performed by different trapping methods. In the last decades, widely used sex pheromone-baited traps have replaced the light traps used before. These baited traps can easily be used and are very effective and species specific, but lure only male moths. However, data of females are more valuable for pest control decisions, so the development of female catching baits have been ongoing since the 1970's (Creighton *et al*., 1973; Cantelo and Jacobson, 1979; Landolt, 2000; Landolt and Alfaro, 2001; Tóth *et al*., 2010). The effectiveness of several synthetic compounds (e.g. phenylacetaldehyde, isoamyl-alcohol and isobutanol in combination with acetic acid) were proved to be effective for Noctuid moths. The effectiveness of these synthetic baits can be increased with wine and beer as natural additives. These 'semi-synthetic' baits lure more species and more individuals than the synthetic ones (Nagy *et al*., 2014; Tóth *et al*., 2015). These synthetic and semi-synthetic baits are more general attractants than species specific pheromones. Using these traps, several important pest species can be monitored in the same time minimizing sampling effort (Tóth *et al*., 2010). The remarkable disadvantage of the lack of specificity is the risk of catching non-target and even rare or protected species. In some cases, even the more specific traps baited with sex pheromone can also catch non target species (Olenici *et al*., 2007), but the probability of non-target catches might be much higher in case of traps baited with feeding attractants.

In the present study, the effect of semi-synthetic baits, consisting of isoamyl alcohol, acetic acid and wine, was analysed on the non-pest, non-target Lepidoptera species. We used data from different studies, which aimed to develop 'bisex' (attractive for both males and females) baits or faunistic analysis of natural and semi-natural habitats. Our goal was to determine the amount of the non-target effect and provide a basis for further investigations.

MATERIAL AND METHODS

In the present analysis we used data of different studies on semi-synthetic baits for trapping Noctuid pest species. The sampling was carried out in six locations in East and Northeast Hungary (5 sites) and West Ukraine (1 site) during 2013-2014. Four of the sampling sites (Forró, Balmazújváros, Debrecen-Ondód, Hernádnémeti) were located in mostly agricultural landscape surrounded by intensively used arable lands while the others (Nagycsere and Nagydobrony) were surrounded with more diverse extensively used landscapes (*Figure 1*, *Table 1*).

Figure 1: **Location of the sampling sites and linear transects of the traps in the six studied sites in 2013-2014 (Surce: GoogleEarth).**

Table 1

GPS coordinates of sites and sampling periods of Noctuid moths in the six sampling sites studied in 2013-2014

Sampling area	N	E	Start	Finish
Forró	47° 19.770'	21° 3.773'	1st July 2013	1st November 2013
Debrecen-Ondód	47° 32.031'	21° 31.053	2nd July 2013	2nd November 2013
Nagydobrony	48° 25.619'	22° 25.128'	20th July 2014	19th October 2014
Nagycsere	47° 31.847'	21° 46.910'	17th July 2014	12th November 2014
Hernádnémeti	48° 9.595'	21° 2.991'	2nd July 2014	16th November 2014
Balmazújváros	47° 36.202'	21° 26.352'	8th July 2014	22nd November 2014

In Forró, Ondód, Hernádnémeti and Balmazújváros the effect of natural compounds (wine and beer) and their extracts on the efficiency of synthetic lures was tested. In Nagycsere the Noctuidae fauna of a semi-natural landscape, while in Nagydobrony the fauna of the protected Nagydobrony Game Reserve was studied using synthetic and semi-synthetic baits for Noctuid species. We use the data collected by semi-synthetic baits contain mixture of isoamyl alcohol, acetic acid and red wine (1:1:1, 3 ml), which was used in all of the six studies. Polypropylene tubes with 4 ml capacity were used as dispensers (Tóth *et al*., 2015). The mixture was administered on dental rolls inside the tubes. The lure could evaporate across a small opening with 4 mm in diameter, which was opened when setting out in the field. The trapped moths were killed by an insecticide strip.

During the studies CSALOMON® VarL+ traps were used in five (Balmazújváros, Ondód, Hernádnémeti and Forró) or four (Nagydobrony, Nagycsere) repetitions. The traps were placed in the sites on trees situated in the edge of the sites in 1.8-2 m height. The distance between the traps was 40-100 m depending on the design of the given study. The samplings were mostly carried out between July and November in 2013 and 2014 (*Table 1*). The traps were emptied twice a week (Forró, Ondód, Balmazújváros and Hernádnémeti) or weekly (in the faunistic studies in Nagycsere and Nagydobrony). The baits were changed in every four weeks. The collected material was deep-frozen and stored until identification. The sampled individuals were identified according the works of Kádár *et al*. (2010), Mészáros and Szabóky (2012) and Varga (2011). For the nomenclature and characterization of species, the book „Magyarország Nagylepkéi" (Varga, 2011) were used.

For characterization of the sampled material total number of species and individuals, number of species and individuals per site and their means per trap was used. These variables were also tallied by families especially for Noctuidae. In order to characterize and assess the effect of the semi-synthetic baits on non-target Lepidoptera species the groups of pest and vulnerable (protected and/or faunistically interesting) species were also characterized with total and mean number of species and individuals in case of groups, families and species. The conservation value of the species was established on the basis of KÖM (2001). The group of pest species was established on the basis of Jermy and Balázs 1993, Szabóky and Leskó (1999) and Tóth (1999).

RESULTS AND DISCUSSION

In the six sampling sites the traps caught 17642 Lepidoptera that belonged to 184 species and nine families (see Appendix 1). The 2.7 % (n=484) of the specimens could be identified only at the family level. In case of Hepialidae only one specimen was caught that also could not be identified at species level (*Table 2*). Beyond that 843 individuals of Vespidae species (*Vespa crabro*, *V. germanica* and *Polistes* sp.) and 11 honey-bees (*Apis mellifera*) were sampled.

The most species rich sites were Nagycsere (128) and Nagydobrony (91), which can be characterised by most diverse landscape structure than the others, where the species number ranged between 57 and 70. The mean number of species per trap was higher in Nagycsere (71.3±7.1) while in Ondód a trap lured only 33.2 (±5.5) species on the average. The abundance of Lepidoptera generally was higher in the less diverse arable lands. The mean number of individuals per trap was the highest in Balmazújváros (1162±127.1), however the abundance was relatively high also in the species rich Nagycsere (640.8±95.3) (*Table 2*).

The semi-synthetic bait used in these samplings was developed to monitor noctuid pest species. In the six sites 126 Noctuidae species of 17 subfamilies were sampled, which were 68.9% of all sampled Lepidoptera. The ratio of Noctuidae species among all sampled Lepidoptera was higher (82.9-90.6%) in the less diverse agro-ecosystems than in the most diverse extensively used landscapes (67.2-72.5%). The total number of Noctuid moths was 14487 that was the 84.4% of the identified Lepidopterans and their ratio varied between 70.2-95.5 by sites. The baits showed much higher effectiveness in case of species belonging to Xyleninae, Noctuinae, Hadeninae and Acronictinae subfamilies, which cumulative ratio was 80.4% (11653 individuals) among sampled Noctuidae moths (*Table 2*).

Table 2

The characteristic variables of samples taken in the six studied sites in 2013-2014. N: number of individuals, Ntrap: mean number of individuals per trap [individuals/trap], S: number of species, Strap: mean number of species by trap [species/trap], SD: standard deviation

	Forró			Ondód			Hernádnémeti			Balmazújváros		
Number of individuals	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD
Hepialidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Pyralidae	77	15.4	9.2	245	49.0	24.7	756	151.2	31.8	124	24.8	8.3
Nymphalidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Sphingidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Geometridae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Thyatiridae	0	0.0	0.0	2	0.4	0.9	33	6.6	4.2	370	74.0	20.6
Nolidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Erebidae	53	10.6	4.4	37	7.4	2.4	104	20.8	15.0	19	3.8	2.2
Noctuidae	2791	558.2	137.6	646	129.2	35.2	2458	491.6	52.2	5297	1059.4	122.7
Xyleninae	991	198.2	50.4	363	72.6	23.9	896	179.2	23.8	3287	657.4	70.4
Noctuinae	103	20.6	4.3	43	8.6	3.8	429	85.8	12.1	1262	252.4	47.7
Hadeninae	912	182.4	48.6	72	14.4	1.8	563	112.6	23.3	191	38.2	5.7
Other Noctuidae subfam.	537	107.4	23.0	94	18.8	13.0	447	89.4	19.5	421	84.2	19.5
non identified Lepidoptera*	140	28.0	14.7	12	2.4	2.2	2	0.4	0.5	0	0.0	0.0
identified Lepidoptera	2921	584.2	140.9	930	186.0	58.8	3351	670.2	61.3	5810	1162.0	127.1
Numberof species	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD
Lepidoptera species number	64	48.4	3.4	59	33.2	5.4	70	57.6	2.2	57	44.6	3.4
Hepialidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Pyralidae	2	1.2	0.4	3	2.2	0.4	3	2.8	0.4	3	2.8	0.4
Nymphalidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Sphingidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Geometridae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Thyatiridae	0	0.0	0.0	1	0.2	0.4	3	1.8	0.4	3	1.8	0.8
Nolidae	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Erebidae	4	3.2	0.4	6	3.0	1.2	6	4.2	1.3	3	1.6	0.5
Noctuidae	58	44.0	3.4	49	27.8	4.5	58	48.8	1.8	48	38.4	3.2
Xyleninae	28	19.0	3.1	24	14.2	2.9	27	21.6	1.1	25	20.0	1.4
Noctuinae	8	7.2	0.4	8	5.0	1.0	10	10.0	0.0	10	7.8	1.1
Hadeninae	11	10.4	0.9	9	4.4	0.9	12	9.6	0.5	8	6.2	1.1
Other Noctuidae subfam.	11	7.4	1.1	8	4.2	0.4	9	7.6	1.5	5	4.4	0.9

	Nagydobrony			Nagycsere			Total		
Number of individuals	N	Ntrap	±SD	N	Ntrap	±SD	N	Ntrap	±SD
Hepialidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Pyralidae	0	0.0	0.0	0	0.0	0.0	1202	42.93	56.46
Nymphalidae	7	1.8	1.0	7	1.8	1.0	14	0.50	0.92
Sphingidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Geometridae	12	3.0	2.2	68	17.0	9.9	80	2.86	6.87
Thyatiridae	121	30.3	17.4	207	51.8	21.5	733	26.18	31.53
Nolidae	0	0.0	0.0	2	0.5	1.0	2	0.07	0.38
Erebidae	330	82.5	13.3	96	24.0	13.0	639	22.82	27.26
Noctuidae	1112	278.0	47.9	2183	545.8	108.7	14487	517.39	313.91
Xyleninae	477	119.3	13.8	1298	324.5	123.7	7312	261.14	210.27
Noctuinae	72	18.0	4.4	471	117.8	78.2	2380	85.00	94.38
Hadeninae	85	21.3	9.3	138	34.5	22.6	1961	70.04	66.91
Other Noctuidae subfam.	421	105.25	32.88	169	42.25	6.18	2089	74.61	38.31
non identified Lepidoptera*	93	23.3	6.6	237	59.3	28.9	484	17.29	23.81
identified Lepidoptera	1583	395.8	62.8	2563	640.8	95.3	17158	612.79	324.49
Numberof species	S	Strap	±SD	S	Strap	±SD	S	Strap	±SD
Lepidoptera species number	91	57.0	5.4	128	71.3	7.1	183	51.14	12.61
Hepialidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Pyralidae	0	0.0	0.0	0	0.0	0.0	3	1.61	1.23
Nymphalidae	4	1.5	1.0	3	1.5	0.6	5	0.43	0.79
Sphingidae	1	0.3	0.5	0	0.0	0.0	1	0.04	0.19
Geometridae	4	1.8	0.5	12	4.5	1.3	15	0.89	1.69
Thyatiridae	3	3.0	0.0	4	3.3	0.5	4	1.57	1.32
Nolidae	0	0.0	0.0	2	0.5	1.0	2	0.07	0.38
Erebidae	13	8.5	1.9	21	8.8	3.3	27	4.61	3.08
Noctuidae	66	42.0	3.2	86	52.8	3.8	126	41.93	8.70
Xyleninae	36	22.8	1.5	45	27.8	3.2	63	20.57	4.59
Noctuinae	12	8.5	0.6	17	11.0	1.2	20	8.14	2.10
Hadeninae	7	4.3	1.0	7	5.5	1.3	15	6.86	2.63
Other Noctuidae subfam.	11	6.5	1.3	17	8.5	1.0	28	6.36	1.93

*Individuals identified only in family level.

In Forró all the five most abundant species, in Ondód, Hernádnémeti and Balmazújváros four, while Nagycsere and Nagydobrony three of them were Noctuid moths. Beyond them the baits lured high number of *Hypsopygia costalis* (Pyralidae), *Pelosia muscerda* (Erebidae) and two Thyatiridae species (*Tethea ocularis* and *Thyatria batis*). The most abundant species of the sites are mostly occurred in all sites, but the locally dominant

Pelosia muscerda, *Cirrhia icterica* and *Craniophora ligustri* occurred only in two sites with higher habitat diversity (Nagycsere and Nagydobrony). The common and polyphagous *Agrochola circellaris*, *Mythimna albipuncta*, *Xestia xanthographa* and *Acronicta rumicis* were dominant in three sites. The also widely distributed *Cirrhia ocellaris*, *Hypsopygia costalis*, *Allophyes oxyacanthae*, *Trachea atriplicis*, *Tethea ocularis* and *Agrotis segetum* reached high relative frequencies in two whereas the others only in one site (*Table 3*). Most of these species feed on tree canopy and only 6 of them can be regarded as real or potential pest species. Among them only *Agrotis segetum*, which can cause significant damage in most crops and even in horticulture, is a harmful pest.

Table 3

Five most abundant species of the studied sites with their relative frequencies [RF%] and number of occupied sites. The species are ordered decreasingly by their summarised RF%

	Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum	site (n=6)
Cirrhia ocellaris				30.31		7.062	11.70	6
Xestia xanthographa			5.222	19.21		11.51	9.58	6
*Agrochola circellaris**		19.46	4.775	11.93			7.06	6
*Hypsopygia costalis**		24.84	20.53				6.06	4
Allophyes oxyacanthae	10.58				17.62		4.59	6
Trachea atriplicis	13.45				12.57		4.14	6
Mythimna albipuncta	12.26	4.731	5.103				3.99	6
*Acronicta rumicis**	5.067	6.882	6.625				3.22	6
Tethea ocularis				6.299		4.955	2.88	3
*Agrotis segetum**	5.923	5.269					2.80	6
*Acronicta megacephala**				5.146			1.89	6
Pelosia muscerda					16.36		1.68	2
Agrochola helvola						6.087	1.29	5
Cirrhia icteritia						4.487	0.80	2
*Thyatira batis**					5.559		0.74	4
Craniophora ligustri					3.348		0.31	2

* pest species

The number of harmful and potentially significant pest species was 32 in the samples. Most of them (20) belong to the Noctuidae family and there were 5 Erebidae, 2 Geometridae, 3 Pyralidae and 2 Thyatiridae species. The mean number of pest species per trap was lower in Debrecen-Ondód (12.0±2.0) while this value reached the maximum in Hernádnémeti (17.6±1.1). The total number of pests was 5373 which was 31.3% of all Lepidoptera samples. The ratio of the pest species was higher in the agricultural sites then in the most diverse ones. The mean proportion of Noctuidea was 74.6(±18.2)% and the Pyralidae was 18.1(±19.1)% while the other three family played a minor role. Baits lured the most individuals of *Hypsopygia costalis*, *Agrochola circellaris*, *Acronicta rumicis*, *Agrotis segetum* and *Noctua pronuba*. Most of them occurred at all of the studied sites, but the *Hypsophygia costalis* was caught only the agricultural sites. In Balmazújváros high abundance of *Agrochola circellaris* and *Acronicta megacephala* was caused by nearby poplar plantation. These plantations can be a source of these pests. Considerable part of the pest species could be found with low abundance and 8 of them occurred only in the two more diverse species rich sites (*Table 4*).

The traps caught 34 individuals of seven protected Noctuidae, one Erebidae and one Nymphalidae species in all of the six sampling sites. Six of them and 19 other species are interesting and valuable in faunistical aspect. They mostly belong to the Noctuidae family however there were two Erebidae and two Geometridae species. During the studies totally 411 individuals of these valuable species were sampled, which is 2.4% of the Lepidopteans identified at species level while the ratio of the protected Lepidopterans was only 0.2%. In Balmazújváros protected species were not sampled and only one valuable species could be found, however the number of protected species was also low both in the species rich Nagycsere and Nagydobrony. The number of faunistically interesting and protected species was much lower in the agricultural sites (max. 7 species) than in the two semi natural ones (14 and 15 species). The number of valuable species was the highest in Nagycsere where 4 protected and 11 faunistically interesting species were trapped. The ratio of valuable individuals differed between 2.9-4.5% by sites, but the ratio of protected species was lower than 1% in each site (*Table 5*).

Table 4

List of the pest species caught in the six sampling sites in 2013-2014 with their number of individuals and ratio among all Sampled Lepidoptera and taxonomy. Species are arranged by decreasing number of individuals

Family		Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum
Noctuidae	*Agrochola circellaris*	61	181	160	693	12	104	1211
Pyralidae	*Hypsopygia costalis*	76	231	688	44	0	0	1039
Noctuidae	*Acronicta rumicis*	148	64	222	68	16	34	552
Noctuidae	*Agrotis segetum*	173	49	88	99	25	46	480
Noctuidae	*Noctua pronuba*	29	29	102	95	17	103	375
Noctuidae	*Acronicta megacephala*	1	2	9	299	3	11	325
Noctuidae	*Lacanobia oleracea*	70	7	69	17	21	13	197
Noctuidae	*Agrotis exclamationis*	40	1	10	1	32	48	132
Noctuidae	*Xestia c-nigrum*	38	1	53	23	11	3	129
Thyatiridae	*Thyatira batis*	0	0	20	2	88	17	127
Pyralidae	*Ostrinia nubilalis*	0	3	50	71	0	0	124
Noctuidae	*Agrotis ipsilon*	26	24	25	36	0	11	122
Noctuidae	*Conistra vaccinii*	14	0	2	8	12	68	104
Noctuidae	*Phlogophora meticulosa*	11	4	48	16	7	13	99
Noctuidae	*Lacanobia suasa*	81	1	4	0	1	3	90
Noctuidae	*Mamestra brassicae*	38	7	28	6	0	0	79
Pyralidae	*Pyralis farinalis*	1	11	18	9	0	0	39
Thyatiridae	*Habrosyne pyrithoides*	0	2	12	2	14	1	31
Noctuidae	*Hadula trifolii*	9	1	13	1	0	0	24
Noctuidae	*Helicoverpa armigera*	0	0	0	0	1	22	23
Noctuidae	*Acronicta psi*	9	8	2	0	0	0	19
Erebidae	*Euclidia glyphica*	15	1	0	0	0	0	16
Noctuidae	*Cosmia trapezina*	4	1	0	0	5	4	14
Erebidae	*Scoliopteryx libatrix*	0	1	0	0	11	0	12
Erebidae	*Phragmatobia fuliginosa*	0	0	0	0	0	3	3
Erebidae	*Lymantria dispar*	0	0	0	0	0	1	1
Erebidae	*Lymantria monacha*	0	0	0	0	0	1	1
Geometridae	*Ectropis crepuscularia*	0	0	0	0	0	1	1
Geometridae	*Peribatodes rhomboidaria*	0	0	0	0	0	1	1
Noctuidae	*Colocasia coryli*	0	0	0	0	0	1	1
Noctuidae	*Autographa gamma*	0	0	0	0	0	1	1
Noctuidae	*Macdunnoughia confusa*	0	0	0	0	0	1	1
Total number of pests		844	629	1623	1490	276	511	5373
Ratio of pests among all Lepidoptera (%)		28.9	67.6	48.4	25.6	17.5	20.0	31.3
Total number of identified Lepidoptera		2921	930	3351	5810	1583	2563	17158

Semi-synthetic baits used in this study attract a large amount of Noctuid moths. Both the species number and abundance were high in each sampling sites, although they depend on the landscape structure. High landscape diversity results in higher species richness but in case of abundance it does not cause differences. The bait also lured Vespidae species with relatively high abundance, but did not attract honey-bees. Most of the sampled Lepidopterans belonged to the Noctuidae family (totally 124 species). Among them the species of Noctuidne, Xyleninae and Hadeninae subfamilies were the most abundant. Beyond them the species number of Erebidae and Geometridae families was the highest. Among the most abundant species there were six pests: *Agrochola circellaris*, *Hypsopygia costalis*, *Acronicta rumicis*, *Agrotis segetum*, *Acronicta megacephala* and *Thyatiria batis*. The dominant species of arable land and more diverse sites were different. The total number of pest species was 32. Most of them (20) were noctuid moths containing such harmful ones as *Agrotis segetum*, *Agrotis exclamationis*, *Agrotis ipsilon*, *Lacanobia oleracea* etc.. The summarised proportion of these species was 31.3% among all identified Lepidopterans. Considering their economic importance the majority of the caught Lepidopterans were indifferent. Both number and abundance of protected and valuable species was low, however the risk of catching valuable and non-target species was higher in the natural and semi natural sites. The traps caught totally 411 individuals of 28 protected and/or faunistically interesting species, which was a very little part (2.4%) of all sampled Lepidopterans.

On the basis of these preliminary results the use of the tested semi-synthetic bait does not endanger the populations of non-target Lepidopterans. For more detailed results we should carry out further studies and should analyse these and other ongoing studies together.

Table 5

List of the protected and faunistically interesting species caught in the six sampling sites in 2013-2014 with their number of individuals and ratio among all sampled Lepidoptera and taxonomy. P: protected, F: faunistically interesting

Prot.	Family		Forró	Ondód	Hernád-németi	Balmaz-újváros	Nagy-dobrony	Nagy-csere	Sum
P/F	Noctuidae	*Meganephria bimaculosa*	2	0	0	0	0	0	2
P/F	Noctuidae	*Enargia paleacea*	0	0	0	0	1	5	6
P/F	Noctuidae	*Lithophane semibrunnea*	0	1	1	0	2	0	4
P/F	Noctuidae	*Mormo maura*	0	0	0	0	3	0	3
P/F	Noctuidae	*Orbona fragariae*	4	0	0	0	0	1	5
P/F	Noctuidae	*Staurophora celsia*	0	0	0	0	0	9	9
P	Erebidae	*Catocala fraxini*	0	0	0	0	1	1	2
P	Noctuidae	*Catephia alchymista*	0	1	0	0	0	0	1
P	Nymphalidae	*Apatura ilia*	0	0	0	0	2	0	2
F	Erebidae	*Catocala hymenaea*	0	1	75	0	0	0	76
F	Erebidae	*Herminia tenuialis*	0	0	0	0	0	1	1
F	Geometridae	*Euphya unangulata*	0	0	0	0	2	0	2
F	Geometridae	*Idaea muricata*	0	0	0	0	0	14	14
F	Noctuidae	*Eucarta amethystina*	0	0	0	0	2	0	2
F	Noctuidae	*Eucarta virgo*	22	0	0	0	14	1	37
F	Noctuidae	*Diarsia rubi*	0	0	0	0	0	5	5
F	Noctuidae	*Euxoa segnilis*	0	0	0	0	2	7	9
F	Noctuidae	*Xestia castanea*	0	0	0	0	2	0	2
F	Noctuidae	*Xestia sexstrigata*	0	0	0	0	2	2	4
F	Noctuidae	*Agrochola humilis*	3	3	2	0	0	8	16
F	Noctuidae	*Agrochola laevis*	3	9	2	0	0	34	48
F	Noctuidae	*Agrochola lota*	0	0	1	0	33	0	34
F	Noctuidae	*Atethmia centrago*	0	0	0	0	4	0	4
F	Noctuidae	*Blepharita satura*	0	0	0	0	0	1	1
F	Noctuidae	*Dryobotodes eremita*	45	7	14	0	0	0	66
F	Noctuidae	*Helotropha leucostigma*	0	0	0	0	0	1	1
F	Noctuidae	*Tiliacea citrago*	0	0	0	0	1	0	1
F	Noctuidae	*Xylena exsoleta*	5	3	20	14	0	12	54
Number of valuable species			7	7	7	1	14	15	28
Number of protected species			2	2	1	0	5	4	9
Number of valuable individuals			84	25	115	14	71	102	411
Number of protected individuals			6	2	1	0	9	16	34
Ratio of valuable individuals			2.88	2.69	3.43	0.24	4.49	3.98	2.40
Ratio of protected individuals			0.21	0.22	0.03	0.00	0.57	0.62	0.20
Total number of identified Lepidoptera			2921	930	3351	5810	1583	2563	17158

ACKNOWLEDGEMENT

Szabolcs Szanyi was supported by the Collegium Talentum grant of the Edutus High School.

REFERENCES

Chreighton, C. S.-Mcfadden, T. L.-Cuthbert, E. R. (1973): Supplementary data on phenylacetaldehyde: an attractant for lepidoptera.

Cantelo, W. W.-Jacobson, M. (1979): Phenylacetaldehyde attracts moths to bladder flower and blacklight traps. *Environmental Entomology* 8:444–447.

Jermy, T.-Balázs, K. (1993): A növényvédelmi állattan kézikönyve 4/A-B. Akadémiai Kiadó, Budapest. 830 p.

Kádár, M.-Petrányi, G.-Ronkay G.-Ronkay, L. (2010): A magyarországi bagolylepkék (Lepidoptera, Noctuidae) fényképes határozója. (Photographic identification guide to the noctuids (Lepidoptera, Noctuidae) of Hungary). Szalkay József Magyar Lepkészeti Egyesület. Budapest.

KÖM (2001): 13/2001. (V. 9.) KöM rendelet a védett és a fokozottan védett növény- és állatfajokról, a fokozottan védett barlangok köréről, valamint az Európai Közösségben természetvédelmi szempontból jelentős növény- és állatfajok közzétételéről.

Landolt, P. J.(2000): New chemical attractants for trapping Lacanobia subjuncta, Mamestra configurata, and Xestia c-nigrum (Lepidoptera: Noctuidae). *Journal of Economical Entomology* 93: 101–106.

Landolt, P. J.-Alfaro, J. F. (2001): Trapping Lacanobia subjuncta, Xestia c-nigrum and Mamestra configurata (Lepidoptera: Noctuidae) with acetic acid and 3-methyl-1-butanol in controlled relesase dispensers. *Environmental Entomology* 30: 656–662.

Mészáros Z.-Szabóky, Cs. (2012): A magyarországi nagylepkék gyakorlati albuma. Szalkay József Magyar Lepkészeti Egyesület. Budapest, 185 pp.

Nagy, A.-Szarukán, I.-Gém, F.-Nyitrai, R.-Tóth, M. (2014): Vizsgálatok bagolylepkék (Lepidoptera: Noctuidae) fogására kifejlesztett szintetikus illatanyag csalétkek hatékonyságának növelésére. *Agrártudományi Közlemények (Acta Agraria Dedreceniensis)* 2014/62: 86-91.

Olenici, N.-Capuse, I.-Olenici, V.-Oprean, I.-Mihalciuc, V. (2007): Non-target Lepidopteran species in pheromone traps baited with attractants for several Tortricid moths. *Annalele ICAS* 50: 185-201.

Szabóky, Cs.-Leskó, K. (1999): Lepidoptera – lepkék. 354 – 409. In: Tóth, J. (Ed.): Erdészeti rovartan. Agroinform kiadó. Budapest.

Tóth, J. (1999): Erdészeti rovartan. Agroinform Kiadó, Budapest. 480 p.

Tóth, M.-Szarukán, I.-Dorogi B.-Gulyás, A.-Nagy, P.-Rozgonyi, Z. (2010): Male and female Noctuid moths attracted to synthetic lures in Europe. *Journal of Chemical Ecology* 36: 592-598.
Tóth, M.-Szarukán, I.-Nagy, A.-Gém, F.-Nyitrai, R.-Kecskés, Zs.-Krakkó, L.-Jósvai, J. K.-Bélai, I. (2015): Félszintetikus "biszex" csalétkek kártevő rovarok nőstényeinek és hímjeinek fogására. *Növényvédelem* 51(5): 197-205.
Varga, Z. (2011): Magyarország nagylepkéi – Macrolepidoptera of Hungary. Heterocera Press, Budapest, 354 p.

Appendix 1

List of the sampled Lepidoptera species with their taxonoamy and conservational status. Pest species are signed with asterix (*). P: protescted, F: faunistically interesting

		Family	Subfamily	Species
		Hepialidae		*one unidentified species*
	*	Pyralidae	Pyralinae	*Hypsopygia costalis* (Fabricius 1775)
	*	Pyralidae	Pyralinae	*Pyralis farinalis* (Linnaeus, 1758)
	*	Pyralidae	Pyraustinae	*Ostrinia nubilalis* (Hübner, 1796)
P		Nymphalidae	Apaturinae	*Apatura ilia* ([Denis & Schiff ermüller], 1775)
		Nymphalidae	Nymphalinae	*Araschnia levana* (Linnaeus, 1758)
		Nymphalidae	Nymphalinae	*Nymphalis c-album* (Linnaeus, 1758)
		Nymphalidae	Satyrinae	*Minois dryas* (Scopoli, 1763)
		Nymphalidae	Satyrinae	*Pararge aegeria tircis* (Godart, 1821)
		Sphingidae	Macroglossinae	*Deilephila porcellus* (Linnaeus, 1758)
		Geometridae	Ennominae	*Apeira syringaria* (Linnaeus, 1758)
		Geometridae	Ennominae	*Cabera exanthemata* (Scopoli, 1763)
	*	Geometridae	Ennominae	*Ectropis crepuscularia* ([Denis et Schiffermüller], 1775)
		Geometridae	Ennominae	*Ematurga atomaria* (Linnaeus, 1758)
		Geometridae	Ennominae	*Hypomecis punctinalis* (Scopoli, 1763)
		Geometridae	Ennominae	*Hypomecis roboraria* ([Denis & Schiffermüller], 1775)
		Geometridae	Ennominae	*Ligdia adustata ([Denis & Schiffermüller], 1775)*
		Geometridae	Ennominae	*Macaria notata* (Linnaeus, 1758)
	*	Geometridae	Ennominae	*Peribatodes rhomboidaria* ([Denis & Schiffermüller], 1775)
		Geometridae	Larentiinae	*Cosmorhoe ocellata* (Linnaeus, 1758)
		Geometridae	Larentiinae	*Epirrita autumnata* (Borkhausen, 1794)
F		Geometridae	Larentiinae	*Euphya unangulata* (Haworth, 1809)
		Geometridae	Sterrhinae	*Idaea aversata* (Linnaeus, 1758)
F		Geometridae	Sterrhinae	*Idaea muricata* (Hufnagel, 1787)
		Geometridae	Sterrhinae	*Timandra comae* (Schmidt, 1931)
	*	Thyatiridae	Thyatirinae	*Habrosyne pyrithoides* (Hufnagel, 1766)
		Thyatiridae	Thyatirinae	*Tethea ocularis* (Linnaeus, 1758)
		Thyatiridae	Thyatirinae	*Tethea or* ([Denis et Schiffermüller], 1775)
	*	Thyatiridae	Thyatirinae	*Thyatira batis* (Linnaeus, 1758)
		Nolidae	Nolinae	*Nola cristatula (Hübner, 1793)*
		Nolidae	Nolinae	*Nycteola degenerana* (Hübner, 1799)
	*	Erebidae	Arctiinae	*Phragmatobia fuliginosa* (Linnaeus, 1758)
		Erebidae	Aventiinae	*Trisateles emortualis* ([Denis & Schiff ermüller], 1775)
	*	Erebidae	Calpinae	*Scoliopteryx libatrix* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala electa* (Vieweg, 1790)
		Erebidae	Catocalinae	*Catocala elocata* (Esper, 1788)
P		Erebidae	Catocalinae	*Catocala fraxini* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala fulminea* (Scopoli, 1763)
F		Erebidae	Catocalinae	*Catocala hymenaea* ([Denis & Schiff ermüller], 1775)
		Erebidae	Catocalinae	*Catocala nupta* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Catocala promissa* (Denis & Schiffermüller, 1775)
		Erebidae	Catocalinae	*Catocala sponsa* (Linnaeus, 1767)
		Erebidae	Catocalinae	*Dysgonia algira* (Linnaeus, 1767)
	*	Erebidae	Catocalinae	*Euclidia glyphica* (Linnaeus, 1758)
		Erebidae	Catocalinae	*Lygephila craccae* ([Denis & Schiff ermüller], 1775)
		Erebidae	Catocalinae	*Lygephila pastinum* (Treitschke, 1826)
		Erebidae	Eustrotiinae	*Protodeltote pygarga* (Hufnagel, 1766)
		Erebidae	Herminiinae	*Herminia grisealis* ([Denis & Schiff ermüller], 1775)
		Erebidae	Herminiinae	*Herminia tarsipennalis* (Treitschke, 1835)
F		Erebidae	Herminiinae	*Herminia tenuialis* (Rebel,1899)
		Erebidae	Hypeninae	*Hypena proboscidalis* (Linnaeus, 1758)
		Erebidae	Hypeninae	*Hypena rostralis* (Linnaeus, 1758)
		Erebidae	Lithosiinae	*Eilema griseola* (Hübner, 1803)
		Erebidae	Lithosiinae	*Lithosia quadra* (Linnaeus, 1758)
		Erebidae	Lithosiinae	*Pelosia muscerda* (Hufnagel, 1766)
		Erebidae	Lithosiinae	*Wittia sororcula* (Hufnagel, 1766)
	*	Erebidae	Lymantriinae	*Lymantria dispar* Linnaeus, 1758
	*	Erebidae	Lymantriinae	*Lymantria monacha* (Linnaeus, 1758)

Continuation of Appendix 1.

	Family	Subfamily	Species
	Noctuidae	Acontiinae	*Aedia leucomelas* (Linnaeus, 1758)
	Noctuidae	Acronictinae	*Acronicta auricoma* ([Denis & Schiff ermüller], 1775)
	Noctuidae	Acronictinae	*Acronicta euphorbiae* ([Denis & Schiff ermüller], 1775)
*	Noctuidae	Acronictinae	*Acronicta megacephala* ([Denis & Schiff ermüller], 1775)
*	Noctuidae	Acronictinae	*Acronicta psi* (Linnaeus, 1758)
*	Noctuidae	Acronictinae	*Acronicta rumicis* (Linnaeus, 1758)
	Noctuidae	Acronictinae	*Craniophora ligustri* ([Denis & Schiffermüller], 1775)
	Noctuidae	Acronictinae	*Moma alpium* (Osbeck, 1778)
	Noctuidae	Amphipyrinae	*Amphipyra berbera svenssoni* (Fletcher, 1968)
	Noctuidae	Amphipyrinae	*Amphipyra livida* ([Denis & Schiff ermüller], 1775)
	Noctuidae	Amphipyrinae	*Amphipyra pyramidea* (Linnaeus, 1758)
	Noctuidae	Amphipyrinae	*Amphipyra tragopoginis* (Clerck, 1759)
	Noctuidae	Bryophilinae	*Cryphia algae* (Fabricius, 1775)
P	Noctuidae	Catocalinae	*Catephia alchymista* ([Denis & Schiff ermüller], 1775)
F	Noctuidae	Condicinae	*Eucarta amethystina* (Hübner, 1803)
F	Noctuidae	Condicinae	*Eucarta virgo* (Treitschke, 1825)
	Noctuidae	Cryphiinae	*Globia algae* (Esper, 1789)
	Noctuidae	Ctenuchinae	*Amata phegea* (Linnaeus, 1758)
	Noctuidae	Hadeninae	*Hada plebeja* (Linnaeus, 1761)
*	Noctuidae	Hadeninae	*Hadula trifolii* (Hufnagel, 1766)
	Noctuidae	Hadeninae	*Lacanobia contigua* ([Denis & Schiff ermüller], 1775)
*	Noctuidae	Hadeninae	*Lacanobia oleracea* (Linnaeus, 1758)
*	Noctuidae	Hadeninae	*Lacanobia suasa* ([Denis & Schiffermüller], 1775)
	Noctuidae	Hadeninae	*Lacanobia thalassina* (Hufnagel, 1766)
	Noctuidae	Hadeninae	*Lacanobia w-latinum* (Hufnagel, 1766)
	Noctuidae	Hadeninae	*Leucania obsoleta* (Hübner 1803)
*	Noctuidae	Hadeninae	*Mamestra brassicae* (Linnaeus, 1758)
	Noctuidae	Hadeninae	*Mythimna (Mythimna) pallens* (Linnaeus, 1758)
	Noctuidae	Hadeninae	*Mythimna albipuncta* ([Denis et Schiffermüller], 1775)
	Noctuidae	Hadeninae	*Mythimna ferrago* (Fabricius, 1787)
	Noctuidae	Hadeninae	*Mythimna l-album* (Linnaeus, 1767)
	Noctuidae	Hadeninae	*Mythimna turca* (Linnaeus, 1761)
	Noctuidae	Hadeninae	*Mythimna vitellina* (Hübner, 1808)
	Noctuidae	Hadeninae	*Tholera cespitis* ([Denis & Schiffermüller], 1775)
*	Noctuidae	Heliothinae	*Helicoverpa armigera* (Hübner, 1808)
	Noctuidae	Heliothinae	*Pyrrhia umbra* (Hufnagel, 1766)
*	Noctuidae	Noctuinae	*Agrotis exclamationis* (Linnaeus, 1758)
*	Noctuidae	Noctuinae	*Agrotis ipsilon* (Hufnagel, 1766)
*	Noctuidae	Noctuinae	*Agrotis segetum* ([Denis et Schiffermüller], 1775)
	Noctuidae	Noctuinae	*Axylia putris* (Linnaeus, 1761)
F	Noctuidae	Noctuinae	*Diarsia rubi* (Vieweg, 1790)
F	Noctuidae	Noctuinae	*Euxoa segnilis (*Duponchel, 1837)
	Noctuidae	Noctuinae	*Metagnorisma depuncta* (Linnaeus, 1761)
	Noctuidae	Noctuinae	*Noctua fimbriata* (Schreber, 1759)
	Noctuidae	Noctuinae	*Noctua interjecta* Hübner, 1803
	Noctuidae	Noctuinae	*Noctua interposita* (Hübner, 1790)
	Noctuidae	Noctuinae	*Noctua janthe* (Borkhausen, 1792)
	Noctuidae	Noctuinae	*Noctua janthina* ([Denis & Schiffermüller], 1775)
	Noctuidae	Noctuinae	*Noctua orbona* (Hufnagel, 1766)
*	Noctuidae	Noctuinae	*Noctua pronuba* (Linnaeus, 1758)
	Noctuidae	Noctuinae	*Ochropleura plecta* (Linnaeus, 1761)
	Noctuidae	Noctuinae	*Xestia baja* ([Denis & Schiffermüller], 1775)
F	Noctuidae	Noctuinae	*Xestia castanea* (Esper, 1798)
*	Noctuidae	Noctuinae	*Xestia c-nigrum* (Linnaeus, 1758)
F	Noctuidae	Noctuinae	*Xestia sexstrigata* (Haworth, 1809)
	Noctuidae	Noctuinae	*Xestia xanthographa* ([Denis & Schiff ermüller], 1775)
	Noctuidae	Oncocnemidinae	*Calophasia lunula* (Hufnagel, 1766)
*	Noctuidae	Pantheinae	*Colocasia coryli* (Linnaeus, 1758)
*	Noctuidae	Plusiinae	*Autographa gamma* (Linnaeus, 1758)
*	Noctuidae	Plusiinae	*Macdunnoughia confusa* (Stephens, 1850)
	Noctuidae	Psaphidinae	*Allophyes oxyacanthae* (Linnaeus, 1758)
P/F	Noctuidae	Psaphidinae	*Meganephria bimaculosa* (Linnaeus, 1767)
	Noctuidae	Rivulinae	*Rivula sericealis* (Scopoli, 1763)
	Noctuidae	Xyleninae	*Actinotia polyodon* (Clerck, 1759)
*	Noctuidae	Xyleninae	*Agrochola circellaris* (Hufnagel, 1766)
	Noctuidae	Xyleninae	*Agrochola helvola* (Linnaeus, 1758)
F	Noctuidae	Xyleninae	*Agrochola humilis* ([Denis & Schiff ermüller], 1775)
F	Noctuidae	Xyleninae	*Agrochola laevis* (Hübner, 1803)
	Noctuidae	Xyleninae	*Agrochola litura* (Linnaeus, 1758)
F	Noctuidae	Xyleninae	*Agrochola lota* (Clerck, 1759)
	Noctuidae	Xyleninae	*Agrochola lychnidis* ([Denis & Schiff ermüller], 1775)
	Noctuidae	Xyleninae	*Agrochola macilenta* (Hübner, 1803)
	Noctuidae	Xyleninae	*Agrochola nitida* ([Denis et Schiffermüller], 1775)

Continuation of Appendix 1.

		Family	Subfamily	Species
		Noctuidae	Xyleninae	*Ammoconia caecimacula* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Apamea anceps* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Apamea lithoxylaea* ([Denis & Schiffermüller], 1775)
		Noctuidae	Xyleninae	*Apamea monoglypha* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Aporophyla lutulenta* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Xyleninae	*Atethmia centrago* (Haworth, 1809)
		Noctuidae	Xyleninae	*Athetis furvula* (Hübner, 1808)
		Noctuidae	Xyleninae	*Athetis gluteosa* (Treitschke, 1835)
F		Noctuidae	Xyleninae	*Blepharita satura* ([Denis & Schiff ermüller], 1775)
F		Noctuidae	Xyleninae	*Brachylomia viminalis* (Fabricius, 1777)
		Noctuidae	Xyleninae	*Caradrina clavipalpis* (Scopoli, 1763)
		Noctuidae	Xyleninae	*Caradrina kadenii* Freyer, 1836
		Noctuidae	Xyleninae	*Caradrina morpheus* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Cirrhia gilvago* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Cirrhia icteritia* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Cirrhia ocellaris* (Borkhausen, 1792)
		Noctuidae	Xyleninae	*Conistra erythrocephala* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Conistra ligula* (Esper, 1791)
		Noctuidae	Xyleninae	*Conistra rubiginosa* (Scopoli, 1763)
	*	Noctuidae	Xyleninae	*Conistra vaccinii* (Linnaeus, 1761)
		Noctuidae	Xyleninae	*Conistra veronicae* (Hübner, 1813)
		Noctuidae	Xyleninae	*Cosmia affinis* (Linnaeus, 1767)
	*	Noctuidae	Xyleninae	*Cosmia trapezina* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Dryobotodes eremita* (Fabricius, 1775)
		Noctuidae	Xyleninae	*Dypterygia scabriuscula* (Linnaeus, 1758)
P/F		Noctuidae	Xyleninae	*Enargia paleacea* (Esper, 1788)
		Noctuidae	Xyleninae	*Euplexia lucipara* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Eupsilia transversa* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Griposia aprilina* (Linnaeus, 1758)
F		Noctuidae	Xyleninae	*Helotropha leucostigma* (Hübner, [1808])
		Noctuidae	Xyleninae	*Hoplodrina ambigua* ([Denis & Schiffermüller, 1775])
		Noctuidae	Xyleninae	*Hoplodrina blanda* ([Denis & Schiffermüller, 1775])
		Noctuidae	Xyleninae	*Lithophane ornithopus* (Hufnagel, 1766)
P/F		Noctuidae	Xyleninae	*Lithophane semibrunnea* (Haworth, 1809)
		Noctuidae	Xyleninae	*Mesapamea secalella* Remm, 1983
		Noctuidae	Xyleninae	*Mesapamea secalis* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Mesogona acetosellae* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Mesoligia furuncula* ([Denis & Schiff ermüller], 1775)
P/F		Noctuidae	Xyleninae	*Mormo maura* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Oligia latruncula* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Oligia strigilis* (Linnaeus, 1758)
P/F		Noctuidae	Xyleninae	*Orbona fragariae* (Vieweg, 1790)
		Noctuidae	Xyleninae	*Parastichtis suspecta* (Hübner, 1817)
	*	Noctuidae	Xyleninae	*Phlogophora meticulosa* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Pseudeustrotia candidula* ([Denis et Schiffermüller], 1775)
		Noctuidae	Xyleninae	*Rusina ferruginea* (Esper, 1785)
P/F		Noctuidae	Xyleninae	*Staurophora celsia* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Thalpophila matura* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Tiliacea aurago* (Denis & Schiffermüller, 1775)
F		Noctuidae	Xyleninae	*Tiliacea citrago* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Trachea atriplicis* (Linnaeus, 1758)
		Noctuidae	Xyleninae	*Xanthia gilvago* ([Denis & Schiff ermüller], 1775)
		Noctuidae	Xyleninae	*Xanthia icteritia* (Hufnagel, 1766)
		Noctuidae	Xyleninae	*Xanthia ocellaris* (Borkhausen, 1792)
		Noctuidae	Xyleninae	*Xanthia togata* (Esper, 1788)
F		Noctuidae	Xyleninae	*Xylena exsoleta* (Linnaeus, 1758)

Növényvédelmi feladatok a Hévízi Természetvédelmi Területen

Bürgés György[1] - Németh György[2]
[1]Pannon Egyetem Georgikon Kar, Keszthely
[2]Hévízgyógyfürdő és Szent András Reumakórház, Hévíz
burges.gyorgy@gmail.com

ÖSSZEFOGLALÁS

A Hévízgyógyfürdő és Szent András Reumakórház, Hévíz gondozásában lévő park közel 60 hektárt tesz ki. Ezen terület a város dél-keleti részéhez csatlakozik, változatos terepviszonyokkal, szintkülönbségekkel. A kórház épületei jórészt a park közepén helyezkednek el. A sétánytól keleti irányban van a híres Hévízi tó, illetve Tófürdő, a csatlakozó déli és északi kifolyókkal. Azok körletében – az alacsony szint miatt – találhatók a kisebb-nagyobb kiterjedésű vizes élőhelyek a maguk flórájával. A kórház épületei a „hegyvonulat" tövében helyezkednek el. Felette található a nyugati véderdő, futballpályával és a város kisebb kerületével. Az északi véderdő a Tófürdő északkeleti oldalán, mély fekvésű, lápos területen helyezkedik el. Rendeltetése ezen sétaparknak az északi széljárás mérséklése, amely a forrás vízének lehűlését lassítja. A részletesnek tűnő bevezetés bizonyítja a szerteágazó természet-, környezet és növényvédelmi feladatokat, illetve azok megoldási sokaságát. A Tófürdő és a környező városrészek eltérő és speciális biotópok, ezért a növényvédelmi kérdések megoldása fokozott figyelmet követel.

SUMMARY

The nature conservation park, which belongs to the Spa and St. Andrew Hospital for Rheumatics of Hévíz, is 60 ha in size. The famous Lake of Hévíz, the two overfalls and the main buildings of the hospital are located in the middle of the park. They are surrounded by protective forests, parks and gravel esplanades. During the past few decades, the population of neophyton plants and invasive insects have increased considerably. These mean serious challanges to develop efficient control methods. Special care must be taken of environmental and plant protection regulations. Keeping plant protective regulations are especially strict around natural and spa waters.

Kulcsszavak: természetvédelem, környezetvédelem, fauna, inváziós rovarok, flóra, özönnövények, erdei ökoszisztémák
Keywords: nature conservation, environment protection, fauna, invasive insects, flora, invasive weeds, forestry ecosystems

CÉLKITŰZÉS

A hévízi természetvédelmi park károsító faunájának, flórájának feltárása.
Potenciálisan veszélyes károsítók kiszűrése, életmódjuk tisztázása.
Védekezési lehetőségek – skálájának bővítése – kidolgozása.

ANYAG ÉS MÓDSZER

Vizsgálataink és feladataink 1996-ban kezdődtek. Az ezredfordulón kiszélesedtek kutatási feladataink, melyek a parkok, véderdők dísz- és fásnövényeire irányultak. Monitoring tevékenységünket hetenként 2-3 alkalommal végezzük a különböző biotópokban.

A korlátozott terjedelem és az előadás több irányú témája miatt a vizsgálati módszerekkel nem áll módunkban bővebben foglalkozni. Azokat azonban az előadás során részletesen bemutatjuk, szemléltetjük, továbbá az irodalomjegyzékben szereplő publikációk bőségesen tartalmazzák.

IRODALMI ÁTTEKINTÉS

A park- és díszfákról történő tömör ismertetőt, színes ábrákkal Horánszky (2001) és Maráczi (2013) könyvében találhatjuk. Az említett növények betegségeivel, kártevőivel Griegel (2003) részletesen foglalkozik. Az özönnövényekkel kiemelten foglalkozik Mihály és Botta-Duka (2004) kötete, míg a fás növények inváziós rovarai Tuba *et al.* (2012) szép kivitelű könyve alapján könnyen felismerhetők. A szóban forgó károsítók (kártevők, kórokozók, gyomok) életmódjával és az ellenük való védekezési lehetőségekkel több publikáció foglalkozik: Czencz és Bürgés (1996) a vadgesztenye aknázó mollyal kapcsolatos írása, Bürgés *et al.* (1997) munkájában a platánfák károsítói elleni védekezési lehetőségekről olvashatunk. Bürgés *et al.* (2011) közleménye a termetes és nehezen megközelíthető fák injektálását ismerteti.

EREDMÉNYEK

A növényvédelmi feladatokat az eltérő domborzat és eltérő talajadottság változatossá teszi. Az özönnövények irtása kötelező a természetvédelmi parkokban.

Véderdők

„Újhonos", özönnövények vagy neofitonok

A **Nyugati véderdő**ben a bálványfa *(Alianthus altissima)* és a zöldjuhar *(Acer negundo)* felszaporodása az elmúlt 1-2 évtizedben erősödött. A féken tartásukhoz két herbicides kezelés (május és augusztus vége) vált szükségessé. A kivágott idősebb fák lombkoronája alatt kikelő magoncok és gyökérsarjak ellen háromszor permeteztünk. A glifozát hatóanyag-csoportba tartozó szerek (Glyfos, Clinic 480 SL, Medallon, Glialka 3,5 %-os dózis) kielégítő eredményt adtak. Végleges kiirtásukhoz azonban több év szükséges. Az idősebb „kapanyél" keresztmetszetű gyökér- és tősarjakat ecsetelés formájában kezeltük. A zöldjuhar herbicid-érzékenysége közel azonos, mint a bálványfáé. Védekezéseink hatékonyságát rontják a szomszédos és egyéb közterületek elhanyagoltsága és gazdáinak hanyagsága. Ugyanis a széllel terjedő magvak gyengítik saját munkánk eredményességét.

Északi véderdő: lápos, alacsony fekvésű, vizes talaján uralkodó neofita gyomfajok: japán keserűfű *(Fallopia japonica)*, gyalogakác *(Amorpha fruticosa)* és a zöldjuhar *(Acer negundo)*. Nevezett fajok vitalitása jó. Bizonyítja ezt a kezeléseket követően a távolabbi gyökérsarjak ismételt fakadási hajlamossága. A Medallon prémium (Glifozát) 3 %-os dózisa, kétszeri kezeléssel eredményesnek bizonyult. A felszaporodó japán keserűfű herbicid érzékenysége jobb, mint az előző fásszárú növényeké.

Őshonos növényi paraziták

Borostyán (*Hedera helix*) főként az alacsony fekvésű, nyirkos talajú parkfákon szaporodik fel. Évekig hordják terheit a félparazita növénynek az idősebb fák. Hajtásaik a fák törzsén kapaszkodnak, miközben zöld leveleikkel asszimilálnak.

Védekezés: talaj közelében, a fásodott szárak elfűrészelésével a növény vízfelvétele megszakad, ezért a levelek néhány hét után elszáradnak. A következő évben ezen száraz ágak könnyebben eltávolíthatóak. Azonban a gyökérzóna ismét kihajt, de 1-2 év után – göllerollóval – könnyedén lemetszhető az új növedék.

Fagyöngy (*Viscum album*): a félparazita növény főként az idősebb éger fafajokon szaporodott fel. A fák felső harmadában, a fák csúcsán gyakoribb, mivel fényigényes. A madarak ürülékükkel terjesztik a fehér termés magját.

Irtása, illetve eltávolítása nehézkes a fás részek „összeforradása" és a 6-15 m fertőzési magasság miatt. Alacsony növekedésű gyümölcsfákról könnyebben eltávolítható a metszések alkalmával. Újabban vegyszeres irtásáról is van tudomásunk, a téli nyugalmi állapot idején.

Fakín (*Loranthus europaeus*), e rokon faj lombhullató, és a termése sárga színű. Előfordulása nem gyakori, csupán észlelési szinten találkoztunk vele munkaterületünkön.

Sétányok és útmenti parkfák

A nevezett területek domináns fajai: a vadgesztenye, platán- és a hársfák.

Vadgesztenye *(Aesculus hippocastanum)*

Fő inváziós kártevője a **vadgesztenye levél-aknázómoly** (*Cameraria ohridella*). A faj három generációs. A rajzás illat-csapdával nyomon követhető. Jól időzített két védekezéssel e kártevő visszaszorítható. Telelése az avarban, báb alakban történik. Ezért fontos az avar égetése, vagy komposztálás. Beteg, idős fák pótlására – az utóbbi években – az ellenálló, pirosvirágú vadgesztenyét (*Aesculus carnea*) telepítjük.

A vegyszeres védekezést sorfák esetén permetezéssel (Dimilin 25 WP) végezzük, míg a nehezen megközelíthető egyedi fákat injektálással (Vivid II.) védjük meg.

Levélbarnulást okozó gomba *(Guignardaria aesculi)*. Jellegzetes tünete a levélerekkel határolt fertőzött foltok elhalása. Kombinált védekezéssel (inszekticid + fungicid + tapadásfokozó szer + lombtrágya) jó eredményt értünk el a vadgesztenya károsítók ellen.

Platánfák *(Platanus* spp.)

Platánpoloska (*Corythuca ciliata*): e jövevény faj 40 éve jelent meg hazánkban. Évenként két nemzedéket képez, és a kifejlett alakja telel át a kéreghéj alatt. A felmelegedéstől függően áprilisban telepednek a zsenge levélkék fonáki részére. A fiatal lárvák barna ürülékcseppjei környezetszennyezőek. A kártevő felszaporodásának – szívogatásuk eredményeként – a levelek kifakulnak, elsárgulnak és korán lehullanak. Kártételük évenként két vegyszeres védekezéssel féken tartható.

Platán levélfoltosság (*Apiognomonia veneta*): a hűvös, esős tavasz - nyár a jellegzetes betegség kialakulásának kedvező. A leveleken, az erek mentén barna nekrózis látható, míg a hajtásvégek fonnyadnak, elszáradnak, majd lehullnak.

Védekezés: a fenti 3 probléma megoldható kétszeri kombinált permetezés formájában (inszekticid + fungicid + tapadásfokozó + lombtrágya).

Hársfák **(*Tilia* spp.)**

Hárslevél-sátorosmoly (*Phyllonorycter issikii*): az inváziós faj előfordulását valamennyi hárs fajon (kis levelű-, nagy levelű és ezüsthárs) kis egyedsűrűségben tapasztaltuk. Az új vendégfaj Japánból terjed Európa felé. A mikrolepke fénylő sárga, a lárva halványsárga színű. A faj két nemzedékes. Babszemnyi aknáiban szembetűnő az ürülékcsomó.

Puszpáng (buxus) bokrok (*Buxus sempervirens*)

Selyemfényű puszpángmoly (*Cydalima perspectalis*): Ebben az évtizedben jelent meg hazánkban. Erős felszaporodása Nyugat-Magyarországon tűnt fel először. Az örökzöld puszpáng bokrokat szinte letarolják a három nemzedék lárvái. Kárképük főként a temetők örökzöld bokrain szembetűnő.

Selyemakác (mimóza) (*Albizia julibrissen*)

Selyemakác levélbolha (*Acizzia jamatonica*): Ázsiából származó, új kártevő. 2 mm, szürkés színű, szúró-szívó szájszervű, ugró rovar. A kifejlett alak és lárvája levelet szívogat, amely elsárgul, hervad, majd lehullik. A lila, bóbitás virágzat elhervad, satnya lesz. Károsításukat bőséges mézharmat jellemzi, amelyet a korompenész megtelepedése követ. A vegyszeres védekezés hatékonyságát gyengíti a rovar viaszos teste.

ÖSSZEFOGLALÁS

A természetvédelmi parkban – védekezés céljára – csakis „közterületi szerek” alkalmazhatóak.
A sétány menti termetes parkfák átlagosan két kezelésben részesülnek a tenyészidőszakban. E munkák kivitelezését a ROVÉRT végzi.
A szigorú szabályzat különösen vonatkozik a Tófürdő és a két kifolyó közeli állományok kezelésére. E helyeken a vegyszeres kezelések az esti, gyógyfürdő bezárását követő időpontban végezhetőek.

IRODALOM

Bürgés Gy. - Bem J. - Szidonya J. (2011): Növényorvosi beavatkozás egyes fás növények kártevői ellen. Növényvédelmi Fórum, Keszthely.

Bürgés Gy. - Czencz K. - Fischl G. - Törőcsik P. (1997): Platánfák levélkártevőivel kapcsolatos vizsgálatok és eredmények. Növényvédelem, 33 (1): 23-27. p.

Czencz K. - Bürgés Gy. (1996): A vadgesztenye levélakánzómoly *(Cameraria ohridella) Descka et Dimic*. Növényvédelem, 32 (9): 437-444. p.

Griegel, A. (2003): Mein gesunder Ziergarten. Díszfák, díszcserjék betegségei és kártevői. Silvanus Kiadó, Fertőszentmiklós.

Horánszky A. (2001): Fák kertben, parkban és a szabad természetben. Magyar Könyvkiadó, Budapest

Maráczi L. (2013): Díszfák, díszcserjék védelme. Nyugat-Dunántúli Díszfaiskolák Egyesülete, Szombathely. 622pp.

Mihály B. - Botta Dukát Z. (2004): Biológiai invázió Magyarországon. Özönnövények. Búvár Kiadó, Budapest

Tuba K. - Horváth B. - Lakatos F. (2012): Inváziós rovarok fás növényeken. Nyugat-magyarországi Egyetem Erdőmérnöki Kar, Sopron

Host plant preference of *Metcalfa pruinosa* (Say, 1830) (Hemiptera: Flatidae) in the north of Hungary

András Bozsik
University of Debrecen, Institute of Plant Protection, Debrecen, Hungary
bozsik@agr.unideb.hu

SUMMARY

Citrus flatid planthopper, a native insect to North America had for a long time a scarce economic importance there. However, being polyphagous made little damage on citrus trees and some ornamentals. In 1979 it was introduced to Italy where it established and spread quickly. It is now an invasive alien species continually spreading in South and Central Europe causing considerable damage in fruit crops and various ornamentals. Present study shows the results of a series of observations carried out from 2011 to 2015 at a number of habitats in north of Hungary. The pest could be found at each habitat but the hedge, the tree row, the gardens and the orchard/vineyard were the most infested. Frequency and population density of Metcalfa pruinosa *were considerable on Asteraceae, Cannabaceae, Fabaceae, Juglandaceae, Lamiaceae, Rosaceae and Sapindaceae. Typical vegetation could be functionally classified as ornamental plants, trees/shrubs, fruit plants, weeds and feral plants. Feral plants – some of them also invasive alien species – were found at each habitat. Plant species native to America were among them the most populated. As the hedgerows were neglected, and most gardens, orchards and vineyards abandoned, these are excellent conditions for the quick and long-lasting establishment of the pest as well as they may be reservoirs to infest cultivated fruit crops and ornamentals. The hedgerow was situated along a railway line. The length of similar hedges can be merely in Pest county several hundred km, which means* M. pruinosa *has plenty of opportunity for spreading along the railway and infest agricultural and ornamental cultures. On the surveyed alfalfa and maize fields, accidentally very few nymphs and adults were observed. Although, the population density of* M. pruinosa *was considerable on many hostplants, economic damage or yield losses could not be detected. Economic or significant damage was observed only on roses, raspberries and stinging nettle. This later is cultivated in Germany and Finland. The applied horticultural oil was efficient.*

Keywords: *Metcalfa pruinosa*, host plant, hedgerow, tree row, garden, orchard, vineyard

INTRODUCTION

Citrus flatid planthopper (CFP) *Metcalfa pruinosa* (Say, 1870) is native to North America from where it was accidentally introduced to Italy in 1979 (Zangheri and Donadini, 1980). After a rapid spreading in Italy it managed to get to more than 15 European countries (Strauss, 2010). Its harm is little in the USA: some fruit trees and ornamentals suffered little damage and aesthetic injury (Mead, 1969). Being polyphagous, *M. pruinosa* attacked various cultivated and wild trees, shrubs and weedy plants in Italy (Bagnali and Luccchi 2000). Sucking of nymphs can cause deformation and injury of shoots and twigs leading to wilt and destruction. Grape quality damaged considerably as a consequence of nymphs' feeding (acidity and sugar content altered) and also soybean suffered a 30-40% yield loss in Italy (Ciampolini *et al*., 1987). Grape quality decreased heavily by the honeydew production of *M. pruinosa* and the following sooty mould formation in France (Della Giustina and Navarra, 1993). Ornamentals in nurseries and parks are in danger because of the waxy filaments produced on leaves and shoots by CFP (Lauterer, 2002; Strauss, 2010). It was revealed that some *M. pruinosa* were infested with various phytoplasmas but they could not transmit them in experiments (Bressan *et al*., 2006 in Strauss, 2010).

In Europe, *M. pruinosa* has been settled in Italy, France (Della Giustina, 1986), Slovenia (Sivic, 1991 in Strauss 2010), Switzerland (Jermini *et al*., 1995), Croatia (Maceljski *et al*., 1995 in Strauss, 2010), Austria (Kahrer and Moosbeckhofer, 2003), Greece (Drosopoulos *et al*., 2004 in Strauss 2010), Spain (Pons *et al*., 2002 in Strauss, 2010), Serbia and Montenegro (Hrncic, 2003), Hungary (Orosz and Dér, 2004), Bulgaria (Tomov *et al*., 2006 in Strauss, 2010), Turkey (Karsavuran and Güçlu, 2004 in Strauss, 2010), Bosnia Herzegovina (Gotlin Culjak *et al*., 2007 in Strauss, 2010), Romania (Grozea *et al*., 2011) and was found also in Albania, Slovakia and Russia (DAISIE website, 2015). *M. pruinosa* populations found in the UK and Bohemia were successfully eradicated by insecticide treatments (C. Malumphy and P. Lauterer, personnel communication in Strauss, 2009).

In Bohemia, Austria and Romania started thorough observations and investigations to get to know its spread, host plants and control. In Austria using the CLIMEX® programme various parameters (temperature index, diapausa index, moisture index, cold, wet, dry and heat stresses) were investigated in order to find the susceptible Austrian areas and cultures and also worked on the control opportunities (Strauss, 2010).

M. pruinosa occurred in Hungary (Budapest) in 2004 but its expansion and injury have not been reported considerable. The pest was observed on feeding *Ambrosia artemisiifolia* L. in Szabolcs-Szathmár county (Lajos Szőke personnel communication, 2011), which was considered as a possible natural weed control.

The aim of this study was studying the most frequent host plants of *M. pruinosa* monitored in various habitats of Gödöllő and countryside as well as to conclude with assessing the population density to the preference of the pest.

Morphology

Mead (1969) and Lauterer (2002) gave a detailed morphological characterisation on adults and nymphs, thus here only a very brief description will be provided. Adults are 7-8 mm in length. Dorsal surface of the body and forewings are blackish brown. Body and forewings are covered with a whitish powdery secretion making the blackish colour grey-bluish. The nymphs' body is flattened and white, covered with a dense waxy substance forming long filaments at the apex. The same waxy secretion is produced on leaves and shoots where the nymphs feed. The 5^{th} – last one – instar is 5-6 mm long. Development stage of nymphs can be distinguished by the size of head capsule and wing pads (Lauterer, 2002).

Life cycle

M. pruinosa has one generation a year and overwinters as eggs laid in the bark of damaged twigs (Mead, 1969, Lauterer 2002). In France and Austria, nymphs can hatch from May to mid July and suck phloem sup of host plants and produce a lot of honeydew. They have five growth stages. Finishing development adults emerge in August and begin laying eggs. Egg production can be maximum 90 eggs (Della Giustina, 1987; Kahrer *et al*., 2009).

Host plants

M. pruinosa is a polyphagous planthopper feeding on a great diversity of plants. Unfortunately, because of this high diversity it is difficult to prove its preference and future injury.

In the USA, CFP was found on citrus, grape fruit, orange, grape, many forest and fruit trees, shrubs and some herbs (Mead, 1969). Bagnoli and Lucchi (2000) reported more than 200 host plants from different families for *M. pruinosa* in Italy. In the Czech Republic, *M. pruinosa* slightly damaged ornamental plants like *Thuja occidentalis* L., *Juniperus communis* L., *Sorbus aucuparia* L., *Lilium* sp. and were found also on some woody species (Lauterer, 2002). In Austria (Vienna), the following host plant genera were observed: *Acer*, *Aesculus*, *Ailanthus*, *Amaranthus*, *Amelanchier*, *Amorpha*, *Arctium*, *Aronia*, *Artemisia*, *Aucuba*, *Ballota*, *Bryonia*, *Buddleja*, *Buxus*, *Calycanthus*, *Campanula*, *Canna*, *Carpinus*, *Catalpa*, *Ceratostigma*, *Cercis*, *Chaenomeles*, *Chelidonium*, *Chenopodium*, *Clematis*, *Clivia*, *Convolvulus, Conyza*, *Cornus*, *Corylus*, Cotinus, *Cotoneaster*, *Crataegus*, *Cucurbita*, *Daphne*, *Daucus*, *Deutzia*, *Dipsacus*, *Duchesnea*, *Echium*, *Epilobium*, *Epimedium*, *Erigeron*, *Euonymus*, *Fagus*, *Falcaria*, *Fallopia*, *Ficus*, *Fontanesia*, *Forsythia*, *Fraxinus*, *Galium*, *Geranium*, *Geum*, *Glechoma*, *Hedera*, *Heptacodium*, *Heracleum*, *Hibiscus*, *Hippophae*, *Humulus*, *Hydrangea*, *Hypericum*, *Jasminum*, *Juglans*, *Knautia*, *Koelreuteria*, *Kolkwitzia*, *Laburnum*, *Lamium*, *Leonurus*, *Ligustrum*, *Lonicera*, *Lycium*, *Lythrum*, *Magnolia*, *Mahonia*, *Majorana*, *Malus*, *Malva*, *Medicago*, *Mercurialis*, *Mespilus*, *Morus*, *Nerium*, *Oxalis*, *Parthenocissus*, *Paulownia*, *Pennisetum*, *Petroselinum*, *Phaseolus*, *Philadelphus*, *Physocarpus*, *Phytolacca*, *Pieris*, *Pinus*, *Plantago*, *Platanus*, *Polygonum*, *Poncirus*, *Populus*, *Potentilla*, *Prunus*, *Ptelea*, *Pyracantha*, *Pyrus*, *Quercus*, *Rhododendron*, *Rhus*, *Ribes*, *Robinia*, *Rosa*, *Rosmarinus*, *Rubus*, *Rumex*, *Salix*, *Sambucus*, *Silene*, *Sisymbrium*, *Skimmia*, *Solanum*, *Solidago*, *Sonchus*, *Sorbus*, *Spartium*, *Spiraea*, *Staphylea*, *Symphoricarpus*, *Syringa*, *Tagetes*, *Tanacetum*, *Taraxacum*, *Taxus*, *Thuja*, *Tilia*, *Triticum*, *Ulmus*, *Urtica*, *Vaccinium*, *Veronica*, *Viburnum*, *Vinca*, *Viola*, *Vitis*, *Weigela*, *Wisteria*, *Yucca*. Nymphs, adults or both of them were found on these genera (Kahrer *et al*., 2009). There was presented another study indicating that 251 plant species among them numerous horticultural and agricultural varieties were attacked either by the nymphs or imagines of the planthopper (Moosbeckhofer *et al*., 2009). In Serbia (Belgrad), *M. pruinosa* were reported on woody species in the genera: *Acer*, *Aesculus*, *Gleditchia*, *Robinia*, *Ailanthus*, *Populus*, *Platanus*, *Prunus*, *Pyrus*, *Ulmus*, *Tilia*, *Cornus*, *Fraxinus*, *Quercus* and *Thuja* (Mihajlović, 2007). In Romania, it was collected and seen on *Acer saccharinum* L., *Juglans nigra* L., *Juniperus* sp., *Thuja occidentalis* L., *Buxus sempervirens* L., *Albizia julibrissin Durazz., Potentilla (Dasiphora) fruticosa* L., *Cycas revoluta* Thunb., *Vitis vinifera* L., *Atriplex hortensis* L., *Sambucus nigra* L., *Melissa officinalis* L., *Philadelphus coronaries* L., *Ligustrum vulgare* L., *Hibiscus rosa-sinensis l.* and *Rosa* sp. (Grozea *et al*., 2011). In western counties of Romania *M. pruinosa* nymphs were observed on 45 host plants species at various habitats like parks, orchard and vineyard. The most important plants were *Acer negundo* L., *Acer pseudoplatanus* L., *Acer campestre* L., *Acer platanoides* L., *Catalpa bignonioides* Walter, *Hibiscus syriacus* L., *Juglans regia* L., *Ligustrum vulgare, Malus domestica* L., *Prunus persica* (L.) Batsch, *Prunus armeniaca* L., *Prunus domestica* L., *Tilia cordata* Mill., and *Vitis vinifera* L. In Greece, 26 ornamental, 15 fruit, nine weed and two vegetable plant species were reported as associated with CFP. Among them there were three monocotyledonous species, each of them weeds such as *Bromus* sp., *Digitaria sanguinals* (L.) Scop. and *Setaria* sp. (Souliotis *et al*., 2008).

In Hungary, *M. pruinosa* was observed in Budapest on the following plants: *Acer* sp., *Aesculus hippocastanum* L., *Berberis* sp., *Crataegus* sp., *Hibiscus* sp., *Syringa* sp., *Ulmus* sp. (Orosz and Dér, 2004). In addition, Bozsik (2012) listed some plants on which adults and waxy secretion of *M. pruinosa* were observed: *Acer negundo* L., *Celtis occidentalis* L., *Clematis vitalba* L., *Crataegus monogyna* Jacq., *Lycium halimifolium* L., *Morus alba* L., *Prunus padus* L., *Prunus serotina* Ehrh., *Prunus spinosa* L., *Robinia pseudoacacia* L., *Rosa canina* L., *Ulmus campestris* L. and *Vitis vinifera* L.

Control of *Metcalfa pruinosa*

In its native area usually there is no need for control except in case of obvious damage which is a rarity (Mead, 1969). Cutting twigs infested with eggs or treatments with horticultural oil and insecticidal soap is enough against *M. pruinosa* (Rebek, 2009). Chlorpyriphos and imidacloprid was efficient in Austria (Kahrer and Moosbeckhofer, 2003). Fenitrothion was used successfully in the Czech Republic (Lauterer, 2002). Strauss (2009) studied control opportunities with special regard for the use of the natural enemy, *Neodryinus typhlocybae* (Ashmead, 1893) (Hymenoptera: Dryinidae) which has been released in Italy, France and Slovenia. She showed that *N. typhlocybae* attacked and parasitised only *M. pruinosa* and the native European planthoppers were saved (Strauss, 2009). Malausa *et al*. (2003) introduced *N. typhlucybae* in the south of France in 1996 to control *M. pruinusa*. The parasitoid was released in about sixty sites and after five years of the first introduction the authors evaluated the establishment and dispersal of *N. typhlucybae*. They found established populations in 51 (86%) sites.

Route of spreading

Spreading of *M. pruinosa* in Hungary could be with transported tree and ornamental seedlings from areas where the pest is established or the planthopper itself could migrate from the same localities. According to Lauterer (2002) the natural annual spreading of *M. pruinosa* is about 50 m on each direction. Grozea *et al*. (2011) thought *M. pruinosa* individuals flew in Romania (Temes County) from the neighbouring Serbia and Hungary. It means that the density of this planthopper in Hungary was estimated as high.

MATERIALS AND METHODS

The surveyed sites were found at Gödöllő and Máriabesnyő about 25 km from Budapest. Most areas at Máriabesnyő belonged to the Szent István University and localised along the railway running towards Budapest. Localities at Gödöllő were in the centre of the town and at the Blaha district. The Blaha district is an area where orchards, vineyards and vegetable gardens were found (*Table 1*).

Hedge (Máriabesnyő)
Vegetation of the area consisted of European and some adventive (with American and Asian origin) trees and bushes that created a very dense structure.

Tree row (Máriabesnyő)
A line of trees – along an alfalfa field and a field path – consisted mainly of matured trees and some saplings. The trees generally do not meet each other.

Stinging nettle spot (Máriabesnyő)
It was found at the border of a deciduous wood below the tree branches.

Backside garden (Máriabesnyő)
It contained ornamental plants, fruit trees and shrubs.

Maize field (Máriabesnyő)
The field was overgrown with weeds such as *Artemisia vulgaris*, *Ambrosia artemisiifolia*, *Cannabis sativa spontanea*, *Chenopodium album* and *Atriplex tatarica*. The weeds hampered even the moving in the field. Four times 25 corn plants were visually surveyed along a transect line. No pesticides were applied.

Alfalfa field (Máriabesnyő)
The field was overrun with weeds such as *Rumex obtusifolius*, *Agropyron repens*, *Setaria glauca*, *Senecio vulgaris* and *Lactuca serriola*. The alfalfa stand was thinned out and the weeds covered more space than the alfalfa. Captures were obtained by sweeping net (4 x 25 sweeps). The individuals captured by sweeping were taken into a freezer, then dried for a while and identified immediately. At the field no pesticides were applied.

Backside garden (Gödöllő)
It contained ornamental and fruit trees and shrubs.

Orchard and vineyard (Gödöllő)
The site was grown over with fruit trees and grapevine.

In the hedge, five shoots of randomly selected trees or bushes – or weedy plants – were observed from a 50 cm distance and the number of nymphs and adults of *M. pruinosa* was recorded (abbreviated as VO1). In case of the other habitats (except the alfalfa field), plants were examined similarly but instead of counting the pest individuals the following approximation was used: 1 = weak infestation (< 5 nymphs or adults on a shoot part); 2 = middle infestation (5 - 10 nymphs or adults on a shoot part); 3 = strong infestation (> 10 nymphs or adults on a shoot part; abbreviated as VO2) (Kahrer *et al*., 2009).

Also the efficiency of chemical control administered at the Máriabesnyő garden was approximately assessed. A horticultural oil (Vectaphid A EC: 83% paraffin oil +17% Atplus 309 F - in a concentration of 0.5%) was applied two times in July and once in August in 2015 with a manual backpack sprayer.

Table 1

Basic data of the surveys

Site and date	Geographic position Altitude	Habitat Size	Surveying method	Surveying frequency
Máriabesnyő 2013 from early July to early October	47°36’3″ N 19°21’59″E 209 m	hedge 660 m	visual observation = VO1	weekly
Máriabesnyő 2015 from early July to early September	47°35’54″N 19°22’56″E 211 m	tree row 649 m	VO2	weekly
Máriabesnyő 2013-15 from early June to early October	47°35’37″N 19°22’59″E 196 m	stinging nettle spot 60 m2	VO2	weekly
Máriabesnyő 2011-15 from early April to early October	47°35’44″N 19°22’54″E 204 m	backside garden 680 m2	VO2	weekly
Máriabesnyő 2015 from early July to early September	47°35’51″N 19°22’29″E 207 m	maize field 2.7 ha	VO1	weekly
Máriabesnyő 2015 from early July to early September	47°35’52″N 19°22’5″E 212 m	alfalfa field 7.7 ha	sweep netting	weekly
Gödöllő 2011-15 from early April to early October	47°36’9″N 19°21’27″E 188 m	backside garden 1296 m2	VO2	weekly
Gödöllő 2011-15 from early April to early October	47°37’25″N 19°19’56″E 192 m	orchard and vineyard 2160 m2	VO2	weekly

RESULTS

Most important habitats in North America of CFP are mixed deciduous woods and open areas overgrown with bushes. Also in Italy, the pest started its spread from an open bushland (Moosbeckhofer *et al*., 2009). In Central and South Europe, similar habitats were sampled. Regarding the Czech Republic, it was found in a nursery of ornamentals (Lauterer, 2002) and in Austria, the pest was first found and sampled in gardens, parks, a city wood with ornamental and not cultivated trees and shrubs and a cemetery (Moosbeckhofer *et al*., 2009).
In Romania, similarly, parks, green areas, public gardens, an orchard, a vineyard and vegetation along the roads were observed and surveyed (Preda and Skolka, 2011; Grozea *et al*., 2015). In Greece, citrus and olive groves were investigated to monitor CFP (Souliotis *et al*., 2008). In the present study, a hedge, a tree row and various horticultural and agricultural spaces such as gardens, an orchard, a vineyard, two fields and a nettle stand were examined.

M. pruinosa individuals or their waxy secretion were observed on 57 species of 31 plant families at seven survey sites (*Table 2*). The most objective investigation was carried out at the hedge where 23 species of 14 families were associated with *M. pruinosa*. *R. pseudoacacia*, *P. spinosa*, *C. vitalba*, *U. campestris*, *P. cerasifera* were the most attacked host plants (*Table 3*). At the tree row the pest was observed on 12 plants of eight families and *R. pseudoacacia*, *C. occidentalis* and *A. pseudoplatanus* showed the highest pest density (*Table 4*). The vegetation of the backside garden at Máriabesnyő indicated the highest number of infested host plants. *R. idaeus*, *C. occidentalis*, *H. lupulus*, *R. damascena*, *J. regia*, *R. canina* and *H. helix* revealed a strong *M. pruinosa* population (*Table 5*). In the Gödöllő backside garden with 15 infested host plants *C. occidentalis*, *J. regia* and *R. damascena* were the most preferred plants (*Table 6*). In the Gödöllő orchard eight plants was infested and the pest was observed mainly on *C. occidentalis*, *R. pseudoacacia* and *A. negundo* (*Table 7*). Plants of the stinging

Table 2

Host plants associated with *Metcalfa pruinosa* at Gödöllő and environment (H = hedge, T = tree row, BB = backside garden Máriabesnyő, BG = Backside garden Gödöllő, OG = orchard, vineyard Gödöllő)

Host plant	H	T	BM	BG	OG
Acer campestre	+	+	+	+	
Acer negundo	+			+	+
Acer platanoides	+	+			
Acer pseudoplatanus		+			
Achillea colinna			+		
Alcea rosea			+		
Ailanthus altissima					
Ambrosia artemisiifolia	+				
Buxus sempervirens				+	
Caryopteris incana x Caryopteris mongholica			+		
Castanea sativa			+		
Celtis occidentalis	+	+	+	+	+
Chrysanthemum indicum			+		
Clematis vitalba	+				
Cornus sanguinea		+	+		
Cosmos bipannatus			+		
Crataegus monogyna	+		+		
Euonymus europeus	+		+		
Euonymus japonicus			+		
Euphorbia salicifolia	+				
Forsythia suspensa				+	
Fragaria vesca	+				
Fraxinus ornus		+			
Gleditsia triacanthos				+	
Hedera helix			+	+	
Helianthus tuberosus			+		
Humulus lupulus	+		+		+
Juglans regia	+	+	+	+	+
Mahonia aquifolium				+	
Malus domestica	+	+	+		
Morus nigra	+				
Nerium oleander			+		
Populus nigra		+			
Prunus cerasifera	+				
Prunus domestica			+	+	
Prunus serotina	+	+			
Prunus spinosa	+				
Philadelphus coronarius				+	
Physostegia virginiana			+		
Robinia pseudoacacia	+	+			+
Rosa canina	+	+	+	+	+
Rosa damascena			+	+	
Rubus fruticosus			+		
Rubus idaeus			+		
Salvia sclarea			+		
Sambucus nigra	+				
Solanum nigrum	+			+	
Solidago canadensis			+		+
Spirea x vanhouttei				+	
Syringa vulgaris			+		
Ulmus campestris	+				
Urtica urens			+		
Vitis vinifera			+		+
Weigela florida			+		

Table 3

Host plants and frequency of *Metcalfa pruinosa* (hedge, Máriabesnyő, 2013, + = waxy secretion found)

Plant	Number of shoots	Number of *M. pruinosa*		
		nymphs	adults	waxy rests
Acer campestre	9	-	5	+
Acer negundo	13	-	40	+
Acer platanoides	35	2	41	+
Ailanthus altissima	2	2	2	+
Ambrosia artemisiifolia	1	-	-	+
Celtis occidentalis	11	2	4	+
Clematis vitalba	99	169	36	+
Crataegus monogyna	56	4	23	+
Euonymus europeus	8	-	10	+
Euphorbia salicifolia	1	-	-	+
Fragaria vesca	1	-	1	+
Humulus lupulus	10	-	13	+
Juglans regia	2	-	4	+
Malus domestica	3	18	-	+
Morus nigra	1	-	-	+
Prunus cerasifera	60	39	66	+
Prunus serotina	11	-	5	+
Prunus spinosa	84	251	36	+
Robinia pseudo-acacia	317	1160	101	+
Rosa canina	6	-	3	+
Sambucus nigra	1	-	-	+
Solanum nigrum	1	-	-	+
Ulmus campestris	130	114	71	+

Table 4

Host plants and frequency of *Metcalfa pruinosa* (tree row, Máriabesnyő, 2015)

Plant	*M. pruinosa*		
	nymphs	adults	waxy filaments
Acer campestre	-	1	-
Acer platanoides	-	1	-
Acer pseudoplatanus	1	2	+
Celtis occidentalis	2	2	+
Cornus sanguinea	-	1	+
Fraxinus ornus	1	1	+
Juglans regia	1	1	+
Malus domestica	-	1	-
Populus nigra	-	1	+
Prunus serotina	-	1	-
Robinia pseudoacacia	1	2	+
Rosa canina	-	1	-

nettle stand were strongly infested. The average number of nymphs and adults of *M. pruinosa* varied between 30 and 100 individuals or more.

Tables 8-12 specify the host plant families classified in functional groups like ornamental plants, trees, fruit plants, weeds and feral plants. The plants studied were almost exclusively dicotyledonous species except maize. CFP was found also on maize plants. Their density was very low: some 4th, 5th instar nymphs and adults of *M. pruinosa* as well as some waxy secretion were observed on the leaves and stalks. The infestation on maize can be regarded as very scarce. The population density of the pest in the alfalfa field was accidental. At this field along the tree row investigated, altogether two adults were found in the net during the survey period in the late of August. On the alfalfa plants no nymphs or waxy rests were observed.

The three times applied horticultural oil at the Máriabesnyő garden allowed to decrease the planthopper's density to a tolerable level in roses and raspberries.

Table 5

Host plants and frequency of *Metcalfa pruinosa* (backside garden, Máriabesnyő, 2011-15)

Plant	*M. pruinosa*		
	nymphs	adults	waxy filaments
Acer campestre	1	2	+
Achillea colinna	-	1	-
Alcea rosea		1	-
Caryopteris incana x Caryopteris mongholica	-	1	+
Castanea sativa	1	1	+
Celtis occidentalis	2	2	+
Chrysanthemum		1	+
Cornus sanguinea	1	2	+
Cosmos bipinnatus	-	1	-
Crataegus monogyna	1	1	
Euonnymus europeus	1	1	+
Euonymus japonicus	1	1	+
Hedera helix	1	3	+
Helianthus tuberosus	-	1	-
Humulus lupulus	2	3	+
Juglans regia	2	2	+
Malus domestica	1	1	+
Nerium oleander	1	1	+
Prunus domestica	-	1	+
Physostegia virginiana	-	1	-
Rosa canina	1	2	+
Rosa damascena	2	3	+
Rubus caesius	-	1	-
Rubus idaeus	3	3	+
Salvia sclarea	-	2	+
Solidago canadensis	-	1	-
Syringa vulgaris	-	1	-
Urtica urens	-	1	+
Vitis vinifera	1	2	+
Weigela florida	-	1	-

Table 6

Host plants and frequency of *Metcalfa pruinosa* (backside garden, Gödöllő, 2011-15)

	M. pruinosa		
Plant	nymphs	adults	waxy filaments
Acer campestre	1	1	+
Acer negundo	1	1	+
Buxus sempervirens	1	1	+
Celtis occidentalis	2	3	+
Forsythia suspensa	-	1	-
Gleditsia triacanthos	-	1	+
Hedera helix	-	1	-
Juglans regia	2	2	+
Mahonia aquifolium	-	1	+
Philadelphus coronarius	-	1	+
Prunus domestica	1	1	+
Rosa canina	1	1	+
Rosa damascena	1	2	+
Solanum nigrum	-	1	-
Spirea × vanhouttei	-	1	-

Table 7

Host plants and frequency of *Metcalfa pruinosa* (orchard and vineyard, Gödöllő, 2011-15)

Plant	*M. pruinosa*		
	nymphs	adults	waxy filaments
Acer negundo	1	2	+
Celtis occidentalis	2	2	+
Humulus lupulus	1	1	+
Juglans regia	1	1	+
Robinia pseudoacacia	1	2	+
Rosa canina	-	1	-
Solidago gigantea	-	1	+
Vitis vinifera	-	1	+

Table 8

Functionally classified host plant families (hedge, Máriabesnyő, 2013)

Plant family	Trees shrubs climbers	Fruit plants	Weeds	Feral plants	Total number of species
Adoxaceae	1				1
Asteraceae			1		1
Cannabaceae	2				2
Celastraceae	1				1
Euphorbiaceae			1		1
Fabaceae	1				1
Juglandaceae		1			1
Moraceae				1	1
Ranunculaceae	1				1
Rosaceae	4	2		1	7
Sapindaceae	2			1	3
Simaroubaceae				1	1
Solanaceae			1		1
Ulmaceae	1				1
Number of species	13	3	3	4	23

Table 9

Functionally classified host plant families (tree row, Máriabesnyő, 2013)

Plant family	Trees shrubs climbers	Fruit plants	Feral plants	Total number of species
Cannabaceae	1			1
Cornaceae	1			1
Fabaceae	1			1
Juglandaceae		1		1
Oleaceae	1			1
Rosaceae	1	1	1	3
Salicaceae	1			1
Sapindaceae	3			3
Number of species	9	2	1	12

Table 10

Functionally classified host plant families (backside garden, Máriabesnyő, 2011-15)

Plant family	Ornamental plants	Trees shrubs climbers	Fruit plants	Weeds	Feral plants	Total number of species
Araliaceae		1				1
Apocynaceae	1					1
Asteraceae	2			1	2	5
Cannabaceae		2				2
Caprifoliaceae	1					1
Celastraceae	1	1				2
Cornaceae		1				1
Fagaceae			1			1
Juglandaceae			1			1
Lamiaceae	3					3
Malvaceae	1					1
Oleaceae	1					1
Rosaceae	1	3	3			7
Sapindaceae		1				1
Urticaceae				1		1
Vitaceae			1			1
Number of species	11	9	6	2	2	30

Table 11

Functionally classified host plant families (backside garden, Gödöllő, 2011-15)

Plant family	Ornamental plants	Trees shrubs climbers	Fruit plants	Weeds	Total number of species
Araliaceae		1			1
Berberidaceae	1				1
Buxaceae	1				1
Cannabaceae		1			1
Fabaceae	1				1
Hydrangeaceae	1				1
Juglandaceae			1		1
Oleaceae	1				1
Rosaceae	2	1	1		4
Sapindaceae		1		1	2
Solanaceae				1	1
Number of species	7	4	2	2	15

Table 12

Functionally classified host plant families (orchard and vineyard, Gödöllő, 2011-15)

Plant family	Trees shrubs climbers	Fruit plants	Feral plants	Total number of species
Asteraceae			1	1
Cannabaceae	2			2
Fabaceae	1			1
Juglandaceae		1		1
Rosaceae	1			1
Sapindaceae			1	1
Vitaceae		1		1
Number of species	5	2	2	8

DISCUSSION

M. pruinosa is a polyphagous pest preferring saplings and shoots of trees and bushes but it can feed also on weed plants. It attacks mainly dicotyledonous plants but some studies reported their feeding on monocotyledonous vegetation. In Greece, it was stated on *Bromus* sp., *D. sanguinalis* and *Setaria* sp. (Souliotis *et al*., 2008) and in Austria on winter wheat, *Canna indica* and not determined grasses (Moosbeckhofer *et al*., 2009). There are many data on its host plants and most of them are ornamental and fruit trees/shrubs and also some horticultural or agricultural crops.

Regarding the Central European region, Austrian data are the most detailed and also some Romanian papers can be of importance. Moosbeckhofer *et al*. (2009) published a thorough study in which they listed 251 plant species observed and evaluated in Vienna and its countryside with additional information on the degree of infestation of the planthopper. This assessment is the same which was presented in the methodical part and abbreviated as OV2. Except 16 species (*A. rosea*, *A. artemisiifolia*, *C. incana*, *C. sativa*, *C. occidentalis*, *Ch. indicum*, *C. bipennatus*, *E. salicifolia*, *F. vesca*, *G. triacanthos*, *H. tuberosus*, *P. serotina*, *Ph. virginiana*, *S. sclarea*, *S. nigrum* and *U. urens*) presented in *Table 2*, all the plants were associated and feed by *M. pruinosa* also in Austria and the degree of infestation was similar too to those of showed in *Tables 3-7*. Preda and Skolka (2011) sampled 37 places (parks with seminatural vegetation) along the Black See in Romania. Despite the geographical position difference of Hungary and Romania, the most frequent plants on which *M. pruinosa* commonly occurred in the Romanian study were similar to those of this study: *A. negundo*, *A, platanoides*, *A. altissima*, *E. japonica*, *Fraxinus* sp., *P. cerasifera*, *Ph. coronarius*, *R. pseudoacacia* and *S. x vanhuttei*). Another study (Grozea *et al*., 2015) conducted in the western counties of Romania, showed an even better match with the present data: *A. campestre*, *A. negundo*, *A. platanoides*, *B. sempervirens*, *C. sanguinea*, *H. lupulus*, *J. regia*, *M. domestica*, *P. domestica*, *Ph. coronarius*, *R. pseudoacacia*, *R. damascena*, *S. x vanhuttei*, *U. campestris* and *V. vinifera* were common hostplants in both countries. This list corresponds also to the Austrian observations mentioned above.

Tables 8-11 present – depending on the habitats' character – a functional classification (ornamental plants, trees/shrubs, fruit plants, weeds and feral plants) of the host plant families observed at the various habitats. In seminatural habitats (hedge and tree row) the trees and shrubs predominated but in areas of agricultural use (backside gardens, orchard and vineyard) ornamental plants and not cultivated deciduous trees were in the majority. Feral plants could be found almost at each site. Some of them such as *S. canadensis* or *P. serotina,* are invasive alien species of North American origin. The number of plants native to America, some of them introduced to Europe as ornamental plants or trees of agricultural or forestry importance is 10: *A. artemisiifolia*, *A. negundo*, *C. occidentalis*, *C. bipannatus*, *G. triacanthos*, *H. tuberosus*, *P. serotina*, *Ph. virginiana*, *R. pseudoacacia*, *S. canadensis*. Considering the frequency of host plants recorded and their degree of infestation of the planthopper, Asteraceae, Cannabaceae, Fabaceae, Juglandaceae, Lamiaceae, Rosaceae and Sapindaceae were the significant families. At least two host plants of American origin were found at each site not respecting the alfalfa field and the nettle stand.

Abiotic conditions like temperature, precipitation, moisture of air and soil play an important role in development, reproduction, survival and spread of CFP. In dry regions its distribution is limited (Strauss, 2009). This can be observed during surveys because in hot and dry conditions e.g. on the top of shoots and places exposed to direct sunshine and high temperature the *M. pruinosa* populations were very scarce or nil. Thus, one could often experience that the host plant preference was influenced by the abiotic conditions of the habitat and the plant density.

A number of papers mentioned the honeydew production of *M. pruinosa* (Souliotis *et al*., 2008; Kahrer *et al*., 2009; Strauss, 2009). Kahrer *et al*. (2009) stressed that a high quantity of honeydew was observed on *Acer* spp., *Malus* sp., *Parthenocissus quinquefolia* and *Clematis vitalba* in August. In order to study the honeybee's response to *M. pruinosa* honeydew, hives were placed adjacent to infested areas but no honeybee flight was detected. As to present investigations no honeydew of *M. pruinosa* has been perceived.

M. pruinosa density approached damage level on roses and raspberries in the Máriabesnyő backside garden in 2015. On raspberries the shoots and leaves were so heavily attacked that their development was hampered while on roses the presence of CFP was the damage. The three applications of Vectaphid A EC were efficient to stop the population increase and prevented the further damage. How is possible to manage potential outbreaks of CFP a more long-lasting or radical way? In Great Britain and Bohemia chemical eradication was successful (C. Malumphy and P. Lauterer, personnel communication in Strauss, 2009). Perhaps, it was due to the generally colder and more humid climate of both countries which did not favour the development and reproduction of the pest. Thus, this eradication with pesticides in Hungary cannot be a right answer. In Austria there was a mass outbreak in Vienna in 2003 and the pest continued spreading and was found also in Graz. According to the risk analysis of Strauss (2010) mainly organic orchards and vineyards in Burgerland, Lower Austria and Styria are threatened by *M. pruinosa*. She proposed inspection of trade and trade pathways of trees and ornamentals, parking sites and gardens along transport routes, pesticide application and the introduction of *Neodryinus typhlocybae*. What can we do in Hungary? Our climatic conditions are more favourable for the planthopper than those in Austria. Our facilities (personnel or material) are limited. The spread of *M. pruinosa* is not estimated and known. The only efficient and environmental friendly control opportunity might be the introduction of natural enemies, in this case *Neodryinus typhlocybae* already established in Italy, France, Switzerland, Slovenia and Croatia (Tommasini *et al*., 1998; Ciglar *et al*., 1998; Malausa, 1999; Jermini *et al*., 2000 in Strauss, 2009; Žeźlina *et al*., 2001). In 2007, the parasitoid has been released in Greece, the Netherlands and Spain (A. Sala, personal communication in Strauss, 2009). *N. typhlocybae* was tested for not target organisms in Austria and it is likely that its host range is restricted to Flatidae, of which merely CFP occurs in Austria (Strauss, 2009).

CONCLUSIONS

Host plant diversity and preference of *M. pruinosa* were detected from 2011 to 2015 at Gödöllő and its countryside. The pest could be found at each habitat sampled but the hedge, the tree row and the gardens as well as the orchard and vineyard proved to be the most infested. Frequency and population density of CFP were considerable on Asteraceae, Cannabaceae, Fabaceae, Juglandaceae, Lamiaceae, Rosaceae and Sapindaceae. Vegetation could be functionally classified as ornamental plants, trees, fruit plants, weeds and feral plants. Feral plants – some of them also invasive alien species – were found at each habitat. Plant species native to America were among them the most populated. This fact obviously might help the establishment and spread of *M. pruinosa*. Regarding the neglected hedgerows, the predominance of abandoned gardens, orchards and vineyards, there are excellent conditions (high plant diversity with many American plant species) for the quick and long-lasting establishment of *M. pruinosa*. The length of hedges which run often parallel with the railway line can be more than several hundred km only in Pest county. This means that the hedge can be a huge reservoir of *M. pruinosa*. These hedges have enormous beneficial importance as resources for firewood, medicinal plants, fruits, berries, mushrooms, bee pastures; structures like ecological networks, corridors and barriers, shelter for protected plant and animal species, and natural enemies. The general management of these hedges is cutting the trees in every five or 10 years to gain some heating material and making a better view. It is a chance that there is neither money, nor intension to apply chemical insecticides in these structures. This means that in case of introduced invasive pests without natural enemies, there is quite a high risk for establishing and spreading in such a highly suitable, new environment especially when many formerly established feral plants make easier this process. Although, the population density of the pest was considerable on many hostplants, economic damage or yield losses could not be assessed. Economic or significant damage was observed only on roses, raspberries and stinging nettle (there are recognised stinging nettle varieties in Germany and Finland; Dreyer, 1999). This highlights that CFP outbreaks may cause under favourable ecological circumstances considerable quality and yield loss. The most favourable and long-ranging control opportunity would be the introduction of the natural enemy, *Neodryinus typhlocybae* already introduced in many European countries. Concerning the environmental and climatic conditions as well as the crop protection opportunities of the country it is dubious that continual inspections or verifications could help not to mention the chemical eradication.

REFERENCES

Bagnoli, B. and Lucchi, A. (2000): Dannosità e misure di controllo integrato. In: A. Lucchi, (ed.). La *Metcalfa* negli ecosistemi italiani. ARSIA. Regione Toscana, Italy. pp. 65-88.

Bozsik A. (2012): Mass occurrence of the citrus flatid planthopper (*Metcalfa pruinosa* (Say, 1830)) (Hemiptera: Flatidae) in an agricultural hedgerow at Gödöllő (Hungary). Journal of Agricultural Sciences, Debrecen, 50 (Supplement), 115-118.

Ciglar, I., Barić, B., Žužic, I. (1998): Biological control of *Metcalfa pruinosa* by the introduction of *Neodryinus typhlocybae* (Ashmead) (Hymenoptera: Dryinidae) to Croatia. Fragmenta Phytomedica et Herbologica, 26(1/2), 95–99.

Della Giustina, W. (1987): *Metcalfa pruinosa* (Say 1830), nouveaute pour la faune de France (Hom. Flatidae). Bulletin de la Societé Entomologique de France 191(3-4), 89-92.

DAISIE *Metcalfa pruinosa* factsheet. Dekivering alian invasive species inventories for Europe. http://www.europe-aliens.org/ Accessed 26 September 2012

Dreyer, J. (1999): Die Fasernessel als nachwachsender Rohstoff. Leistungsprüfung von Fasernesseln (*Urtica dioica* L., Grosse Brennessel) unter besonderer Berücksichtigung der phänotypischen Differenzierung anbauwürdiger Klone. Verlag Dr. Kovač, Hamburg, pp. 206.

Grozea, I., Gogan, A., Virteiu, A.M., Grozea, A., Stef, R., Molnar, L., Carabet, A. and Dinnesen, S. (2011): *Metcalfa pruinosa* Say (Insecta: Homoptera: Flatidae): a New pest in Romania. African Journal of Agricultural Research 6 (27), 5870-5877.

Grozea, I., Gogan, A., Vlad,M., Virteiou, A.M., Stef, R., Carabet, A., Damianov, S., Florian, T. (2015): A new problem for Western Romania: *Metcalfa pruinosa* emiptera: Flatidae. BulletinUASVM Horticulture, 72 (1), 74-80.

Kahrer, A, Moosbeckhofer, R. (2003): Ein neuer Schädling –*Metcalfa pruinosa* – in Österreich eingeschleppt. Bienenvater 10, 16.

Kahrer, A., Strauss, G., Stolz, M., Moosbeckhofer, R. 2009 Beobachtung zur Faunistik and Biologie der vor kurzem nach Österreich eingeschleppten Bläulingszikade (*Metcalfa pruinosa*). Beiträge zur Entomofaunistik, 10,17-30.

Lauterer, P. (2002): Citrus flatid planthopper, *Metcalfa pruinosa* (Hemiptera: Flatidae), a new pest of ornamental horticulture in the Czech Republic. Plant Protection Science 38(4): 145-148.

Malausa, J.C. (1999): Un espoir face aux pullulations de *Metcalfa pruinosa*. Introduction en France de Neodryinus typhlocybae, parasite larvaire de cette „cicadelle". Phytoma, 512,37–40.

Mead, F.W. (1969): Citrus flatid planthopper, *Metcalfa pruinosa* (Say) Homoptera: Flatidae. Florida Department of Agriculture, Division of Plant Industry, Entomology Circular No. 85. 1-2.

Mihajlović, Lj. (2007): *Metcalfa pruinosa* **(S**ay**)** **(**Homoptera**:** Auchenorrhyncha**)** a new harmful species for entomofauna of Serbia. Glacnik Sumarskog Fakulteta, Beograd, 95, 127-134.

Moosbeckhofer, R., Heigl, H., Kahrer, A., Strauss, G., Stolz, M. (2009): Untersuchungen zum Auftreten der Bläulingszikade *Metcalfa pruinosa* (Say 1830; Hemiptera, Flatidae), einer in Österreich neuen Honigtauerzeugerin, und die möglichen Auswirkungen auf die Bienenzucht (Investigations on the incidence of Metcalfa pruinosa (Say 1830; Hemiptera, Flatidae), a new honeydew producing insect in Austria, and its possible implication on beekeeping). pp. 39. http://www.ages.at/fileadmin/_migrated/content_uploads/Abschlussbericht_Metcalfa_Pruinosa_Bienenzucht_SRL.pdf

Orosz A. és Dér Zs. (2004): Idejében szólunk a *Metcalfa pruinosa* (Say, 1830) kabóca esetleges megjelenéséről. Növényvédelem 40 (3), 137-141.

Preda, Ch., Skolka, M. (2011): Range expansion of *Metcalfa pruinosa* (Homoptera: Fulgoroidea) in Southeastern Europe. Ecologia Balcanica 3(1), 79-87.

Rebek, E.J. (2009): Pest du Jour: Flatid Planthoppers. Pest alerts, Oklahoma State University 8(16), 2. http://entoplp.okstate.edu/Pddl/

Souliotis,C, Papanikolaou, N.E., Papachristos, D. and Fatouros, N. (2008): Host plants of the planthopper *Metcalfa pruinosa* (Say) (Hemiptera: Flatidae) and bservations on its phenology in Greece. Hellenic Plant Protection Journal 1, 39-41.

Strauss, G. (2009): Host range testing of the nearctic beneficial parasitoid *Neodriynus typhlocybae.* Biocontrol 54, 163-171.

Strauss, G**.** (2010): Pest risk analysis of *Metcalfa pruinosa* in Austria. Journal of Pest Science 83(4), 381-390.Tommasini, M.G., Mosti, M., Dradi, D., Girolami, V. (1998): Lotta biologica contro *Metcalfa pruinosa* con *Neodryinus typhlocybae*: prime esperienze sull'acclimatazione del parassitoide in Emilia-Romagna. Inf. Fitopatol. 48(12), 51-54.

Zangheri, S. and P. Donadini. (1980): Comparsa nel Veneto di un omottero neartico: *Metcalfa pruinosa* Say (Homoptera, Flatidae). Redia 63, 301-305.

Žeźlina, I., Milevoj, L. & Girolami, V., (2001): Wasp *Neodrynus typhlocybae* Ashmead – succesuful predator and parasitoid for reducing the population of flatid planthopper (*Metcalfa pruinosa* Say) also in Slovenia. - Zbornik Bioteh. Fak. Univ Ljubljana. Kmet. 77(2), 215-225.

Contributions to the 2014 and 2015 flight pattern and damages of *Carpomyia schineri* Loew.

Erzsébet Voigt[1] – Dóra Kelemen[2] – Miklós Tóth[3]
[1]Hungarian Horticultural Propagation Material Non-Profit Ltd., Budapest, Hungary
[2]Research Institute of Fruit Production, Érd Research Station, Budapest, Hungary
[3]Plant Protection Institute of HAS ARC, Budapest, Hungary
evoigt55@gmail.com

SUMMARY

The fly Carpomyia schineri *Loew is a pest of the berries of the feral* Rosa canina *group but is can also be found in the berries of grown rose cultivars. The larva damages the flesh of the berry, several larvae can develop inside a single berry. It can decrease the quantity and ascorbic acid content of the tea and jam, which are important human ascorbic acid sources during winter. At the same time in trapping experiments the adult can be confounded with adults of the walnut husk fly (*Rhagoletis completa *Cresson). In collections of berries at several sites in Hungary damage levels ranged from 0.88% to 65.08 %. Based on these damage levels we had the impression that the yellow sticky traps CSALOMON® PALz or PALs baited with the synthetic* Rhagoletis *lure caught moderate numbers of adults and were not satisfactory for detection, consequently improving trapping methods is necessary in the future.*

Keywords: *Carpomyia schineri* flight dynamics, damage

INTRODUCTION

First records on the damage of *Carpomyia schineri* Loew. (Diptera, Tephritidae) from Hungary date back to 1947 from the arboretum of Horticultural University. Later (1953-1955) its presence was shown out also at the Budatétény plot of the Horticultural Research Institute. (Balás and Tóth, 1958). In recent years attention was drawn to the pest because in CSALOMON® PALz traps set out to detect the quarantine walnut husk fly (*Rhagoletis completa* Cresson) single specimens of *C. schineri* were regularly recorded, and to the inexperienced eye the two species can easily be confounded (Orosz *et al*., 2012, Voigt *et al*., 2015). However, *C. schineri* damages only rose berries (Papp, 1994; Surányi, 2005; Surányi and Haltrich, 2006; Tuba, 2009). We were prompted on the one hand by the above to start a study on the biology and damages of *C. schineri*. On the other, rose berries (*Rosa canina* group, which includes several *Rosa* spp.) are an important source of ascorbic acid for humans. Dried berries are important for making tea, and the jam produced from berries is also preferred by many consumers, what is more, it is used also in wine making.

MATERIALS AND METHODS

In general CSALOMON® PALz (fluorescent yellow) traps with feeding attractant were used for monitoring the flight pattern. In studies on the effect of the addition of the feeding attractant CSALOMON® PALs (yellow) traps were used. As feeding attractant the described *Rhagoletis* lure containing ammonium salts was used (Tóth *et al*., 2004), which had been reported to be active in observations on several *Rhagoletis* spp. (Voigt and Tóth, 2008; Voigt *et al*., 2012; Tóth *et al*., 2014). Traps were suspended at the height of 1.0-1.5 m on rose bushes with ripening berries, and were inspected at 3-5 day intervals or weekly.

We selected first of all sites where *Rosa canina* group was part of the natural vegetation: i.e. Tétényi highland, Nadap, Telki, Pázmánd, Érd-Elviramajor, or Budatétényi Rózsakert in earlier studies. Berries collected were held in laboratory rearing dishes, larvae coming out and pupae were removed daily and were stored at 5°C.

RESULTS

Damages of *C. schineri* could be recorded on all *Rosa canina* group bushes from which collection of berries was performed. It was reared out also from berries of cultivated tea-rose hybrids at the Budatétényi Rózsakert. Pupae obtained most probably belong to the taxon *C. schineri*; species verification will be possible after diapause from adults emerging next year.

The pest develops one generation per year, it overwinters as pupa in the soil, and adults swarm during the summer. According to some reports flight can start in June or July (Papp, 1994), others report the flight between end of July to middle of August (Tuba, 2009).

The place of egglaying on the berry is not easy to notice, however, the subsequent damage of the larva is clearly visible from the outside, a dark line appears along the feeding of the maggot. It feeds exclusively on the flesh, does not damage the seeds. Damage percentages are shown in *Table 1* (Data collection closed at September 21, 2015).

Table 1

Damage levels of rose berries in 2015 at the different sites

	Érd-Elvira 2	Nadap 2	Pázmánd 1	Budatétény Rózsakert	Sóskút	Telki	Tétényi fennsík	∑
Size of berries (mm)	10-27 x 6-16	12-25 x 9-19	10-33 x 7-18	9-23 x 7-15	11-20 x 7-16	10-25 x 6-12	9-22 x 5-16	-
Total number of adults caught (PALz trap+ *Rhagoletis* lure)	31	44	no trap operated	14	10	0	9	108
Total of collected berries	534	453	232	2052	339	502	1190	5302
Total of pupae	**35**	**291**	**151**	**334**	**3**	**40**	**194**	**1048**
Damage level (%)	**6.55**	**64.24**	**65.08**	**16.27**	**0.88**	**7.96**	**16.30**	**19.76**

1 Observations started later
2 PALs traps were used

In our previous observations on the flight in 2014 we established that the main flight took place first of all in August, although 3 adults were already caught at June 25 in PALz traps (Budatétény, Rózsakert). Flight was monitored at two sites: at Nadap (hedge, with one floral component of spp. of *Rosa canina* group), and Nagytétény –Rózsakert, where also several spp. of *Rosa canina* can be found. First adults were recorded at both sites at the very end of June, and the last ones in the first days of September. Already in 2014 we had the impression that the damage levels of berries was higher than expected on the basis of catch figures.

In 2015 traps were set out in the middle of June. *Table 2* shows catch figures until the last inspection at September 22, from traps which were operated during the whole flight period.

Table 2

Beginning and end of flight of *C. schineri* in 2015

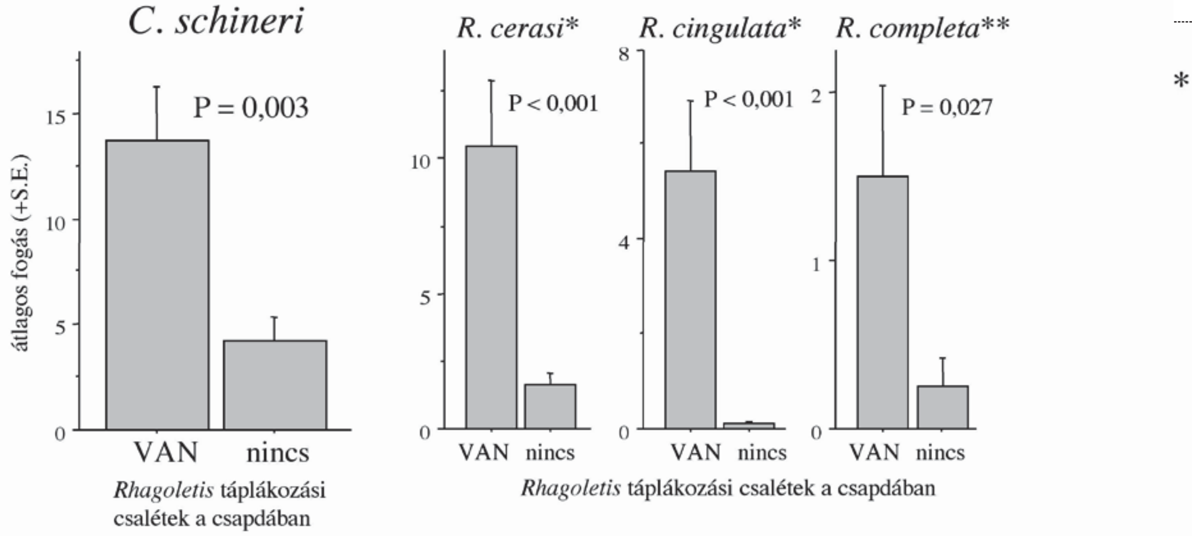
	Set out date	Date of first catch	Date of last catch	Total caught
Érd-Elvira	30 June	12 July	20 September	31
Nadap	15 June	8 July	8 September	44
Budatétény-Rózsakert	22 June	16 July	8 September	14
Telki	1 August	-	-	0
Tétényi highland	5 August	6 August	2 September	9

In the course of the obervation period flight stopped or only single specimens were captured on the "high heat days" in 2015 at all observation sites.

As in our earlier studies the presence of the synthetic *Rhagoletis* feeding attractant significantly increased catches in yellow traps in three *Rhagoletis* spp. (Voigt and Tóth, 2008; Tóth *et al.*, 2014), we set up an experiment with the objective of studying the influence of the addition of this lure on *C. schineri* catches. Observations were performed at Nadap and Érd-Elviramajor.

Results clearly showed that the addition of the lure significanlty increased catches also in *C. schineri* (*Figure 1*).

Despite the fact that traps with lures caught higher numbers, when comparing the relatively moderate catch figures with damage levels at the respective sites, we got the impression that CSALOMON® PALz traps were relatively insensitive for catching *C. schineri*, and can be used for sensitive detection purposes only with reservations.



Total caught in test 144 flies. P values derive from Student *t* test.
* after Voigt and Tóth, 2008; ** after Tóth *et al*., 2014.

DISCUSSION

Based on our preliminary results we can conclude that the main flight period of *C. schineri* takes place in August and beginning of September, in contrast to June and July mentoned in earlier literature. At this time berries already start to get red colouring. Traps available at this time (PALz and PALs) do not yield satisfactory performance, not even when combined with the *Rhagoletis* feeding attractant. They can be used for detection purposes (which is of utmost importance for harvest of berries) only with reservations. Running observations should be continued in 2016. Studies should concentrate among others on the correlation between the size of the berry and damage, and on sensitivity of different rose cultirvars.

REFERENCES

Balás, G. – Tóth, Gy. (1958): Adatok a fúrólegyek hazai elterjedésének és tápnövényeinek ismeretéhez. A Kertészeti és Szőlészeti Főiskola Évkönyve. 22, 17-26.

Orosz, Sz. – Melika, G. – Krizbai, L. – Avar, K. – Lakosi, T. (2012): A nyugati dióburok-furólégy (*Rhagoletis completa* Cresson, 1929 – Diptera: Tephritidae) 2012. évi hatósági felderítésének eredményei. XXIX. Integrált termesztés a kertészeti és szántóföldi kultúrákban Budapest, 2012 november 27. 37-45 pp.

Papp, L. (1994): Fúrólegyek. In. Jermy T. és Balázs K. (szerk.) A növényvédelmi állattan kézikönyve 5. Akadémiai Kiadó. Bp. 96 pp.

Surányi, D. (2005): A csipkebogyó-termesztést befolyásoló rovarok. Diplomamunka. Budapesti Corvinus Egyetem. Kertészettudományi Kar. Rovartani Tanszék. Budapest.

Surányi, D. – Haltrich, A. (2006): A csipkebogyó-termesztést befolyásoló rovarok. 52. Növényvédelmi Tudományos Napok előadásainak és posztereinek összefoglalója. 91 pp.

Tóth, M. – Szarukán, I. – Voigt, E. – Kozár, F. (2004): Hatékony cseresznyelégy- (*Rhagoletis cerasi* L., Diptera, Tephritidae) csapda kifejlesztése vizuális és kémiai ingerek figyelembevételével. Növényvédelem. 40, 229-236.

Tóth, M. – Voigt, E. – Baric, B. – Pajac, I. – Subic, M. – Baufeld, P. – Lerche, S. (2014): Importance of application of synthetic food lures in trapping of *Rhagoletis* spp. and *Strauzia longipennis* Wiedemann. Acta Phytopath. Entomol. Hung. 49, 25-35.

Tuba, K. (2009): Adatok három gyümölcslégyfaj Vas megyei előfordulásához. Növényvédelem 45, 491-495.

Voigt, E. – Tóth, M. (2008): Az amerikai keleti cseresznyelegyet és az európai cseresznyelegyet egyaránt fogó csapdatípusok. Agrofórum 19, 70-71.

Voigt, E.. – Subic, M. – Baric, B. – Parac, I. – Tóth, M. (2012): A szintetikus táplálkozási csalétek fontossága gyümölcskárosító fúrólegyek (*Rhagoletis* spp.) csapdázásában. Agrofórum Extra 43, 82-86.

Voigt, E. – Lengyel, G. – Markóné Nagy, K. – Károlyi, M. – Tóth, M. (2015): A célkártevővel összetéveszthető légyfajok a *Rhagoletis* csalétekkel felszerelt CSALOMON® PALz csapdákban. 61. Növényvédelmi Tudományos Napok előadásainak és posztereinek összefoglalója, 83 pp.

Varietal dependent response of barley to soil-borne *Waitea circinata* infection

Gyula Oros
Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary
gyoros@aim.com

SUMMARY

The disease syndrome caused by Waitea circinata*, a soil-borne pathogen introduced in the past decade into Carpathian basin, visually indistinguishable of those caused by various* Rhizoctonia *strains in diverse host plant. Dicotyledonaceous species in general proved to be more tolerant to this new pathogen than monotyledonaceous ones. This mesophilic fungus can seriously damage cereals. The barley varieties, similarly to other plants, exhibited highly different individual reaction to soil borne infection, Bivoy being the most while Maresi the less tolerant among the 9 tested varieties. Two groups could be separated on the base of their response to* Rhizoctonia*; Jubilant, Bivoy, Pasadena formed one group being moderately tolerant and Anabell, Scarlett, Rex and Omega the other group of more susceptibles. Three significant factors influence on the virulence of* Rhizoctonia *strains comprised 62% of total variation*.

Keywords: *Rhizoctonia*, *Waitea*, barley, susceptibility, soil-borne pathogens

INTRODUCTION

Traditionally, farmers in temperate zone paid little attention to field damage caused by soil-borne *Rhizoctonia* infection in cereals, because either seed-borne or air-borne fungi (rust, mildew, smut etc.) infecting stem, leaves and spikelets had been the main constrains of yield. Due to success in breading and arise new synthetic fungicides, these fungi presently do not cause catastrophic yield losses. However, in the last two decades increasing number of papers was published on yield losses (30% to 70%) caused by *Rhizoctonia* species in main cereal cultivating areas (Dorofeyeva *et al*., 1996; Oros *et al*., 2013). In South Eastern Hungary damage by the *R. cerealis* and *R. solani* has been observed (Simay, 1998; Kövics and Lőrinc, 2001). In August 2002, brown patches were observed on turf grasses in Budapest (Vajna and Oros, 2005). The causative agent associated to *R. solani* was identified as *Rhizoctonia zeae* Voorhees (teleomorph *Waitea circinata* Warcup and P.H.B. Talbot) and seemingly is a complex of diverse physiological groups (Ogoshi *et al*., 2000). This fungus was first found and described on maize in the USA (Vorhees, 1934), than was found in India (Narayanaswamy and Rao, 1984), Japan (Oniki *et al*., 1985), England (Burton *et al*., 1988), Alaska (Leiner and Carling, 1994), New Zealand (Christensen, 1996), Turkey (Demirci and Eken, 1999), Iran (Aghajani, 2000), Australia (Lanoiselet *et al*., 2001) and Brasilia (Poltronieri *et al*., 2002). *R. zeae* was associated to *R. solani* in other samples as well (Sumner and Bell, 1982), By means of comparative studies on more than 150 potential host plants its host range similar to that of *R. solani* (Vajna and Oros, 2005), although the monocotyledonaceous species proved to be less tolerant than dicotyledonaceous ones, contrary *to R. solani* strains.

Both roots and leaves of barley can be infected by *Rhizoctonia* (Murray, 1982) and coexists as an endophytic fungus frequently without symptoms, however, under unfavorable environmental conditions typical disease syndrome evolves (stunting, wilting, lesions). These typically soil-borne pathogens most frequently cause damping off prevalently in moist and cool conditions that are the main stress factors requested to induce disposition to increased susceptibility of potential host plants (Grogan, 1981). In a comparative study involving 19 wheat varieties, the symptomes caused by 26 *R solani* strains and *R. zeae* were indistinguishable with unarmed eye, and all varieties showed highly variable differences in their individual responses to soil-borne infection in both cases (Oros *et al*., 2013). Demirci (1998) isolated *R. solani* on barley and wheat in near the same frequency, however, the abundance of *R. zeae* was 2.5 times more in barley samples. Few data are available of the barley/*Waitea* interaction (Leiner and Carling, 1994; Demirci, 1998; Paulitz *et al*., 2003; Al-Abdalall, 2010).

Our objectives of this study to make comparative evaluation of responses of germinating barley seeds to *Rhizoctonia* strains of various origin and taxonomic position as well as to reveal factors influence on barley/*Rhizoctonia* interaction with special regard to the new Carpathian basin pathogen, *R. zeae*.

MATERIALS AND METHODS

Greenhouse experiment was undertaken to compare the infectivity of *Rhizoctonia zeae* strain with seven *R. solani* strains of various origin. Susceptibility of nine barley varieties and fifteen other monocot species were involved in the tests (*Table 1*). No seed-dressing or any other manners were applied to avoid repression of microbiota in spermosphere. The potting medium was made by mixing forest soil with peat before autoclaving (1.15 atm per 20 mins), at the ratio of 3:1.

Test Plants

Seeds of barley varieties (*Table 1*) were supplied by Dr. A. Tomcsányi (Martonvásár, Hungary), except a local one with unknown genetic background. *Triticum monococcum* L. cv. Alcor, *T. turgidum* L. cv. Hegyes were supplied by Elitmag Ltd. (Martonvásár, Hungary), while *T. aestivum* L. cv. Alcedo was of own propagation. *Zea mays* L. *saccharata* cv. Beregi szürke is a local collected variety (Bereg county, East Hungary), and all other seeds were purchased on the market (HERMES Ltd., Budapest, Hungary).

Test Fungi

The origin of *Rhizoctonia* strains were from different locations and various hosts. *R. zeae* B-405 (mixed grass of *Festuca* and *Lolium*, Hungary). *R. solani* strains were isolated in Hungary: B-321 (*Solanum tuberosum* cv. Ella), B-409 (*Hibiscus rosa-chinensis* L., imported from Tripoli, Lybia), B-410 (*S. tuberosum* cv. Kisvárdai rózsa), B-411 (*S. tuberosum* cv. Desirée), B-412 (*S. tuberosum* cv. Cleopatra), B-413 (*Malus domestica* L.) and B-433 (*Festuca arundinacea* Schreb.). The strains were maintained on potato dextrose agar (Merck, Darmstadt, Germany) amended with 2 g soya peptone L44 (Oxoid, Basingstoke, UK).

Test for Pathogenicity

The sterile potting medium prepared as above was admixed with chickpea seeds previously infested with the pathogen (10 seeds per 250 g pot), than incubated 96 hours at 26-28 ^{o}C to evolve mycelia. The seeds were put on the surface of infested soil (1×1 cm), than covered with 5 mm layer of sterile soil. Sterile distilled water was used to moist the surface (15 mL per pot) and covered with plastic wrap layer to avoid desiccation. The control plants were grown up in *Rhizoctonia*-free soil.

When the coleoptiles of control plants had been fully developed (8 days after emergence of first germling) the pathological status of all seedlings was evaluated following four fold scale to assess the tolerance of test plants at the 8th days: 0 = none of seedlings had no visible symptoms by the naked eye; 1 = most of seedlings were similar to control, but as minimum as one diseased; 2 = the majority of seedlings was dead, but at least one survivor was presented either symptomless or bearing severe symptoms (the coleoptyle and the roots damaged, the root neck scoring); 3 = all seedlings were destroyed. The results of observations were compiled into data matrix ((9 barley varieties + 15 reference plants) × [1+7] *Rhizoctonia* strains). The method was discussed in detail previously (Oros *et al.*, 2013).

Data Analysis

The relationships between host (barley varieties and reference species) and *Rhizoctonia* strains (potential soil-borne pathogens) have been analyzed by multivariate methods: Potency Mapping (PM) technique and Spectral Component Analysis (Lewi, 2005) combined with Principal Component Analysis (PCA), following a previously described scheme (Magyar and Oros, 2012). In the latter case only the components having an eigenvalue greater than one were included in the evaluation of data to demonstrate potential number of factors remarkably influencing on host-parasite system. The similarity in host spectra of strains was evaluated by Canonic Correlation Analysis (CanCor). Box plot analysis was applied to demonstrate selective differences both in tolerance of test plants and and virulence of *Rhizoctonia* strains.

Statistical functions of Microsoft Office Excel 2003 (Microsoft, Redmondton, USA) and Statistica5 program (StatSoft 5.0., Tusla, USA) were used for analysis of data. The graphical presentation of result of data analysis was edited uniformly in MS Office Power Point 2003.

Table 1

Susceptibility of barley varieties and reference species to soil borne *Rhizoctonia* infection

Test plants	*Rhiz. zeae*	*Rhizoctonia solani*							PS[a]
		Festuc	*Malus*	*Hibisc*	Potato strains				
	B-405	B-433	B-413	B-409	B-151	B-412	B-410	B321	
1. *Hordeum vulgare* L.[b]	0	0	0	2	2	2	0	0	0.9
2. cv. Anabell	2	0	1	2	2	1	1	1	1.1
3. cv. Bivoy	2	0	0	2	2	0	1	1	0.9
4. cv. Jubilant	2	0	0	3	1	0	0	0	0.6
5. cv. Maresi	2	0	0	2	2	0	0	0	0.6
6. cv. Pasadena	2	0	0	2	1	0	1	1	0.7
7. cv. Scarlett	1	0	0	2	1	1	0	0	0.6
8. cv. Rex	2	1	1	2	1	0	0	0	0.7
9. cv. Omega	1	1	0	2	2	0	0	0	0.7
10. *Triticum durum* Desf.	1	1	1	3	2	0	1	0	1.1
11. *T. spelta* L.	0	0	0	1	0	0	0	0	0.1
12. *T. aestivum* L.	2	0	0	3	2	2	0	1	1.1
13. *Festuca arundinacea* Schreb.	2	1	1	1	1	0	1	0	0.7
14. *Festuca rubra* L.	1	0	0	0	1	0	1	0	0.3
15. *Festuca* sp.	0	0	0	3	1	0	0	0	0.6
16. *Zea mays* L. *cornata*	0	0	0	2	1	1	0	0	0.6
17. *Z. mays* L. *everta*	0	0	0	2	1	1	0	0	0.6
18. *Z. mays* L. *saccharata*	1	3	3	3	0	1	0	0	1.4
19. *Allium cepa* L. cv. Owa	3	2	2	3	3	1	3	1	1.1
20. *A. cepa* L. cv. Makói bronz	1	0	1	3	3	1	0	0	2.1
21. *A. cepa* L. cv. Makói bronz	3	3	3	3	2	2	3	3	2.7
22. *Allium sativus* L.	1	1	1	2	2	1	2	2	1.6
23. *Allium schoenoprasum* L.	1	0	0	0	3	0	0	0	0.4
24. *Allium tuberosum* Rottler	3	3	3	3	3	3	3	3	3.0
PV[b] barley	1.6	0.2	0.2	2.1	1.6	0.4	0.3	0.3	0.7
PV *Triticum*	1.0	0.3	0.3	2.3	1.3	0.7	0.3	0.3	0.8
V *Festuca*	1.0	0.3	0.3	1.3	1.0	0.0	0.7	0.0	0.5
PV *Zea*	0.3	1.0	1.0	2.3	0.7	1.0	0.0	0.0	0.9
PV *Allium*	2.0	1.5	1.7	2.3	2.7	1.3	1.8	1.5	1.8

[a]= Potential susceptibility of plant to *R. solani* strains, [b]= local variety, [c]= Potential aggressivity of strains to test plants. Border limits of the scale of evaluation: 0= no damage, 1=as minimum as one plant injured, 2= as minimum as one plant survivied, 3= all plants destroyed.

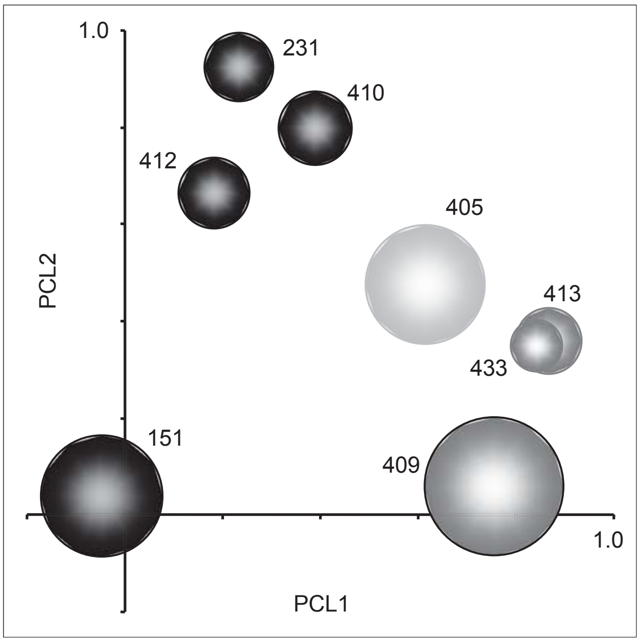
RESULTS

Responses of host/pathogen pairs

The susceptibility of test plants varied within large limits (*Table 1*), and low correlation was revealed between responses to *R. zeae* and *R. solani* strains ($r_{wc,tc}$=0.759, p=0.028) by means of multiple correlation. *Festuca rubra*, *Triticum turgidum* and a local variety of barley tolerated well both *Waitea* and *Thanatephorus* strains, while *Allium tuberosum* proved to be the most susceptible in both host/parasite systems. In general, barley varieties exhibited medium tolerance to *Rhizoctonia*s with marked selectivity to strains. No differences were observed in symptoms caused in various host/parasite pairs, although there were great alterations in individual responses of seedlings. Stunted growth was the most frequent symptom. The leaf spots occurred in the case of each test plant independently on the longitudinal growth of coleoptiles randomly. No wilted plant was found without root neck decay. Most of *A. tuberosum* seeds were destroyed during the germination, and none of them developed coleoptiles longer than 5 mm before dumping off.

Figure 1: **Scatter plot of strains as PC loadings by two major Principal Components of Spectral Map**

Spectral scores		Spectral Components		
No.	Strains	PCL1	PCL2	PCL3
1.	B405	0.603	0.475	0.061
2.	B433	0.838	0.348	-0.208
3.	B413	0.862	0.357	-0.210
4.	B409	0.741	0.057	0.371
5.	B151	-0.060	0.039	0.891
6.	B412	0.176	0.664	0.378
7.	B410	0.383	0.797	-0.158
8.	B231	0.226	0.924	0.008
	Eigenvalues	2.59	2.41	1.19
	Prop. Total (%)	32.4	30.1	14.9



The accession numbers of strains were underlined PC loadings are significantly influencing the component concerned. The distribution of variables on the plot is determined by 62% of total variation. The grey and black spheres are proportional to overall potential virulence and mark clusters *A* and *B* of *R. solani* strains, respectively.

The strains isolated from *Hibiscus* twig and potato tubers (cv. Desirée) pairing with *R. zeae* were significantly more virulent than the other *R. solani* strains (*Table 1*), but their host spectrum showed low similarity ($r_{rz,hib}$=0.34, $r_{rz,des}$=0.14, $r_{des,hib}$=0.09 < r0.1=0.36). Interestingly, only one of *Thanatephorus* strains (B151) harmed *A. schoenoprasum* and *Waitea* caused significant stunting only.

Factors influence on virulence of *Rhizoctonia*s and plant responses

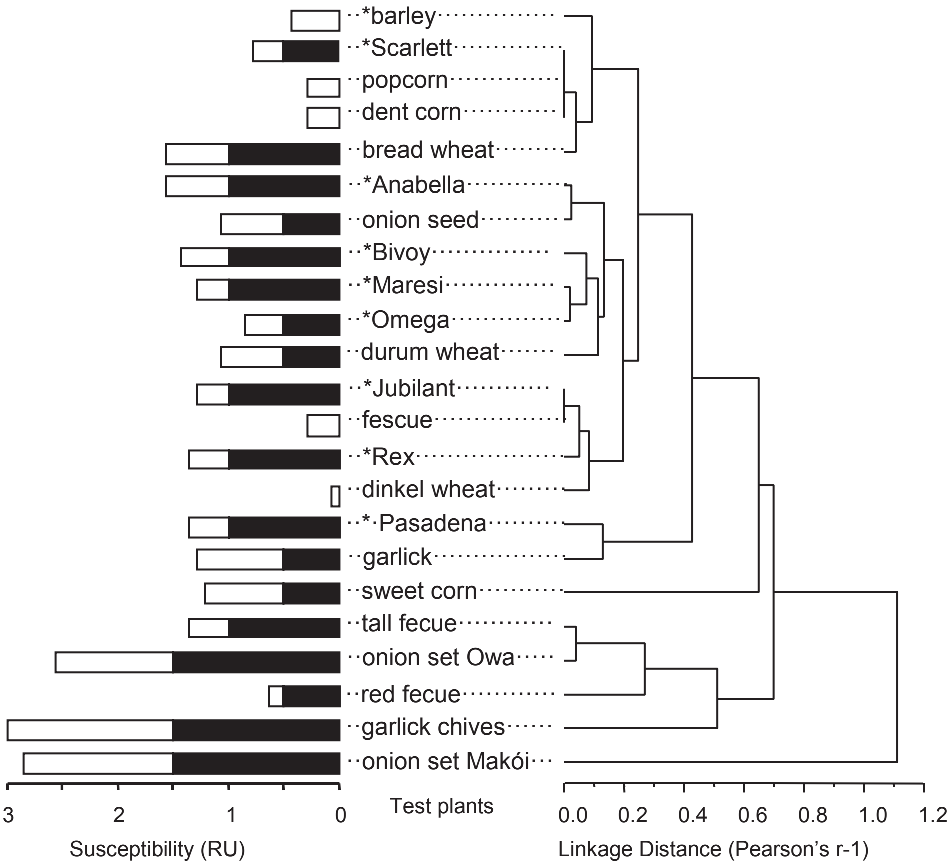
The strength of virulence of *Rhizoctonia* strains was separated by Potency Mapping and their host selectivity analyzed by multivariate techniques (PCA and CanCor). Neither the overall infective potential (Table 1) nor the host range of *Rhizoctonia* strains were related to their origin (*Figure 1*). Three components comprised 77% of total variance of the Spectral Map, where the potato strain (B151) significantly deviated of others that strains clustered into two groups (*A* and *B*) as it was demonstrated on scatterplot (*Figure 2*). The similarity of host spectrum of *R. zeae* to these groups was significantly different being $R_{405,A}$=0.54 > $R_{405,B}$=0.70. The origin of strains seemingly did not take role in their host spectrum that was for example, similar ($r_{433,413}$=0.94) of strains originated of *Festuca* roots and apple cambium.

Factors influencing on plant responses to soil-borne *Rhizoctonia* infection

The potential susceptibility of test plant was separated by Potency Mapping. The strength of response to *Rhizoctonia*s varied within large limits (*Figure 2*), and there was not revealed relationship between taxonomic position and overall potential susceptibility. Although some plants (1, 11, 15, 16, 17) proved to be tolerant to *R. zeae*, all others but garlic and sweet corn exhibited higher potential susceptibility to this new pathogen than to *R. solani* strains (*Figure 2*).

The relationship between test plants and their host spectra was evaluated applying Cluster Analysis (unweighted pair group averages) based on Pearson's correlation matrix of Spectral Map (*Figure 2*). The plants formed five groups with two outliers (18, 20), where barley varieties distributed within four clusters. Seemingly, both response of host and virulence of pathogens are influenced by complex interaction of diverse factors.

Figure 2: **Potential susceptibility of monocotyledonaceous species to soil borne *Rhizoctonia* infection and their relationships in host specificity**



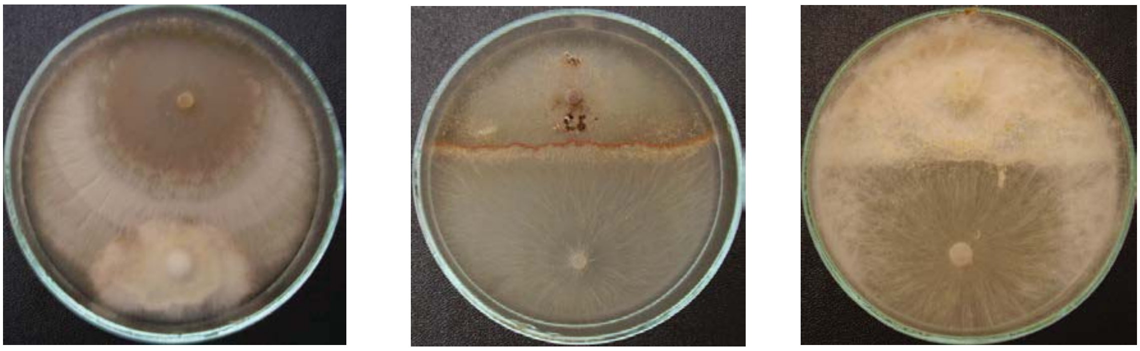
The bold and opened prism on the left graph are proportional to potential susceptibility to soil-borne *Waitea circinata* and *Thanatephorus cucumeris* strains. The clusterogram on the right side was calculated of Spectral Map derived of *Table 1* according to Lewi (1976). The asterisk (*) labelled plants are barley varieties.

DISCUSSION

The gene center of barley was most probably in Levant (Gyulai, 2004), and nowadays the most diverse group of *Rhizoctonia*s was found in this area: strains of five anastomosis groups of *Thanatephorus cucumeris* and two pathotypes of *W. circinata* were isolated of barley in East Turkey (Demirci, 1998). These two fungi occurred frequently together, and different types are infecting in consortium (Roget *et al*., 1996; Yamauchi *et al*., 2002). Nevertheless, their ecological requirements seem to be different, as *R. zeae* was not affected tillage methods contrary to *R. solani* (Schroeder and Paulitz, 2008). The virulence of new for Carpathian basin soil-borne pathogen, *W. circinata* was demonstrated in this study to be almost the most virulent *R. solani* strains tested on barley varieties. Similar results were found with set of strains used in this study with okra (Bittsánszky *et al*., 2012), ricinus (Bittsánszky *et al*., 2015) and wheat varieties (Oros *et al*., 2013). *R. solani* strains divided into two groups having different host range within monocot plants, and the host range of *R. zeae* strain studied showed significantly similar pattern to one of them.

The elucidation of physiological background of host/*Rhizoctonia* needs further studies as well as use of experimental models mimicking the field conditions. More attention should be also paid to interaction among associated *Rhizoctonia* strains residing in the field (Yamauchi *et al.,* 2002). The *R. zeae* (B405) strain antagonized the associated *R. solani* strain (B433) in brown patches of *Festuca*/*Lolium* turf (*Figure 3*), and it was found in microscopic studies to parasite some other strains as well. However, this parasitic action was strain specific, and there was not revealed relationship between virulence of *R. solani* strains and their susceptibility to *R. zeae*. The strain specific toxin production may take place in determination of virulence and antagonism (Oros *et al*., 2014), where the acceptor's reaction might be specific as well.

Figure 3: **Strain specific interaction between *R. zeae* and *R. solani***



R. zeae vs B151 | *R. zeae vs* B433 | *R. zeae vs* B409

Five days old cultures are shown on Potato Dextrose Agar

Some efforts have been done to utilize the mycoparasitic property of *W. circinata* in control of several common root diseases (Webb *et al*., 2015). This initiative underlines the importance of the use of more complex experimental models, as testing only one cultivar of plant to be protected does not result supportive data for application of any preparation in large scale, due to highly varietal selective response of cultivated plants to *W. circinata* infection as well as strain-selective interaction between fungi, thus there is no surety to positive outcome of the application of *W. circinata* based mycopreparate.

CONCLUSIONS

No relationship was found between taxonomic position and origin of *Rhizoctonia* strains, indicating that traits used for their classification are not closely related to the expression of their pathogenicity against barley cultivars and other test plants.
Three factors were revealed that significantly affect the host range and virulence of strains in barley/*Rhizoctonia* system, and only limited overlapping was revealed between *R. zeae* and *R. solani* strains.
We have got empirical evidence from plant/pathogen system on the possibility of selection; the barley phenotype resistant to *R. zeae* and one pathotype of *R. solani*.

ACKNOWLEDGEMENTS

This study was supported by *The National Office for Research and Technology*, Grant No. K67688

REFERENCES

Aghajani, M.A. (2000): Identification of *Rhizoctonia* and *Rhizoctonia*-like fungi on poaceae in central region of Mazandaran, M.S. Thesis, Tarbiat Modarres University, Tehran, IR.

Al-Abdalall, Amira Hassan Abdullah (2010): Assessment of yield loss caused by root rots in wheat and barley. Journal of Food Agriculture & Environment 8, 638-641.

Bittsánszky, A. – Rai, R.V. – Oros, G. (2012): Response of glutathion conjugation system to soil borne *Rhizoctonia* infection of okra. Acta Phytopathologica et Entomologica 47, 191-202.

Bittsánszky, A. – Deepak, S.A. – Oros, G. (2015): Selective response of *Ricinus communis* seedlings to soil borne *Rhizoctonia* infection. Ecocycles 1, 33-38.

Burton, R.J. – Coleysmith, J.R. – Wareing, P.W. – Gladders, P. (1988): *Rhizoctonia oryzae* and *R. solani* Associated with Barley Stunt Disease in The United-Kingdom. Transactions of The British Mycological Society 91, 409-417.

Christensen, M.J. (1996): Antifungal activity in grasses infected with *Acremonium* and *Epichloe* endophytes. Australasian Plant Pathology 25, 186–191.

Dean, R. – Van Kan, J.A.L. – Pretorius, Y.A. – Hammond-Kosack, K.E. – Di Pietro, A. – Spanu, P.D. – Rudd, J.J. – Dickman, M. – Kahmann, R. – Ellis, J. – Foster, G.D. (2012): The Top 10 Fungal Pathogens in Molecular Plant Pathology. Molecular Plant Pathology 13, 414-430.

Demirci, E. (1998): *Rhizoctonia* Species and Anastomosis Groups Isolated from Barley and Wheat in Erzurum, Turkey. Plant Pathology 47, 10-15.

Dorofeyeva, L.L. – Tytova, K.D. – Pavlova, V.V. – Syzova, T.P. (1996): Cereals' rhizoctonias. Mikologiya I Fitopatologiya 30, 52-55.

Grogan, R.G. (1981): The Science and Art of Plant Disease Diagnosis. Annual Review of Plant Pathology 19, 333-351.

Gyulai F. (2004): Distribution and history of the cultivation of barley. In: The Barley (eds. Tomcsányi A. and Turcsányi G.), Akadémia Kiadó, Budapest, pp. 53-79. (in Hungarian)

Kövics, G.J. – Lőrincz N. (2001): Causal Agents of Stem-Base Diseases of Winter Wheat in Eastern Hungary. In: P*roceedings of Conference*, *Resources of the Environment and Sustained Development*, Oradea, 24-26 May 2001, *Analele Universitátii din Oradea. Tom. VII. Scientific Communication Session*: *Partea I-a. Fascicula Agri-cultură-Horticultura*, pp. 37-44.

Lanoiselet, V.M. – Ash, G.J. – Cother, E.J. – Priest, M.J. – Watson, A. (2001): First report on *Waitea circinata* causing sheath spot and *Rhizoctonia oryzae-sativae* causing aggregate sheath spot on rice in Southern-Australia. Australian Plant Pathology 30, 369-370.

Leiner, R.H. – Carling, D.E. (1994): Characterization of *Waitea circinata* (*Rhizoctonia*) isolated from agricultural soils in Alaska. Plant Disease 78, 385-388.

Lewi, P.J. (2005): Spectral Mapping, a Personal and Historical Account of an Adventure in Multivariate Data Analysis. Chemometrics and Intelligent Laboratory Systems 77, 215-223.

Magyar, D. – Oros, G. (2012): Application of the Principal Component Analysis to Disclose Factors Influencing on the Composition of Fungal Consortia Deteriorating Remained Fruit Stalks on Sour Cherry Tree. In: P. Sanguansat, Ed., *Principal Component Analysis*, InTech, Rijeka, pp. 89-110.

Martin, S.B. – Lucas, L.T. (1983): Pathogenicity of *Rhizoctonia zeae* on tall fescue and other turfgrasses. Plant Disease 67, 676–678.

Murray, D.I.L. (1982): Penetration of Barley Root and Coleoptile Surfaces by *Rhizoctonia solani*. Transactions of The British Mycological Society 79, 354-360.

Narayanaswamy, T. – Rao, A.V. (1984): *Waitea circinata* - A New Fungus Causing Sheath Blight on Rice. Current Science, 53, 874-874.

Ogoshi, A. – Cook, R.J. – Bassett, E.N. (1990): *Rhizoctonia* species and anastomosis groups causing root rot of wheat and barley in the Pacific Northwest. Phytopathology 80, 784-788.

Oniki, M.O. – Araki, A. – Sakai, T. – Tanaka, R.S. (1985): The perfect state of *Rhizoctonia oryzae* and *Rhizoctonia zeae*, and the anastomosis groups of *Waitea circinata*. Transactions of The Mycological Society of Japan 26, 189–198.

Oros, G. – Bittsánszky, A. – Pilinszky, K (2014): Response of *Arabidopsis* clones to toxic compounds released by various *Rhizoctonia* species. American Journal of Plant Sciences 5(3):364-371.

Oros, G. (2004): *Rhizoctonia* Species. Gaps to Be Filled in the Hungarian Soil Science. Tiszántúli Növényvédelmi Fórum Előadásai, Debrecen, 18-20 October 2004, pp. 321-329.

Oros, G.- Naár, Z. – Magyar, D. (2013): Susceptibility of wheat varieties to soil-borne *Rhizoctonia* infection. American Journal of Plant Sciences 4, 2240-2258.

Paulitz, T.C. – Smith, J.D. – Kidwell K. K. (2003): Virulence of *Rhizoctonia oryzae* on wheat and barley cultivars from the Pacific Northwest. Plant Disease 87, 51-55.

Poltronieri, L.S. – Trinidade, D.R. – Albuquerque, F.C. (2002): Rot of corn caused by *Rhizoctonia zeae* in the state of Pará, Brazil. Fitopatologia Brasilera 27, 423–423.

Roget, D.K. – Neate, S.M. – Rovira, A.D. (1996): Effect of Sowing Point Design and Tillage Practice on the Incidence of *Rhizoctonia* Root Rot, Take-All and Cereal Cyst Nematode in Wheat and Barley. Australian Journal of Experimental Agriculture 36, 683-693.

Schroeder, K.L. – Paulitz, T.C. (2008): Effect of inoculum density and soil tillage on the development and severity of *Rhizoctonia* root rot. Phytopathology 98, 304-314.

Simay, E.I. (1998): Outbreak of *Rhizoctonia solani* Kühn on oat (*Avena sativa*) in Hungary. *Cereal Research Communications* 17, 233-235.

Sumner, D.R. – Bell, D.K. (1982): Root diseases induced in corn by *Rhizoctonia solani* and *Rhizoctonia zeae*. Phytopathology 72, 86– 91.

Sváb, J. (1981): Biometrical Methods in Research Work. Mezőgazdasági Kiadó, Budapest (in Hungarian).

Vajna, L. – Oros, G. (2005): First Report of *Rhizoctonia zeae* in Hungary. Plant Pathology 54, 250.

Vajna, L. – Oros, G. (2005): Turfgrass Blight in Hungary. The Role of *Rhizoctonia solani* and *R. zeae* in the Disease Development. Plant Protection 59, 149-157. [in Hungarian]

Voorhees, R.K. (1934): Sclerotial Rot of Corn Caused by *Rhizoctonia zeae*, n. sp. Phytopathology 24, 1290-1303.

Webb, K.M. – Harveson, R.M. – West, M.S. (2015): Evaluation of *Rhizoctonia zeae* as a potential biological control option for fungal root diseases of sugar beet. Annals of Applied Biology 167, 75-89.

Yamauchi, R.A. – Carling, R. – Kageyama, D.E. – Hyakumachi, K.M. (2002): Differentiation of three varieties of *Rhizoctonia circinata* var. *circinata*, var. *oryzae* and var. *zeae* on the basis of cellular fatty acid composition. Journal of Phytopathology 150, 1-5.

Debreceni Egyetem Agrártudományi Közlemények – Acta Agraria Debreceniensis
Főszerkesztő – Editor-in-chief: Dr. Jávor András rektorhelyettes
Szerkesztőség – Editorial office: H-4032 Debrecen Böszörményi út 138.
Telefon, fax – Phone, fax: (36-52) 508-392, 508-460
Felelős kiadó – Executive publisher: Dr. Nagy János prorektor
HU-ISSN 1587-1282
AK-AAD-JAS Home Page: http://mek.unideb.hu/index.php/en/ipps
E-mail: editor-agraria@agr.unideb.hu