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Editor & Publisher

Harald K. BERGER
c/o AGES
Spargelfeldstraße 191 ; P.O.B. 400
A - 1226 WIEN - VIENNA
AUSTRIA – EUROPE
e-mail: harald.berger@ages.at

IWGO –NEWSLETTER XXV / 1

EDITORIAL

There was no meeting of the IWGO – *Diabrotica* Subgroup in 2003. The reason was the meeting of the EU – project group which took place in Göttingen in January 2003. The project was finalized in 2003 and according to the contract with EU a meeting presenting the results of the project took place. The papers presented at this meeting and the results of the project will be published in 2004 by CABI.

In 2004 the Xth IWGO took place regularly. As usually the meeting was held together with the EPPO ad hoc Panel on *Diabrotica* and the FAO – *Diabrotica* project group. The meeting took place in Engelberg, Switzerland and a wonderful mountain area best organized by Uli KUHLMANN from the CABI *Bioscience* Switzerland Centre in Delémont, Mario BERTOSSA from the Swiss Federal Research Station for Plant Production in Contone, KCS Convention Service and the staff of CABI – Bioscience in Delémont.

More than 100 participants (110) out of 24 countries (as well as from the EU and EPPO) attended this meeting and showed the interest of – mainly European - scientist in this “new” pest. Compared with the participants of the 1st IWGO Subgroup Meeting in Graz in 1995 where only about 20 persons attended the meeting, we can really speak of a successful work within the group.

In this issue of the IWGO – NEWSLETTER you find the abstracts of the papers presented at the meeting in Engelberg except the report about the poster – session and of the FAO – group. These papers will be published in IWGO – NEWSLETTER XXV / 2.

Harald K. BERGER
(Editor)

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10th International IWGO – Workshop

8th FAO/TCP Meeting
9th EPPO ad hoc Panel
Engelberg, Switzerland; January 14 – 16, 2004

ORGANIZING COMMITTEE

Convenor

International Working Group of *Ostrina* and other maize pests (IWGO)
Harald Berger, AGES, Spargelfeldstr. 191, 1226 Vienna, Austria
E-mail: h.k.berger@gmx.at

***Diabrotica* – Subgroup Convenor**

Prof. Dr. C. Richard Edwards
Purdue University, 901 State Street, W. Lafayette, Indiana, USA
E-mail: rich_edwards@entm.purdue.edu

LOCAL ORGANIZATION



Dr. Ulrich Kuhlmann
CABI Bioscience Switzerland Centre
Rue des Grillons 1, 2800 Delémont, Switzerland
u.kuhlmann@cabi-bioscience.ch



Mario Bertossa
Swiss Federal Research Station for Plant Production
Centro di Cadenazzo, 6594 Contone, Switzerland
E-mail: mario.bertossa@rac.admin.ch

CONFERENCE ORGANIZER

KCS Convention Service
Agency for Conference & Convention Management
Rue des Raimontpierre 5, 2800 Delémont, Switzerland
H.Kuhlmann@bluewin.ch

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List of Participants of the

8th FAO/TCP Meeting
9th EPPO ad hoc Panel
10th International IWGO – Workshop

Engelberg, Switzerland; January 14 – 16, 2004

Albert, Reinhard, Dr.

Landesanstalt für Pflanzenschutz
Reinsburgstr. 107
70197 Stuttgart, Germany
E-mail: reinhard.albert@fp.bwl.de

Agnès, Andrea, Mr.

Provincia Di Novara-Settore Agricoltura
Via Dominiononi, 4
28100 Novara, Italia
E-mail: A.Agnes@Provincia.Novara.it

Baca, Franja, Dr.

Maize Research Institute
Zemun Polje
11185 Zemun, Belgrade, Serbia&Montenegro
E-mail: Fbaca@MRIZP.CO.YU

Baufeld, Peter, Dr.

Biologische Bundesanstalt für Land- und
Forstwirtschaft
Stahnsdorfer Damm 81
14532 Kleinmachnow, Germany
E-mail: p.baufeld@bba.de

Bazok, Renata, Dr

Faculty of Agriculture
Svetosimunska 25
10000 Zagreb, Croatia
E-mail: rbazok@agr.hr

Berger, Harald, Dipl. Ing.

AGES
Spargelfeldstr. 191
1226 Vienna, Austria
E-mail: h.k.berger@gmx.at

Bertossa, Mario

Swiss Federal Research Station for Plant
Production
Centro di Cadenazzo
6594 Contone, Switzerland
E-mail: mario.bertossa@rac.admin.ch

Bigler, Franz, Dr.

Swiss Federal Research Station of Agroecology
Reckenholzstr. 191
8046 Zürich
E-mail: franz.bigler@fal.admin.ch

Boriani, Marco, Dr.

Phytosanitary Service
Piazza in Novembre 5
20124 Milano, Italy
E-mail: marco-boriani@regione.lombardia.it

Boulin, Pascal

Bayer Cropscience France
16, rue Jean Marie Leclair
69337 Lyon, France
E-mail: pascal.boulin@bayercropscience.com

Breitenbach, Sven

BBA Braunschweig
Messeweg 11-12
38104 Braunschweig, Germany
E-mail: s.breitenbach@bba.de

Burger, Regina

Landi Reba
Lyonstr. 18
4053 Basel, Switzerland
E-mail: regina.burger@landireba.ch

Cate, Peter, Dr.

AGES
Spargelfeldstr. 191
1226 Vienna, Austria
E-mail: peter.cate@ages.at

Cean, Mirela, Dr.

Central Laboratory for Phytosanitary Quarantine
11 Afumati
077190 Bucharest, Romania
E-mail: lccf@lccf.ro

IWGO –NEWSLETTER XXV / 1

Cheek, Sharon
Central Science Laboratory
Sand Hutton
York YO41 1LZ, UK
E-mail: s.cheek@csl.gov.uk

Colombo, Mario, Dr.
Istituto Entomologica Agraria
Via Celoria 2
20133 Milan, Italy
E-mail: mario.colombo@unimi.it

Cota, Ejup, Dr.
Plant Protection Institute Durres
L14 Shkozet, Durres
Albania
E-mail: cotaentom59@yahoo.com

Derridj, Silvie, Dr.
INRA-Unité de Phytopharmacie
Route de St. Cyr
78026 Versailles, France
E-Mail: derridj@versailles.inra.fr

Derron, Jacques, Dr.
Station Fédérale de Recherche en Production
Végétale, RAC Changins
1260 Nyon, Switzerland
E-mail: jacques.derron@rac.admin.ch

Dömötör, Istvan
Department of Plant Protection
Szent Istvan University
Pater Karoly 1
2100 Gödöllő, Hungary
E-Mail: domepista@fau.gau.hu ??

Edwards C. Richard, Dr. Prof.
Purdue University
901 State Street
W. Lafayette, Indiana, USA
E-mail: rich_edwards@entm.purdue.edu

Ehlers, Ralf-Udo, Dr.
Institut für Phytopathologie
Klausdorfer Str. 28-36
24223 Raisdorf, Germany
E-mail: ehlers@biotec.uni.kiel.de

Ester, Albert
Applied Plant Research
Edelhertweg 1
821g PH Lelystad, Netherland
E-mail: albert.ester@wur.nl

Ellsbury, Michael M., Dr.
USDA, ARS, NPA-Northern Grain Insects Research
Laboratory
2923 Medary Avenue
57006 Brookings, South Dakota, USA
E-mail: mellsbur@ngirl.ars.usda.gov

Eke, Istvan, Dr.
Ministry of Agriculture
Kossuth ter 11
1055 Budapest, Hungary
E-mail: Ekel@posta.fvm.hu

French, Bryan Wade, Dr.
USDA, ARS, NGIRL
2923 Medary Avenue
57006 Brookings, USA
E-mail: wfrench@ngirl.ars.usda.gov

Furlan, Lorenzo, Dr.
Department of Agronomy, University of Padova
Via Carozzani 18
30027 San Dona di Piave, Italy
E-mail: lorenzo.furlan@inwind.it

Gathmann, Achim, Dr.
RWTH Aachen, Biology V
Worringerweg 1
52056 Aachen, Germany
E-mail: gathmann@bio5.rwth-aachen.de

Girardin, Philippe, Dr.
I.N.R.A.
B.P. 507
68021 Colmar Cedex, France
E-mail: girardin@colmar.inra.fr

Gottschalk, Heike, Dr.
KWS
Grimsehlstr. 31
37574 Einbeck, Germany
E-mail: h.gottschalck@kws.de

Governatori, Gianluca, Dr.
Osservatorio Per Le Malattie Delle Piante Regione
Autonoma Friuli, Venezia, Giulia
Via Beato Odorico, 13
33170 Pordenone, Italia
E-mail: gianluca.governatori@regione.fvg.it

Graepel, Heinrich
Bayer Crop Science Deutschland GmbH
Vor dem Dorfe 11
27327 Martfeld, Germany
E-mail: heinrich.graepel@bayercropscience.com

IWGO –NEWSLETTER XXV / 1

Grossrieder, Manfred

Cabi Bioscience Switzerland Centre
Rue des Grillons, 1
2800 Delémont, Switzerland
E-Mail: m.grossrieder@cabi-bioscience.ch

Grozea, Iona, Dr.

Banat's University of Agricultural Sciences
Calea Aradului, 119
1900 Timisora, Romania
E-mail: ioana_entomol@yahoo.com

Hatala Zseller, Ibolya

Plant Protection and Soil Conservation Service
of Csongra County
Rarosi Str. 110
6800 Hodmezovasarhely, Hungary
E-mail: hatalane.ibolya@csongrad.ontsz.hu

Heimbach, Udo, Dr.

BBA-A
Messeweg 11-12
38104 Braunschweig, Germany
E-mail: u.heimbach@bba.de

Hummel, Hans E. Prof. Dr.

Biological and Biotechnical Plant Protection,
University Giessen
Heinrich-Buff Ring 26-32
35392 Giessen, Germany
E-mail: Hans.E.Hummel@agr.uni-giessen.de

Imgraben, Hansjörg

Regierungspräsidium Freiburg
Pflanzenschutzdienst
Bertoldstr. 43
79083 Freiburg, Germany
E-mail: hansjoerg.imgraben@RPF.BWL.de

Igrc Barcic, Jasminka, Prof. Dr.

Faculty of Agriculture
Svetosimunska 25
10000 Zagreb, Croatia
E-mail: igr@agr.hr

Ivezic, Marija, Prof. Dr.

University of J.J. Strossmayer in Osijek
Trg Sv. Tojstva 3
31000 Osijek, Croatia
E-mail: marija.ivezic@pfos.hr

Ivanka, Ivanova

National Service of Plant Protection
120, Blv. Nikola Muchanov
1330 Sofia, Bulgaria
E-mail: clkr@bgnet.bg

Jess, Stephen, Dr.

Department of Agriculture for Northern Ireland
Agriculture and Food Service Center
Newforge Lane
Belfast BT19 7ZN, Northern Ireland
E-mail: Stephen.Jess@dardni.gov.uk

Jucker, Costanza, Dr.

Fondazione Minoprio
V.Le Raimondi 54
22070 Vertemate con Minoprio, Italy
E-mail: biolomb@fondazioneminoprio.it

Karic, Nedzad

Faculty of Agriculture Sarajevo
Zmaja od Bosne 8
71000 Sarajevo, Bosnia
E-mail: Nkaric@BIH.NET.BA

Kiss, Jozsef, Prof. Dr.

Department of Plant Protection, Szent Istvan
University, Gödöllő
Pater K.
2100 Gödöllő, Hungary
E-mail: jkiss@gikk.gau.hu

Klapal, Helmut, Ing.

AGES
Spargelfeldstr. 191
1226 Vienna, Austria

Kokoranova, Krassimira

National Service for Plant Protection
Regional Service for Plant Protection Vidin
120, Blv. Nikola Muchanov
1330 Sofia, Bulgaria
E-mail: kokoranova@mail.bg

Komaromi, Judith, Dr.

Department of Plant Protection, Szent Istvan University
Pater Karoly 1
2100 Gödöllő, Hungary
E-mail: komaromij@fau.gau.hu

Konstantinova, Nataliya

Plant Quarantine Service
Koloskova Str. 7
03138 Kiyv, Ukraine
E-mail: pqsu@bigmir.net

IWGO –NEWSLETTER XXV / 1

Krohn, Peter, Dr.
Bayer Crop Science AG
Alfred-Nobel-Str. 50
40789 Monheim, Germany
E-mail: peter-wilhelm.krohn@bayercropscience.com

Kuhlmann, Ulrich, Dr.
Cabi Bioscience Switzerland Centre
Rue des Grillons, 1
2800 Delémont, Switzerland
E-mail: u.kuhlmann@cabi-bioscience.ch

Kuske, Stefan, Dr.
Swiss Federal Research Station Wädenswil
Schloss
8820 Wädenswil, Switzerland
E-mail: stefan.kuske@faw.admin.ch

Lammers, Wiebe
Plant Protection Service
Geertjesweg 15
6700 Wageningen, Netherlands
E-mail: J.W.Lammers@Pd.Agro.NL

Lanfranchini, Fabio
Federazione Interprovinciale Coltivatori Diretti Novara
Via Ravizza 10
28100 Novara, Italy
E-mail: fabio.lanfranchini@coldiretti.it

Larraz, Virginia
Cabi Bioscience Switzerland Centre
Rue des Grillons, 1
2800 Delémont, Switzerland

Lefko, Steve, Dr.
Pioneer HI-Bred
7250 NW 62ND Ave
50131 Johnston, IA, USA
E-mail: steve.lefko@pioneer.com

Maarel van der, Henk
Syngenta Crop Protection
Stepvelden 8
4700 Roosendaal, Holland
E-mail: Henk.Maarel_Van_Der@syngenta.com

Majdancic, Meho
Secondary School of Agriculture
Patriotske Lige BB
75260 Kalesija, Bosnia
E-mail: mehoma@inet.ba

Manea, Nicolae, Dr.
Phytosanitary Directorate Dambovita
Campulung 152
0200 Targoviste, jud. Dambovita, Romania
E-mail: manea.nic@k.ro

Mazzini, Nicoletta, Dr.
Federazione Interprovinciale Coltivatori Diretta Novara
Via Ravizza 10
28100 Novara, Italy
E-mail: nicoletta.mazzini@coldiretti.it

Meijer, Anneke
Plant Protection Service
Geertjesweg 15
6700 Wageningen, Netherlands
E-mail: a.c.meijer@pd.agro.nl

Melnik, Pavel, Dr.
Ukrainian Scientific Research Plant Quarantine
Station UAAS
60321 Boyani, Ukraine
E-mail: vlad@flashmail.com

Meroni, Donata
European Commission Food and Veterinary Office-Plant
Health
Dunsany Grange, Co Meath
Ireland
E-mail: donata.meroni@cec.eu.int

Mezei, Imre, Dr.
DowAgrosciences R&D
Vörösmarty
5008 Szolnok, Hungary
E-mail: imezie@dow.com

Moeser, Joachim, Dr.
Institut für Pflanzenpathologie
Grisebachstr. 6
37077 Göttingen, Germany
E-mail: jmoeser@gwdg.de

Moran, Tony
Syngenta
30 Priestley Road
Guilford GU2 7YH, UK
E-mail: tony.moran@syngenta.com

Muller, Franck
Cabi Bioscience Switzerland Centre
Rue des Grillons, 1
2800 Delémont, Switzerland
E-mail: f.muller@cabi-bioscience.ch

IWGO –NEWSLETTER XXV / 1

Muresanu, Felicia, Dr.
Agricultural Research Development Station
Agriculturii Street 4
400100 Turda, jud Cluj, Romania
E-mail: scaturda@rdslink.ro

Naibo, Bernard
Arvalis Institut du Végétal
21 chemin de Pau
64121 Montardon, France
E-mail: b.naibo@arvalisinstitutduvegetal.fr

Neubauer, Karl, Ing.
Bayer Cropscience
Lerchenfelder Gürtel 9-11
1164 Vienna, Austria
E-mail: karl.neubauer@bayercropscience.com

Niehoff, Berthold, Dr.
KWS Saat AG
Grimsehlstr. 31
37574 Einbeck, Germany
E-mail: b.niehoff@KWS.de

Omelyuta, Victor, Dr.
Institute of Plant Protection of UAAS
33 Vasylykivska Street
03002 Kiyv, Ukraine
E-mail: plant_prot@ukr.net

Pershing, Jay C., Dr.
Monsanto Co.
800 N. Lindbergh Blvd.
63167 St. Louis, MO, USA
E-mail: jay.c.pershing@monsanto.com

Petrache, Tomel
Agricultural Research and Development station Lovrin
Principala Nr. 200
370250 Lovrin, Romania
E-mail: ptomel@yahoo.com

Pigott, Simon, Dr.
Becker Underwood
Harwood Road
Littlehampton BN17 7AU, UK
E-mail: simon.piggott@beckerunderwood.com

Pons, Xavier, Dr.
Universitat de Lleida
Av. Rovira Roure, 191
25198 Lleida, Spain
E-mail: xavier.pons@irta.es

Pradel, Benoist
Limagrain Genetics
Coussan
47200 Marmande, France
E-mail: Benoist.pradel@limagrain.com

Princzinger, Gabor, Dr.
Ministry of Agriculture
Kossuth ter 11
1055 Budapest, Hungary
E-mail: princzinger@posta.fvm.hu

Raps, Andrea, Dr.
Swiss Agency for the Environment, Forests and
Landscape
3003 Bern, Switzerland
andrea.raps@buwal.admin.ch

Rasmann, Sergio
University of Neuchâtel
Emile-Argand 11
2007 Neuchâtel, Switzerland
E-mail: sergio.rasmann@unine.ch

Raspudic, Emilija, Dr.
University of J.J. Strossmayer in Osijek
Trg Sv. Tojstva 3
31000 Osijek, Croatia
E-mail: emilija.raspudic@pfos.hr

Reynaud, Philippe
DGAL/SDQPV
2 Place Viala
34060 Montpellier, France
E-mail: reynaud@ensam.inra.fr

Ripka, Géza, Dr.
Central Service for Plant Protection
and Soil Conservation
PF 340
1519 Budapest, Hungary
E-mail: Ripka.Geza@ntks.ontsz.hu

Romeis, Jörg, Dr.
Swiss Federal Research Station for Agroecology
Reckenholzstr. 191
8046 Zürich, Switzerland
E-mail: joerg.romeis@fal.admin.ch

Roy, Ann-Sophie
EPPO
1 Rue le Notre
75016 Paris, France
E-mail: roy@epo.fr

IWGO –NEWSLETTER XXV / 1

Ryabyy, Ivan
Plant Quarantine Service
Koloskova Str. 7
03138 Kiyv, Ukraine
E-mail: pqsu@bigmir.net

Sivcev, Ivan, Dr.
Institute for Plant Protection and Environment
Banatska 33
11080 Zemun, Serbia&Montenegro
E-mail: ibsivcev@EUnet.yu

Sivcek, Peter, Dr.
Central Control and Testing Institute of Agriculture
Hanulova 9/A
84429 Bratislava, Slovak Republik
E-mail: p.sivcek@uksup.sk

Salinas H., Solveig, Dr.
Norwegian Crop Research Institute, Plant Protection
Centre
Hogskoleveien 7
1432 AS, Norway
E-mail: solveig.haukeland@planteforsk.no

Springer, Bernd, Dr.
Bayer Crop Science AG
Alfred-Nobel Str. 50
40789 Monheim, Germany
E-mail: bernd.springer@bayercropscience.com

Stankovic, Sladjan
Institute for Application of Science in Agriculture
29. Novembra 68 B
11000 Belgrade, Serbia&Montenegro
E-mail: ssladjan@Eunet.yu

Schaub, Lukas, Dr.
RAC Changins
CP 254
1260 Nyon, Switzerland
E-mail: lukas.schaub@rac.admin.ch

Stigter, Henk
National Plant Protection Organisation
Geertjesweg 15
6706 EA Wageningen, Netherlands
E-mail: H.stigter@minlnv.nl

Tinland, Bruno, Dr.
Monsanto Services International
Avenue de Tervuren
1150 Brussels, Belgium
E-mail: bruno.tinland@Monsanto.com

Töpfer, Stefan, Dr.
University Gödöllő/ Plant Health Service
Rarosi UT 111
6800 Hodmezovasarhely, Hungary
E-mail: stoepfer@gmx.net

Tollefson, Jon, Prof. Dr.
Iona State University
17 Insectary Building
50011 Ames, USA
E-mail: tolly@iastate.edu

Toth, Miklos, Prof. Dr.
Plant Protection Institute
Herman O. u. 15
1022 Budapest, Hungary
E-mail: H2371TOT@ELLA.HU

Tsitsipis, John, Prof. Dr.
University of Thessaly
Fytokoy
38446 Nea Ionia, Greece
E-mail: tsitsipi@uth.gr

Turlings, Ted, Dr.
University of Neuchâtel
Case Postale 2
2007 Neuchâtel, Switzerland
E-mail: ted.turlings@unine.ch

Urek, Gregor, Dr.
Agricultural Institute of Slovenia
Hacquetova 17
1000 Ljubljana, Slovenia
E-mail: Gregor.Urek@KIS.SI

Vahala, Otmar
State Phytosanitary Administration
Trnkova 103
62800 Brno, Czech Republik
E-mail: obo.brno@srs.cz

Vicinanza, Sonia
USDA, APHIS
Boltzmanng, 16
1091 Vienna, Austria
E-mail: Sonia.Vicinanza@aphis.usda.gov

Vörös, Gèza, Dr.
Plant Protection and Soil Conversation
Service of County Tolna
PF 104
7101 Szekszdra, Hungary
E-mail: voros.geza@tolna.ontsz.hu

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Vos, Janny
Cabi-Bioscience
Bakeham Lane
Egham, Surrey TW20 9TY
E-mail: j.vos@cabi.org

Wilhelm, Ronald
BASF AG, Agricultural Products, E-APE/T
Carl-Bosch-Str. 64
67117 Limburger Hof, Germany
E-mail: ronald.wilhelm@central-europe.basf.org

Wührer, Bernd, Dr.
AMW Nützlinge
Ausserhalb 54
64319 Pfungstadt, Germany
E-mail: amwnuetzlinge@aol.com

Yakobchuk, Vasyl, Dr.
Plant Quarantine Service
Koloskova Str. 7
03138 Kiyv, Ukraine
E-mail: pqsu@bigmir.net

Yakovets, Petro, Dr.
Plant Quarantine Service
Koloskova Str. 7
03138 Kiyv, Ukraine
E-mail: pqsu@bigmir.net

Yushchuk, Taras, Dr.
Plant Quarantine Service
Koloskova Str. 7
03138 Kiyv, Ukraine
E-mail: pqsu@bigmir.net

Zellner, Michael, Dr.
Bavarian State Research Centre for Agriculture
Lange Point 10
85354 Freising-Weihenstephan, Germany
E-mail: Michael.Zellner@Lfl.Bayern.de

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Abstracts of the papers presented at the Xth IWGO – *Diabrotica* Subgroup Meeting in Engelberg, Switzerland; January 14 – 17, 2004

Session I – MONITORING

Population level changes of western corn rootworm in SERBIA

Ivan **SIVCEV**¹ & Sladjan **STANKOVIC**²

¹Institute for Plant Protection and Environment, Banatska 33, 11080 Zemun, Serbia, ibsivcev@eunet.yu; ²Institute for Science Application in Agriculture, ssladjan@eunet.yu

Population density of *Diabrotica virgifera virgifera* dramatically fluctuates since 1992 when it was discovered in localised outbreak area. At the beginning population was growing and spreading causing each year more and more damages. It was not linear increase since it is mainly dependent on number of cornfields in repeated sowing. Before *Diabrotica virgifera virgifera* was introduced it was estimated that there were under continuous corn around 30-40% of total corn production. Besides that, adverse climatic conditions during winter wheat sowing in some years directly influenced increase in continuous cornfields. Severe damages were the results of such significant population increase. Having damages from WCR on corn during several consecutive years farmers started to rotate corn with other crops. The most significant damages were registered during the period 1998- 2000. After that corn rotation was used by majority of the farmers who experienced damages from *Diabrotica virgifera virgifera* and learned how to control it. Besides that, year 2000 was exceptionally warm and dry, which resulted with probably more important population reduction over large space in Serbia. It is evident that in year 2001 and 2002 there were only sporadic damages in small corn producing areas in the north and south of Serbia. Also, it was registered that after population breakdown in year 2000 it is recovering but slowly.

In the year 2003 population recovering is registered as well as small increase of damaged fields. Areas with economic population are registered over much larger space comparing to previous year. In 2003 there were around 3.000 ha of reported damaged cornfields with damages, which can be characterised as low, ranging up to 30% lower yield.

Monitoring of WCR spreading showed that in 2003 there were no further spreading on the south. Out of 30 counties in Serbia only one (area around city Vranje) is still considered as uninfested. Minor spreading was registered in the southwest of Serbia.

Monitoring of western corn rootworm beetles in REPUBLIC OF SRPSKA in 2003

Franja **BACA**¹, Jovo **STOJICIC**², Vojislav **TRKULJA**², Slavko **RADANOVIC**³, Dragisa **LOPANDIC**¹, Dragica **ZIVANOVIC**³ & Dragisa **MARKOVIC**⁴

¹MRI, Zemun Polje, 11185 Belgrade-Zemun, Serbia and Montenegro, fbaca@mrizp.co.yu; ²Institute of Agriculture, Banja Luka; ³Agricultural Station, Bijeljina; ⁴Agricultural Station, Doboj, Republic of Srpska

Western corn rootworm (WCR) imagoes monitoring in Republic of Srpska (RS) has been performed within a monitoring procedure of a new maize pest occurrence and distribution in this region since 1998. The

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arrangement of traps has been changed over years in a way that the number of locations has been decreasing in the eastern parts, while it has been increasing in the western parts of the region.

In 2003, similar to the preceding year, WCR beetles monitoring was carried out by the application of the Hungarian pheromone traps of a Csalomon make placed in 49 locations distributed in 24 municipalities. The entire territory to the west border with Croatia was covered. Flight monitoring, depending on a location, was performed for 45, 63 and 80 days. In the majority of locations, monitoring was performed from mid June to mid September - 80, 45 and 63 days in eastern, central and western parts of the region, respectively.

Larger plots under maize were selected for trap distributions. The trap replacement was, as a rule, done four weeks after the beginning of monitoring, while counting and removal of trapped beetles were done once a week, or once in two weeks. Obtained data were systematised according to 50-km territory areas. Summarised numbers of trapped beetles were compared with corresponding data of previous years. In order to interpret results, data on the precipitation sum and distribution, mean daily and maximum air temperatures in Bijeljina, Doboj and Banja Luka were taken into account.

According to the east-west territorial division, 241.7 beetles, on the average, were trapped in the first 50 km away from the Serbian border in 11 locations distributed in the municipalities Bijeljina, Brčko, Lopare, Ugljevik and Zvornik. It is interesting to mention that the same level of the population (241.8) was recorded in the second 50 km, in five locations of the municipalities Modriča, Pelagićevo and Šamac. In the further 50 km (100 to 150 km towards west), 192.1 beetles were registered on the average in eight locations of the municipalities Doboj, Srpski Brod and Teslić. The high numbers of WCR beetles were registered in all 24 locations in each of the stated municipalities. In the territory beyond 150 km towards west, three-fold higher presence of WCR beetles than in 2002 was registered in 22 to 25 locations.

The abundance index (AI) in 2003 in relation to the abundance registered in 2002 was as follows:

- in the first 50 km, (241.7 : 377.1), AI = 64.1
- in the second 50 km (50-100 km), (241.8 : 168.0), AI = 143.9
- in the third 50 km (100-150 km), (192.1 : 107.1), AI = 179.4, and
- beyond 150 km (26.4 : 8.8), AI = 300.0.

The reduction in the number of trapped WCR beetles in the first 50 km can be related to the lowest precipitation sum in relation to further western regions (Doboj and Banja Luka), and to extremely high temperatures due to which traps were less efficient. The increase in the second 50 km and further was quite expected as maize was grown there on greater areas.

The present situation of western corn rootworm in HUNGARY

István **EKE**¹, Géza **RIPKA**² & Gábor **PRINCZINGER**¹

¹Ministry of Agriculture and Rural Development, H-1860 Budapest, Pf. 1, ekei@posta.fvm.hu, princzinger@posta.fvm.hu; ²Central Service for Plant Protection and Soil Conservation, H-1519 Budapest Pf. 340, ripka.geza@ntksz.ontsz.hu

In the past few years Western corn rootworm (WCR) (*Diabrotica virgifera virgifera* LeConte, 1868), originating from North America has spectacularly quickly spread in various countries of the European Union. This species has become a major pest of maize also in Europe. In 2003, it caused considerable economic losses by crop lodging in large areas of Hungary. Similarly to the previous years, trapping of the beetle was carried out by the entomologists, forecasting specialists and plant protection inspectors of the plant protection and soil conservation county services. Traps were placed in the fields for two kinds of purposes:

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1. Scout trapping. Based on the data of 2002 on the survey for detecting the pest, in 2003 this kind of trapping continued by using sex-pheromone traps at 12 locations of 5 counties where the beetle has not been recorded.
2. Permanent trapping (monitoring) (FAO Standard). In addition to the previous observations, we estimated the populations of the pests in 20 infested fields of 19 counties with Csalomon[®] sex-pheromone traps and Pherocon[®] AM yellow sticky traps. The traps were operated from 13 June to harvesting (October), with checking of the catches at 10-day intervals and changing the traps every 30 days.

Assessment of larval damage. From 1997, in every June, thus also in 2003, we assessed larval damage especially in maize grown in monoculture. We determined the severity of the injuries – in 53594 hectares of the 14 counties with the longest history of WCR infestation, on about 5% of all the maize fields – using Hills-Peters's scale on root damage.

We observed the first larvae on 27 May in the southern and central counties of Hungary. Calculating the effective degree-days, we expected hatching of larvae from 12 May. In 2003 flight of the beetles started on 16 June. Seasonal flight of the pest was very intensive in late June – the first part of July. In August a second, lower flight peak was observed. The average beetle catches of both types of traps exceeded previous year's data.

During the representative survey for root damage conducted in 14 counties of the country in 2003, root injuries were recorded in 10922 hectares (20.4 %) of 12 counties. In 5955 hectares (11.1 %), damages reached scale 3 indicated as the economic threshold for root injury. Throughout the country the area affected by larvae was estimated to 105500 hectares, out of which lodging of plants was observed in about 35360 hectares.

Data on the survey for root damage by western corn rootworm in 2000-2003

Year	Nr. of surveyed fields	Surveyed area (ha)	Area infested by WCR larvae (ha)
2000	969	41357	3103
2001	955	44895	10311
2002	919	40621	7488
2003	1145	53594	10922*

Growers carried out treatments on several thousands of hectares by soil disinfestations together with sowing, or by in-crop aerial application of insecticides to control the beetles.

Current status and results of the monitoring of western corn rootworm in 2003 in CROATIA

Jasminka **IGRC BARČIĆ** & Renata **BAŽOK**

Department for Agricultural Zoology, Faculty of Agriculture, Svetošimunksa 25, 10000 Zagreb, Croatia, igrc@agr.hr

A progressive increase of adult population abundance was registered during seven-year monitoring of the occurrence, spreading and population density of the western corn rootworm in Croatia. For years the pest has been spreading on main corn growing area without any visible damage and farmers did not take the WCR a serious pest. The first economic damage caused by WCR occurred in 2002 in region of Baranja. In 2002, big yield reductions were observed only in fields with very heavy larval damages. Rainfalls occurred

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very often through July and August. Root regeneration was very intensive what diminished yield reduction. Yield loss on one field in Baranja according to the information of the farmer was 85%. In spite of the high attack of the WCR in 2002, the damages were not very visible in numerous fields. Favorable climatic conditions diminished yield loss caused by WCR, but the population level was increased.

In 2003, monitoring of the WCR had 3 main tasks: to establish the further spread of the pest; to establish increase in population density and to establish economic population area and the average yield losses due the WCR larval attack.

In 2003 *Diabrotica virgifera virgifera* LeConte was monitored following a common protocol. Monitoring of the WCR was conducted on 121 monitoring sites. On each site 1 pheromone and 1 Pherocon AM trap were placed at least 50 m apart. Traps were placed in the field between June 10th and 17th. Each 7 days traps were checked and beetles collected.

Significant spread of the pest in 2003 was recorded. The new line of the spreading of the pest is on the line Hodošan- Prelog- Donja Dubrava- Donja Stubica- Otok Svibovski- Hrašće- Mala Gorica- Dvor na Uni. WCR has infested an area of about 23.500 km². In that area approximately 80 % of all Croatian corn production is conducted.

Alltogether in monitoring action 31760 beetles were caught. Main ratio of beetles was caught on pheromone traps (93,4 %) while only 6,6 % of all beetles were caught on Pherocon AM traps. An increase in population density is occurred. Population growth index for the 2003 is 4, if it was calculated based on the data from all monitoring sites in all previously infested counties. The data from permanent monitoring sites show somewhat lower population growth index, 3.

In 2003, on the 5 fields with visible symptoms of the attack of the WCR larvae, in order to evaluate the damages, root damage rating and plant lodging were conducted. Yield loss by yield weighting was predicted. The average root damage rate on all observed fields was over the economic threshold level. The percentage of the lodged plants was between 26,3 and 91,1%. Yield loss on the lodged plants was between 12,9 and 49,4 %. Extreme drought climatic conditions in 2003 caused very weak germination of corn. Low plant population together with unfavorable climatic conditions in 2003 caused an average yield loss of 30 % on all cornfields in corn production area. Yield loss caused by larval damage on observed fields was between 4,8 and 45%. This yield loss should be added to the previously mentioned yield reduction. Some yield reduction was caused by silk clipping and during harvesting also. Correlation between root damage rate and yield loss in extreme climatic conditions is not so obvious as in regular climatic conditions.

Damages caused by WCR larvae were recorded on the fields located in the Osječko- Baranjska, Vukovarsko- Srijemska, Požeško- Slavonska and Virovitičko- Podravska counties. This is an area of 12.500 km². All damages were recorded on continuous cornfields, what stress again the importance of the crop rotation in future corn production. Economic population area from year to year is increasing and probability for the damages in continuous cornfields on larger area is growing.

Monitoring of *Diabrotica virgifera virgifera* LeConte in ROMANIA in 2003

Mirela CEAN

Entomology Department, Central Laboratory for Phytosanitary Quarantine, 11 Afumati str., Bucharest, 077190,
e-mail address: lccf@lccf.ro

Monitoring of WCR (*Diabrotica virgifera virgifera* Le Conte) was carried out by the Ministry of Agriculture, Waters, Forests and Environment, through the Central Laboratory for Phytosanitary Quarantine, the County Phytosanitary Units and Border Inspections Points. The observations were done from the beginning of

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June to mid-September and were carried out in 25 counties (15 infested counties and 10 non infested counties including 3 airports areas: Bucaresti, Constanta, Suceava)

In the year 2003 Romanian and Hungarian pheromone traps and Pherocon[®] AM yellow sticky traps have been used. The traps were placed in 193 sites, 148 sites were located in infested counties and 45 within non-infested counties. On each site 1 pheromone and 1 Pherocon[®] AM trap were placed 50m apart. The pheromone traps were changed every 30 days and yellow sticky traps every 15 days.

Diabrotica virgifera virgifera was caught in 15 out of 25 counties. In one infested county (Gorj-first report in 2000) western corn rootworm was not caught in any trap throughout 2003. Economic damages were registered sporadically in county Arad (“small farmers”) and Timis.

Comparing the population density from last year it is obvious that in 2003 population increased in the infested areas: total number of captures was 71206 (368,9 beetles/installed trap), while in 2002 total number of captures was 14959 (138,5 beetles/installed traps).

Monitoring of spreading western corn rootworm in BOSNIA and HERZEGOVINA 2003

Husnija **FESTIC** & Nedžad **KARIC**

Faculty of Agriculture, Zmaja od Bosne 8, 71 000 Sarajevo, Bosnia and Herzegovina, hfestic@bih.net.ba, nkaric@bih.net.ba

Our work in Project - Monitoring of Western Corn Rootworm during 2003 is done on the similar way as during previous years. We established 60 monitoring locations: 30 permanent and 30 new locations during 2003. We established new monitoring locations on WCR spreading frontiers from last year. In the beginning we controlled traps every second day but later it is done once per week. Permanent monitoring locations we established again on locations with bigger cornfields with goal to check WCR population density. We used sticky yellow traps at permanent locations and pheromone traps at new locations.

Monitoring done this year showed that WCR spread mainly along rivers and roads –the same as previous years. It is interesting to mention that we noted WCR near the Sarajevo Airport, which is 80 km far away of the nearest location where we noted WCR last year.

It is known that we noted WCR in B&H first time 1997 but there are still no registered corns laying or damages on corn roots. It is probably result of low WCR population density, which is caused by changeable weather condition during last, different soil types and small areas under corn. There are 240000 ha under corn in Eastern and Northern part of B&H. It is mainly about private land and about location, which are quit far away each from other. It could also be reason for low WCR population density.

We are going to do WCR monitoring in future. Also we are going to check reasons for faster or slower pest spreading, for bigger or smaller growth of WCR population density.

The work was conducted under the FAO Project GTFS/RER/017/ITA

Monitoring of western corn rootworms in BULGARIA in 2003

Ivanka **IVANOVA**

Central Laboratory for Plant Quarantine, Sofia 1330, 120, Blvd. N. Mouchanov

The WCR was found in Bulgaria in 1998. A monitoring of WCR has been performed every year ever since. Thanks to the monitoring we can report on the pervasion of the pest and its population dynamics', and it

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also helps for the preparation of proposals for measures aiming to prevent the damages caused by the pest.

Methods: Soil excavations were initiated late in May and continued in June. Areas in the regions of Vidin and Montana, where high density of the pest was monitored in 2002, were covered. The larvae not found. However, in August and September we have discovered the specific “goose neck” wrench of the stalks in maize areas in the regions of Bregovo, Gramada, Dolna Biala Rechka and Prevala. During the current year the monitoring started at the beginning of June. According to the FAO project for the countries from Central and Eastern Europe, the pheromone and pherocon traps for performing the monitoring, were delivered free of charge. They were allocated and placed in the regions of Vidin, Vratza, Montana, Pleven and Sofia. The total number was 65 and 8 of them were under permanent monitoring. The distances between pheromone and pherocon traps were from 50 to 1000 meters, depending on the region. The traps were checked every 7-10 days and in some places even every 20 days.

Results:

1. The pest is slowly spreading to the east and south. In the region of Peven it was found not only in Knezha but also in Dolni Lukovit, Iskar, Brenitza, Lazarovo.
2. In 2003 it was found for the first time in the region of Dragoman.
3. This year we monitored the specific wrench of the stalks known as “goose neck”, which is caused by the WCR larvae.
4. We have found damages on the roots caused by the pest's larvae in the regions of Bregovo, Gramada, Dolna Biala Rechka and Prevala for the first time.
5. No economic losses of the crops were found.
6. The total number of trapped adults in 2003 is 4,770. Their allocation per region is as follows: Vidin – 1,587, Montana – 2,906, Vratza – 82, Pleven – 28, Sofia – 167. The largest number of trapped adults in is Dolna Biala Rechka – 1,735 followed by Prevala – 972, Gramada – 651, Dolni Lom – 448. 4,707 of them were trapped with the pheromone traps and 63 with the pherocon traps.
7. The climatic conditions have significant influence on the pervasion of the pest. During the last years we could see very high temperatures in July and August and just a little bit of rainfalls. These conditions are unfavourable for the maize growth (the vegetation is very limited even in July, the plants are low, the leaves turn yellow). The pest can't be found in the plains and semi-mountainous areas in the regions of Vidin, Montana and Vratza as well as in non-irrigation areas. However, adults can be found in the irrigation areas (Gramada) or in areas with large amount of subsoil waters (Rakitnitza). For example, if we compare Bregovo and Rakitnitza, which have only a few kilometers distance between them, we will see that in Rakitnitza, where the level of subsoil waters in higher, the maize developing better and the number of trapped adults is higher (75 - 100).
8. Population levels – In the maize, which was grown in Dolna Biala Rechka in two consecutive years without rotation, we have established a level of 36 male adults /per pheromone trap/ per day during the population peak.

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Diabrotica virgifera virgifera LeConte in Italy in 2003: an overview

Lorenzo FURLAN¹, Giorgio PERISSINOTTO¹, Marco VETTORAZZO², Roberto MINUZO², Carlo FRAUSIN³, Gianluca GOVERNATORI³, Giovanni PETRIS³, Willer ZILLI³, Luciano LUSINA³, Stefano MAZEGGA SBOVATA³, Massimo BARISELLI⁴, Marco BORIANI⁵, Giacomo MICHELATTI⁶, Rocco TANGO⁶, Roberta FRANCHI⁷, Pietro GIOVANELLI⁷, Gino ANGELI⁷, Federico BIGARAN⁸ & Bruno FARAGLIA⁹

¹Department of Agronomy, Entomology, University of Padova, Legnaro PD; ²Veneto Region, Phytosanitary Service, Via Poerio 34, Mestre-Venezia; ³Friuli Venezia Giulia, Phytosanitary Service, Via Caccia, 17, 33100 Udine; ⁴Emilia Romagna Region, Phytosanitary Service, via di Saliceto 81, 40129 Bologna; ⁵Lombardia Region, Phytosanitary Service, P.zza IV Novembre 5, 20124 Milano; ⁶Piemonte Region, Phytosanitary Service, Via Livorno 60, 10144 Torino; ⁷Istituto Agrario di S. Michele All'Adige TN, via E. Mach 1; ⁸Provincia autonoma di Trento, Via G.B. Trener, 338100 Trento; ⁹Ministero per le risorse Agricole e Forestali, via XX Settembre, Roma

In 2003 monitoring continued using a common protocol. In areas where WCR had not been detected yet sex pheromone traps (mainly PAL) were placed out almost exclusively in monoculture fields at increasing distances from already infested areas or in potential introduction areas. In infested areas some Pherocon AM yellow sticky traps were placed, in addition to the sex pheromone traps, almost exclusively in monoculture maize fields, with the exception of the focus areas where maize monoculture is prohibited. The following quantities of sex pheromone traps have been placed out: more than 270 in Friuli Venezia Giulia, 1488 in Veneto, 212 in Emilia Romagna, more than 350 in Lombardia, 520 in Piemonte, 74 in Trentino, 20 in Campania, 9 in Lazio.

PRESENCE: restricted focus areas where a containment-eradication program based on prohibition of maize monoculture and treatments against the adults was being implemented: in *Veneto* only 4 specimens were captured in the focus area and 4 in the close safe area; in *Pordenone* (Friuli) 3 beetles were captured in the focus areas and 19 in the close safe area; in both cases captures records stopped just after treatments against adults and the size of focus areas had a very limited increase. Largely infested areas: *Lombardia*: in the area where an economic population was detected in 2002 (totally about 5,000 ha of cultivated land) maize planting was allowed only after the 15 June; this resulted in a dramatic reduction of maize fields. No specific prohibitions of maize monoculture and obligations of treatments against the adults were implemented in the other zones. Beetles were found also in the only not infested province in 2002, *Mantova*, so that currently all the cultivated land may be considered virtually infested with the exception of a restricted area along the boundary with Veneto. *Piemonte*: no containment strategies based on prohibition of maize monoculture and treatments against the adults were implemented. Infested cultivated area increased by about 65,000 ha (totally about 385,000 ha). All the provinces but Asti are at least partially infested. Other regions: the very first specimens were captured in *Emilia Romagna* in the areas of Parma and Piacenza provinces close to the border with Lombardia, in *Trentino*, in a small Valley -Chiese- (about 270 ha of cultivated land) bordering the northern part of Lombardia region, in the provinces of *Udine* and *Gorizia* (north eastern Italy, close to Slovenia). Most of the newly infested fields and those surrounding were treated with insecticide to control the adults within a few days after captures had been noted. *Campania* and *Lazio* no beetles were captured.

POPULATION LEVELS: negligible peaks of male captures were recorded in *Veneto*, *Friuli Venezia Giulia*, *Emilia Romagna*, *Trentino*. In a very restricted area of *Udine* province (Buttrio municipality) at population peak about 75 WCR males/ PAL trap/day and 6 beetles/sticky trap/day were recorded from monoculture maize fields. Negligible captures of beetles were recorded in all the area around. *Lombardia*: due to the measures described above no economic populations (visible lodging and heavy feeding damage on leaf tissues and ears) were observed neither in the area of some dozens of hectares in Como Province seriously damaged in 2002 nor in the surrounding cultivated areas. In the Provinces of Como, Varese and

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Milano just around the area with planting restrictions levels up to at least 200 WCR males/ PAL trap/day and over 10 beetles/sticky trap/day were recorded while low captures were found in the rest of the region. *Piemonte*: conspicuous populations were detected only in the area where the species had already been detected in 2001. On Pal traps the maximum peak population was over 90 males/trap/day. Negligible captures were recorded on the sticky traps.

Results of monitoring western corn rootworm *Diabrotica virgifera virgifera* in the SLOVAK REPUBLIC

Peter **SIVIČEK**

Central Control and Testing Institute of Agriculture, Hanulova 9/A, 844 29 Bratislava 42; p.sivicek@uksup.sk

The first occurrence of the WCR in Slovakia took place in 2000. In 2003 we had continued to survey the infestation of the Slovak Republic by *Diabrotica virgifera virgifera* LeConte. We also had made field training for corn growers from infested areas. Both activities had been carried out within the FAO projects. The survey had been carried out by phytosanitary inspectors of the Central Control and Testing Institute of Agriculture and other external observers within the framework FAO project – WCR Network activities. Some data on population density of pest have been obtained from FAO project focused on field farmers training.

We used pheromone traps Csalomon and yellow traps Pherocon AM for survey. The monitoring points have been set as in infested as in endangered corn belts. The pheromone and yellow traps had been set together in infested areas. The pheromone traps only had been set in endangered corn belts. We added a next pheromone traps at need into new endangered areas a later. The monitoring adults of WCR started in half June. We caught adults in new localities in east part of Slovakia but also in districts Piešťany, Hlohovec, Topoľčany, Nové Mesto Nad Váhom and Trenčín.

FAO Project: GTFS/RER/017/ITA

Monitoring of *Diabrotica* in SWITZERLAND in 2003

Jacques **DERRON**

Station fédérale de recherches agronomiques de Changins, 1260 Nyon, jacques.derron@rac.admin.ch

In Switzerland the monitoring for the Western Corn Rootworm started in 1999 in the surroundings of the three airports of Geneva, Zurich and Lugano. In 2000 we registered the first 4 beetles in our pheromone traps (Csalomon® PAL) near Lugano, south of the Alps. From 2001 up to 2003 the monitoring network was gradually extended in the south and the north of the Alps, in all the areas where maize is cultivated. Most of the traps were placed in maize fields located around the airports and along the main roads and railways. In the south of the Alps the number of captures has increased continuously since 2000.

In 2003 the first captures were recorded north of the Alps. The first catch (15.07) occurred in a maize field close to the northern exit of the tunnel of Gotthard. Then we caught 3 males along the same motorway farther to the north, near Lucerne (14.08 and 19.08) and 3 other beetles near Basel in a quite isolated field located at approximately 20 km to the south of the Euroairport in Alsace on 28.07, 4.08, 12.08. We finally had one more capture on 15.08 in a maize field close to the tracks of the airport of Zurich.

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Five to ten traps were added in the four sites within five days after the first catch. Only one beetle was caught in the supplementary traps.

In 2004 it will be forbidden to grow maize after maize in a radius of ten kilometres around the sites where *Diabrotica* was detected in 2003 and the monitoring network will be substantially strengthened in the north of the Alps.

The peculiarities of spread of western corn rootworm (*Diabrotica virgifera virgifera*) in UKRAINE

Victor OMELYUTA & Nataliya FILATOVA

Institute of Plant Protection of UAAS Vasyl'kivs'ka str., 33, 03022, Kyiv, Ukraine, Phone: (044) 257-11-24, Fax: (044) 257-21-85, E-mail: plant_prot@ukr.net

The Western corn rootworm (WCR) was registered officially in Ukraine in 2001 after catching the first beetles into the pheromone traps in the Vinogradovsky and Beregovsky districts of the Transcarpathian Region. Distribution of the pest in the world goes passively by means of transportations and active flight from one place to another. It appeared in Europe from the USA with the help of aviation.

During 2001-2003, there were carried out the visual inspections and pheromone monitoring of the cornfields in the Transcarpathian Region. There were analyzed the reports and publications of other researchers on the pest's distribution in Ukraine and neighbour countries – Hungary and Romania.

As the results of researches and analysis show, the first insects of the WCR were caught with sex pheromone traps in the cornfields not far from the border of settlements on the border with Romania (Dyakovo) and Hungary (Bobove v.). An active stream of the railway and motor transport goes via these settlements from the countries of the former Yugoslavia, Romania and Hungary. However, at the same time (in 2001) the pest was not registered yet in neighbour regions of Romania and Hungary. We discovered not only the first beetles into the traps but and small spots of the loading corn plants that were typical with damage of roots by larvae. There were caught only 6 beetles in 36 traps for the whole season. On these grounds, we suppose that the first females of the pest could be brought with the railway and motor transport as long ago, as 2000. These females could lay the eggs from that the beetles were developed and were caught with the traps.

In connection with increasing pest density in 2002, there was an increase in the number of spots for catching imago of WCR into the traps. For a season, it has been caught 84 beetles with the 63 traps to be situated along railway in the direction of Dyakovo-Chop and motor highways from Romania and Hungary. The outbreaks of the loading corn plants to be typical for damage by larvae were found more often. Because the numbers of the outbreaks and cases of beetles' catching were very small we suppose that the flight in of the beetles isn't confirmed.

In 2003, the beetles were caught practically with all the traps in the cornfields along the railway and motor highways and in valleys of rivers Uzh and Tissa. Distribution of the pest occupied practically all the territory of low-lying marshy lands in the Transcarpathian Region (areas more 3000 km²). For a season, there were caught 656 beetles in 65 traps. So, in the period of July 24-26, it was marked a maximal catching of the beetles into the traps and was their visual counting on the corn plants. It can be thought as an invasion (flight in) of the beetles from zones of the outbreaks in neighbouring countries.

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Monitoring of the occurrence of *Diabrotica virgifera virgifera* LeConte in the CZECH REPUBLIC from 1999 to 2003

Otmar VAHALA

Regional Division of the State Phytosanitary Administration, Trnkova 103, 628 00 Brno, Czech Republic,
obo.brno@srs.cz

State Phytosanitary Administration (SPA) has been carried out the monitoring of *D. v. virgifera* in the Czech Republic since 1999, especially in the South Moravia region. In 1999 – 2002 this monitoring was carried out in the district of Brno – Province and in the districts of Breclav, Hodonin, Uherske Hradiste and Znojmo. These last 4 districts listed above are adjacent to State borders with Austria and Slovakia which are, point of view for *D. v. virgifera* spread into the territory of the Czech Republic, risk states indeed. The majority of observation points for the monitoring were searched and located along these borders. In 2001 the monitoring was initiated at the next risk locality Turany airport in the district of Brno – City.

Pheromone traps (Csalomon® PAL) produced in Hungary, were placed and changed at the observation points to the monitoring *D. v. virgifera* in maize fields each month from 1 July till 30 September. Inspections of the traps (captured males) were carried out once within 7 – 10 days by inspectors of the SPA. Dates and results of the inspections were recorded to special protocols and used traps were sent to the Regional Division of the SPA in Brno to the first check and after for the final check to the Diagnostic Laboratory of the SPA. In the South Moravia region were used a total of 84 traps in 30 cadastres in 1999, 90 traps in 27 cadastres in 2000, 84 traps in 26 cadastres in 2001, 87 traps in 26 cadastres in 2002 and 161 traps in 60 cadastres in 2003.

The inspectors of the SPA preferred, when the traps were placed in fields, where maize was grown in continuous cropping or monocultures, namely in cadastres with a higher concentration of maize cultivation, especially corn maize.

The first record of *D. v. virgifera* in the South Moravia region and also in the territory of the Czech Republic was confirmed in the district of Hodonin in the cadastre Cejc (faunistic quadrat 7067) on 10 July 2002 (1 male) and on 11 July 2002 (1 male). These males were identified at the Regional Division of the SPA in Brno and at the Mendel University of Agriculture and Forestry in Brno and after the beetles were sent for confirmation to the Diagnostic Laboratory of the SPA in Olomouc. The same year other males of *D. v. virgifera* were captured in the district of Breclav in the cadastres Hrusky (1 male) and Lanzhot (1 male), in the district of Hodonin in the cadastres Cejc (2 males), Luzice (1 male) and Sudomerice (1 male) and in the district of Uherske Hradiste in the cadastre Borsice u Blatnice (1 male). A total of 9 males were captured till 27 September 2002. These results the SPA published in scientific and agricultural journals and presented at meetings for growers of maize.

In 2003 the method of the monitoring was used in the same way as in previous years, however all 61 observation points were located by GARMIN GPS. The Regional Division of the SPA in Brno also established the monitoring net for continual observation of the occurrence and population density of *D. v. virgifera* in all 14 districts of the South Moravia region. The number of the observation points in odd districts (3 - 7), depending on the occurrence of *D. v. virgifera* in the district in 2002, the vicinity of the district with infested districts and the number of Extraordinary Phytosanitary Measures, which were imposed to the growers of maize in the district a view of eradication of this pest. In this year 13 growers got from the Pioneer company the traps for the self-monitoring. The occurrence of *D. v. virgifera* was confirmed in the district of Breclav in the cadastres Bohumilice (1 male) and Lanzhot (8 males), in the district of Hodonin in the cadastres Cejc (2 males), Kostelec (1 male), Sudomerice (3 males) and Vnorovy (1 male), in the district of Uherske Hradiste in the cadastre Uhersky Brod (1 male) and in the district of Vyskov in the cadastre Mouchnice (2 males). Total number of captures was 19 males (6 males on the traps of the Pioneer company) from 22 July till 11 September 2003.

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Monitoring of *Diabrotica virgifera virgifera* in FRANCE and first results of the eradication programme

Philippe REYNAUD

DGAL/LNPV - Unité d'entomologie - 2, place Viala 34060 Montpellier cedex 01, reynaud@ensam.inra.fr

Since 1999, a traps network has been carried out in cornfields and near international airports by the French Ministry of Agriculture (DGAL: Direction générale de l'alimentation – Food Directorate-General) with the help of the Interprofessional Association of corn producers (ARVALIS). The 2002 survey network made possible the detection for the first time of *Diabrotica virgifera virgifera* Leconte in France near Paris international airports.

1/ Official survey

In 2003, a network of 401 sites (2 PAL traps by site) was active during July and August, the most favourable period to the insect flight (Figure 1).

The monitoring was carried out half in corn areas and half near "at risk" zones, essentially close to airports (29% of the sites) or to motorways (16%). The inspection network detect a new outbreak near Blotzheim (Alsace region) on July 30, 2003 near the Basel-Mulhouse-Freiburg international airport (Euroairport), close to the German border (4,7 km) and the Swiss border (4,8 km). The identification was confirmed by the entomology laboratory of DGAL on July 31.

2/ Eradication measures

In accordance with the European Directive of October 24, 2003 on emergency measures to prevent the spread within the Community of *Diabrotica virgifera* LeConte (2003/766/EC), an eradication program is in progress in known outbreaks.

In **Ile-de-France region** (Orly and Roissy), corn seeds used in the focus zone (5 km radius) and the safety zone (10 km) were treated with imidacloprid. In the focus zone, 539 ha of corn received a carbofuran application. Monoculture is prohibited during one or two years in these 2 zones. Two hundred trapping sites (PAL or VARs+ traps) were set up in 2003. In all, 9 adults were trapped in the core of the outbreak (first captures on July 10). Some additional individuals were captured on volunteers' corn on a fallow following corn. A double adulticide treatment was carried out at the end of July (deltamethrin plus oil) on 1630 ha of corn and fallow in the core of outbreaks. These measures will be continued in 2004.

In **Alsace region**, the same phytosanitary measures that in *Ile-de-France* region were implemented as soon as July 31, 2003. Corn production is very significant in this area, in particular for animal consumption. Corn represent about 70% of the acreage surface in focus and safety zones. A reinforcement of the trapping (92 traps) led to the capture of a total of 9 specimens in 2003 in a radius of 5 km. For the moment, origin of the contamination is not known because a significant motorway network coming from Switzerland is also present. Adulticides treatments (deltamethrin) were carried out in August. Official measures will be continued in 2004.

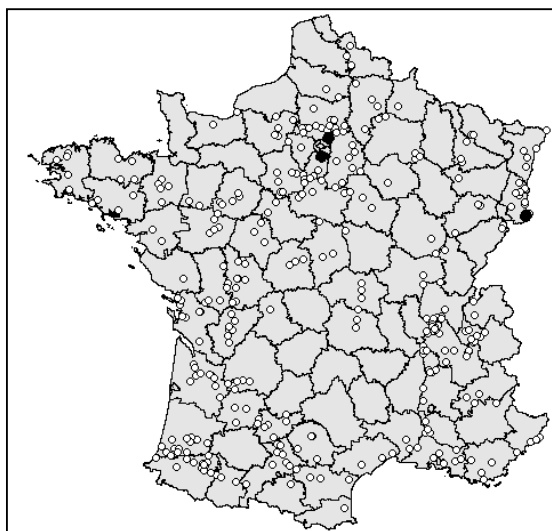


Figure 1 : 2003 traps network with current WCR outbreaks (○ : traps location, ● : outbreaks location)

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The 2003 monitoring program for western corn rootworm (*Diabrotica virgifera virgifera*) in AUSTRIA

Peter C. CATE

Austrian Agency for Health and Food Safety (AGES), Spargelfeldstrasse 191, A-1226 Vienna, Austria,
peter.cate@ages.at

The first WCR beetles were caught in Austria in 2002. The monitoring program was intensified and extended to all Austrian provinces in the following year. In 2003 a total of 581 traps were installed in all parts of the country. Trap procurement and data compilation and distribution was coordinated by AGES, trap installation and monitoring was conducted by the provincial plant protection offices. For research purposes AGES also installed and monitored traps in those areas where the largest numbers of beetles were caught in 2002 as well as in some other regions.

Pheromone traps of the Csalomon PAL type were used in all cases. The provincial monitoring systems were set up at the beginning of July and discontinued at the end of August. Traps and pheromones were renewed at the beginning of August, after approx. 4 weeks. Trap locations were determined by GPS, monitoring results were sent to AGES weekly. Data from the whole country was then compiled and sent to the provincial plant protection offices on a weekly to bimonthly basis.

Of the 581 traps installed in Austria, beetles were recorded in 256 traps. The grand total of beetles captured was 8673, whereby 8330 were caught in Burgenland province, 339 in Niederösterreich and 4 in Steiermark. In 2003 we see an influx of WCR along the entire eastern border of the country, a distance of 231 km from north to south. Distribution ranges up to approx. 30 km into Austrian territory, whereby new infections were primarily recorded in the southern areas. In the North the range of the pest increased by only a few kilometres inland, compared to 2002. No beetles were recorded in other parts of the country.

In order to determine begin and end of beetle flight in Austria, AGES installed traps in the middle of June and monitored them until the middle of October or until harvest. The first beetle was captured on July 4th, the last on October 9th. 57.18% were captured in July, 37.25% in August, 5.32% in September and 0.25% in October. This means that 94% of the total beetle catch was captured in July and August.

First findings of the western corn rootworm *Diabrotica virgifera virgifera* in the UK

S. CHEEK, R.H.A. BAKER, R.J.C. CANNON, A. MACLEOD, E. AGALLOU & P. BARTLETT

Central Science Laboratory, DEFRA, Sand Hutton, York, YO41 1LZ, UK, s.cheek@csl.gov.uk

The first pest risk analysis (PRA) to determine the risks posed by the western corn rootworm (WCR), *Diabrotica virgifera virgifera* to the UK was carried out in 1994. This supported the recommendation for listing the pest in Plant Health legislation within the European Union, but indicated only a marginal risk to the UK due to the limited area of maize production and cool summer temperatures. Following the detection of the pest around Paris in 2002, the PRA was reviewed. Dramatic increases in the area of maize grown and climatic warming were found to have substantially increased the risks of WCR establishment in the UK. Whilst the southeast of England is under greatest threat, with climate change, the area of potential establishment in very hot summers, which might be expected to occur every [ten] years will include most of the maize-growing areas in the UK. However, given that the impact of the pest could be limited, the cost-benefit analysis suggests that action involving destruction of crops and the loss of crop rotation might not be justified.

A monitoring programme was instigated for the first time in 2003 with the placement of over 60 pheromone (PAL) traps in maize fields near to international civil and military airports. In late August/ early

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September the pest was confirmed in forage maize crops at four holdings near Heathrow airport and a further site near Gatwick airport. At one of the sites, a few miles from Heathrow, trap counts indicated that the pest might have been present for one or more years prior to the finding. Pesticide application on the growing crop was considered, but the height of the mature crop (>2.5 metres) precluded the option of high-clearance tractor-mounted ground spraying, and authorisation for aerial spraying could not be obtained, partially due to the close proximity of urban areas and risk of bystander exposure. Measures were therefore taken to minimise risk of spread during harvest operations and extensive additional trapping was carried out in the outbreak area. On confirmation of continuing adult activity, an insecticide was applied post-harvest to the primary outbreak field. Whilst crop rotation remains the primary recommendation for long-term management of this pest, insecticide-treated seed also provides a useful option as a protective measure for maize grown in the vicinity of the outbreak area. Investigations are continuing to clarify the extent of current and potential establishment of the pest in the UK, the potential economic impact and the suppression measures that can be implemented without destroying maize growers' and dairy farmers' livelihoods.

Monitoring of western corn rootworm in GERMANY 2003

Peter **BAUFELD**

Federal Biological Research Centre for Agriculture and Forestry, Department for National and International Plant Health, Stahnsdorfer Damm 81, 14532 Kleinmachnow, Federal Republic of Germany

The monitoring of western corn rootworm (WCR) has been executed in Germany since 1997 and started in the federal land Baden-Wuerttemberg. In 2003, 459 traps were placed on 305 locations in Germany. All federal lands are involved in the supervision of *Diabrotica virgifera virgifera* except two federal lands (Hamburg and the Saar). In the first line the Hungarian pheromone traps of type PAL were used, in Baden-Wuerttemberg in addition traps of type PALs. The traps were located in maize fields, at points of entry, in the near of airports, rail and road terminals (transshipment places), motorway parking places and seed corn-breeding stations. The most intensive monitoring with 248 traps was carried out in Baden-Wuerttemberg because of the latest, close introductions of the WCR into Alsace (France) and Baselland canton (Switzerland) in 2003, 4.7 km and 11 km respectively from the German border. The WCR was not found in Germany.

Monitoring of western corn rootworm (*Diabrotica virgifera virgifera* LeConte) in ALBANIA 2003

Ejup **ÇOTA**

Plant Protection Institute, Shkozet Durres, Albania, cotaentom59@yahoo.com

The Albanian Plant Protection Institute, since 1999 has carried out a nationwide survey of Western Corn Rootworm (WCR) in Albania every year.

Trapping: On 6 locations of our country, Hungarian pheromone traps (Csalomon^R) were placed in cornfields. In the uninfested area of 6 counties (Shkodra, Rinas International Airport, Elbasan, Dibra, Durres, Saranda) the traps were monitored from 20 June until the end of September at intervals of 7 days. The traps were replaced every month.

Also, in the same counties Multigard yellow sticky traps were placed. The distance between Csalomon and Multigard traps was 50m.

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In all locations the pheromone and Multigard yellow sticky traps were placed, no *Diabrotica* specimen was found. Some other *Chrysomelid* specimens were collected near the International Rinas Airport, but identification confirmed that there was not any *Diabrotica virgifera virgifera* LeConte.

Monitoring *Diabrotica virgifera virgifera* LeConte by pheromone traps in GREECE

John A. TSITSIPIS¹, K. D. ZARPAS¹, M. TOTH², V. POLYMEROU³, K. LILIS⁴
& C. MOUROUTOGLOU⁵

¹Laboratory of Entomology and Agricultural Zoology, University of Thessaly, Fytokou str. 384 46, Nea Ionia, Magnesia, Greece; ²Plant Protection Institute, Hungarian Academy of Sciences, Pf 102, H-1525, Budapest, Hungary; ³Regional Center for Plant Protection and Quality Control of Thessaloniki, Ministry of Agriculture, Georgikis Sxolis, 570 01, Themi, Thessaloniki, Greece; ⁴Regional Center for Plant Protection and Quality Control of Kavala, Ministry of Agriculture, Agios Loukas 651 10, Kavala, Greece; ⁵Sarantis Nurseries S.A., 49^d Votsi str., Patra, Greece

A survey was performed for the presence of Western Corn Rootworm (WCR), *Diabrotica virgifera virgifera* LeConte (Coleoptera: Chrysomelidae), in several regions of Greece for the years 2002 and 2003. The survey was deemed essential in Greece, since WCR has been introduced to the Balkans in 1992 (Serbia) and thereafter it is considered as a serious potential quarantine pest. The study focused on corn-cultivated areas adjacent to main state civil or military airports, since these are considered as the most important sources of passage of WCR in Greece. The survey was performed under the supervision of the Greek Ministry of Agriculture and in cooperation with several institutions.

In 2002, four main airport-adjacent areas were selected: Thessaloniki, Kavala, Alexandroupoli (northern Greece) and Patra (southern Greece). In total, 16 "VARs+ funnel" pheromone traps were set up in cornfields. Each trap bore two pheromone dispensers: one sex attractant for males and one bait attractant for both sexes. Traps were serviced once weekly and attractant dispensers were changed every 40 days. Traps were set up in late July and monitoring period lasted until mid-October (maize harvest).

In 2003, three airports were selected: Kavala, Alexandroupoli and Thessaloniki (Thermi, Vassilika, Epanomi and Nea Redestos) along with two more maize-cultivated regions near the national borders to the north (Promahonas, Serres and Orestiada, Evros). In total, 17 traps were set up that year in early August and kept until mid-October. In both years, no WCR adults' captures were recorded in all monitoring sites.

Monitoring will continue in Greece for the year 2004.

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Session II – CONTAINMENT STRATEGIES / MANAGEMENT OPTIONS

Effect of containment strategies against *Diabrotica virgifera virgifera* in SWITZERLAND

Mario **BERTOSSA**

Swiss Federal Agricultural Research Station Changins, 6594, mario.bertossa@rac.admin.ch

In 2000 the first western corn rootworm (WCR) beetles have been detected in south Switzerland. Since that moment containment measures have been enacted in the infested regions. In the following we present the effects where measures have been acted. Since the first detection in a region, two main decrees have been acted and strictly controlled: First, a minimum one year, field oriented, corn cultivation stop, second, the elimination of spontaneous corn in the alternative crop, especially in soybeans after corn. The municipalities had the supervision on corn-cultivated fields and reported them to the Phytosanitary service of Canton Ticino.

The evolution of the WCR population after introduction of the rotation decrees has been observed using a same number of pheromone traps (Csalomon® PAL). In two selected fields second year corn was observed in detail searching for eggs, larvae, adults and root damage.

With the same amount of traps per region the WCR population has decreased the first year after rotation in 2003, then increased in 2003 in the border regions of the Canton Ticino, farer away from the border near Bellinzona/Locarno region a 46% decrease after rotation introduction was observed this year.

The second year cornfields showed important population growing's from one year to another. For the first time in Switzerland it was possible to see free flying WCR adults and slight leaf and silk damage was noted. Soil and root analyses are still on the way.

We can conclude that a strictly controlled crop rotation can be successful to keep the WCR population under an economic damage level. Even in the border region with a relative dense population no lodging plants were observed.

***Diabrotica virgifera virgifera* eradication – containment in restricted promptly detected focus areas: Veneto study case**

Lorenzo FURLAN¹, Marco **VETTORAZZO**², Giorgio **PERISSINOTTO**¹, Stefano **PALMIERI**³, Giorgia **FABRIS**³, Giancarlo **MARTINI**², Lanfranco **DONANTONI**³, Roberto **MINUZZO**², Andrea **DI BERNARDO**¹ & Vincenzo **GIROLAMI**¹

¹Department of Agronomy, Entomology, University of Padova, Agripolis, via Romea 16, LEGNARO PD; phone 0039 049 8272801; FAX: 0039 049 8272810; e-mail: ento@agripolis.unipd.it; ²Phytosanitary Service of Veneto, Venice Office, via Poerio 34, 30173 MESTRE VE, phone 0039 041 2795700; FAX: 0039 041 2795703; e-mail: serv.fitove@regione.veneto.it; ³Freelances

The attempt to eradicate or at least to contain the newly arrived population of *Diabrotica virgifera virgifera* (WCR) near the International Airport of Venice was implemented using the strategies deployed in previous years.

MATERIALS AND METHODS: The eradication program was based on: ♦ Initial focus area (3000 ha of cultivated land): - monitoring the WCR population: 567 sex pheromone traps (most of them PAL) were placed out; most of them from the 30th of June to the 16th of July. - Imposing restrictions on the planting of

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maize in fields: it was prohibited to plant maize after maize. - Applying insecticide treatments to maize fields to control WCR adults; the insecticide used was Dursban (chlorpyrifos) WG at the rate of 1,1 kg/ha; 286 ha of maize fields were sprayed between the 7th to the 30th of July. - Prohibiting the movement of fresh maize or soil in which corn was grown the previous year outside of the focus area. - Not allowing maize to be harvested before September 1st. ♦ Safe area (about 25.000 ha of cultivated land): - monitoring of WCR population: totally 368 sex pheromone traps were deployed (most of them from the 17th to the 27th of June) in all the monoculture maize fields of the part of safe area (named safe-endangered area) close to the border of focus area (about 2-3 km around); 105 PAL traps were placed out according to a 2 km X 2 km grid in monoculture maize fields localized in the rest of the safe area. In the first part of the season trap inspections were done twice per week, subsequently once per week. - Applying insecticide treatments to maize fields (and those all around) where WCR specimens are caught: 23 ha of maize fields, including the field in safe-endangered area where one specimen was captured by a PAL trap and all the maize fields around, were sprayed. ♦ Other sensitive sites in Veneto region: further 448 PAL traps were deployed in sensitive sites of the region where a jumping movement of the species may occur; particularly around other airport facilities, in areas where there is an high presence of maize fields and along the border with Lombardia (infested region). All the traps were placed out in monoculture fields, most of them planted with maize for 3 to 20 subsequent years.

RESULTS: Field checks in focus area: all the fields in the focus area that had been planted to maize in 2002 were checked to determine what crop was planted in 2003. Four fields totaling 1,45 ha of monoculture maize were found and destroyed. Eight PAL traps placed out in these fields before the destruction captured no specimens. WCR captures: ♦ Initial focus area: 4 beetles were captured on 3 traps from the 10th to the 14th of July in three maize field kept at set aside or planted with soybean in the previous year, all planted with maize in 2001. ♦ Safe area and new focus area: in a monoculture maize field about 500 m north of the border of the initial focus area, 1 WCR male was captured on a PAL trap on August 29th. Two further specimens were captured in a monoculture maize field on the same day in the western part of the safe area, beyond the urban centre of Mestre, near Venice Port. One further specimen was found nearby on September 17th. After insecticide treatments, the traps did not catch any more beetles until the end of the season. The focus area was enlarged to about 4000 ha of cultivated land. ♦ Other sensitive sites in Veneto region: no specimens were caught.

CONCLUSIONS: The strategies implemented in Veneto proved to be very effective in stopping WCR populations; the population has been kept at very low level for 6 years (first detection in 1998). Differently from all the other sites in the world where the species was detected, in six years there was no significant spread from the initial focus area and a dramatic reduction of the population levels despite the fact that the area proved to be suitable for WCR population development. In 2003 the same strategies proved to be effective in Pordenone province too.

***Diabrotica* management in Europe – preliminary experience with Clothianidin (Poncho®), Bayer CropScience's new neonicotinoid insecticidal seed treatment**

Bernd SPRINGER, Wolfram ANDERSCH & Wolf C. BECKER

Bayer CropScience AG, Alfred-Nobel-Str. 50, 40789 Monheim, Germany, bernd.springer@bayercropscience.com

Diabrotica virgifera virgifera, the western corn rootworm (WCR), was first detected in Europe near Belgrade airport in 1992 and has since spread within Europe. First outbreaks in the EU were reported in Italy in 1998 and in both Austria and France in 2002. Latest observations in 2003 have revealed the

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pests' arrival in the Netherlands near Schipol airport and more recently in the UK, close to Heathrow airport, and in Belgium around Brussels airport.

WCR is a pest of major economic importance in maize, originating in the Midwest USA, where in 2003 over 13,5 mio ha were infested causing yield losses between 10-90 %. The adult beetle lays its eggs in the soil and the larvae emerge during the following spring and feed on the roots of the crop, with older stages penetrating the roots and feeding internally. The larvae pupate in the soil and then adults emerge to feed on the leaves and 'silks' on the cobs. Because the larvae feed on the roots, nutrients and water up-take are restricted, leading to a reduction in yield. Depending on the degree of infestation, maize plants may grow poorly, and severe root damage can result in crop lodging which can severely reduce harvest.

Current *Diabrotica spp.* control practice in the USA is the application of granular insecticides such as Bayer's tebufospyr based insecticide Aztec[®] to the soil at sowing.

In 2003, Bayer CropScience received registration for its new neonicotinoid seed treatment product Poncho[®] (active ingredient *Clothianidin*) in maize in the USA against all major pests including *Diabrotica spp.* at 1,25 mg active ingredient per seed. The insecticide is highly root systemic and enters the transpiration stream through the roots of germinating seedlings and developing plants. Pests become toxified mainly through ingestion of protected plant tissue causing an early anti-feeding reaction.

In 2003, Bayer CropScience conducted trials with Poncho in maize in Europe. The results confirmed the excellent *Diabrotica* management potential of Poncho at 1,25 mg ai./seed. Crop damage caused by root feeding larvae was significantly reduced enabling treated crops to realize their full yield potential. Representative results from Croatia, Hungary and Italy are presented.

Seed treatment has clear safety and handling advantages as the products are contained "on-the-seed" and "in-the-bag". By comparison, soil applied insecticides have the disadvantage of the cost and time required to install and calibrate the granule applicator equipment, the loading of granules during planting and the handling and return of the insecticide containers.

In addition to its excellent activity against *Diabrotica spp.* Poncho shows outstanding control of important European maize pests including wireworms (*Agriotes sp.*), frit fly (*Oscinella frit*), plant hoppers (*Macrostelus spp.*, *Zyginidia spp.*) at 0.5 mg active ingredient per seed.

With its confirmed technical profile, Poncho is set to play a key role in *Diabrotica* management in Europe.

Using spatial dispersion of corn rootworms to improve management efficiency

Jon J. TOLLEFSON & Yong-Lak PARK

Department of Entomology, Iowa State University, Ames, Iowa 50011 U.S.A., tolly@iastate.edu

The control tactics that have been most widely used to manage corn rootworms are crop rotation and insecticides applied at planting time. This past season, genetically engineered corn that prevents corn rootworm larval injury was registered and sold commercially in the United States. All of these control tactics are preventive; they are applied at the time of planting before the larval stage is present. Usually they are applied to a whole field without any knowledge of the distribution of the insect in the field. Prevention of corn rootworm larval injury would be less costly if the controls could be directed toward only those portions of fields where control was warranted, i.e., site-specific pest management.

A three-year study of the within-field spatial distribution of corn rootworms was conducted. In this study, there was within-field spatial correlation of adult numbers between years and the within-field distribution of larvae was related to adult numbers the previous season. The best predictor of larval numbers was adult density at peak beetle numbers in August. By specifying the amount of root injury that would be tolerated, maps of the area where controls should be applied were generated. While it is not likely that growers will target insecticides at only portions of their fields, mapping larval infestations may have utility in the

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planting of genetically engineered corn. When corn rootworm, genetically engineered corn is planted, a 20% refuge (non-transgenic corn) must be planted. By sampling adult populations in August, the grower will be able to plant the more expensive genetically engineered corn where the pest populations are greatest and plant the non-transgenic, susceptible corn where corn rootworm losses will be the least.

Towards biotechnical pest management of *Diabrotica virgifera virgifera* in Illinois, USA

Hans E. HUMMEL¹, J.T. SHAW², C. KUNIYOSHI² & G. AREE²

¹Justus-Liebig-University, Biol. Biotechn. Plant Protection, IFZ, D-35392 Giessen, Germany; ²Illinois Natural History Survey, Econom. Entomol. Center, Champaign, Illinois 61820, USA

With one billion US dollars of annual damages and losses in the US, the western corn rootworm *Diabrotica v.v.* (Col.: Chrysomelidae) (*D.v.v.*) is among the dozen most destructive insect species worldwide. Efforts to reduce *D.v.v.* populations therefore have been in effect within the US Corn Belt for several decades-with many surprises along the way. In the 1960's, *D.v.v.* developed cyclodiene resistant strains now found throughout North America. Very recently, a behavioral ecotype with the ability for "crop rotation resistance" has been found expanding from Illinois into adjacent parts of the Corn Belt. Thus, *D.v.v.* demonstrated its ability to surprise entomologists time and again until the early 1990's when the species was accidentally introduced to Belgrade/Serbia. Subsequently it spread into surrounding countries of *southeastern* and from there to *central* Europe. As of Sept. of 2003, only Germany, Denmark and Poland are still assumed to be virtually "*Diabrotica* free". In spite of considerable efforts and support by the EU commission there remains a need for sustainable, non-toxic management approaches in both North America and Europe.

As a new biotechnical approach to population reduction in Illinois we tried during August and Sept. of 2003 mass trapping combined with a "shielding/deflection" strategy along a line of traps baited with the synthetic kairomone 4-methoxy-cinnamaldehyde as a medium range attractant (for both males and females) combined with cucurbitacin powder as a short range attractant. Those *D.v.v.* adults landing on the center strip of the newly designed "Intensive Rootworm Collection (IRC) trap" are ingesting a lethal dose of carbaryl mixed with the cucurbitacin powder bait and soon fall down into a screw top jar where they can be easily counted and sexed. Classical mass trapping with *D.v.v.* is running against considerable odds because of the unfavorable ratio of *total* adults within maize fields (100-250 000 adults / ha in August) to *trappable* adults. It is estimated that with reasonable costs and efforts not more than 10-20% of the beetles in a field can be trapped. However, mass trapping in combination with "shielding and deflecting" the mobile adults along a trap line, we are finding *significantly* reduced adult populations on plants inside of the "shielded field" in comparison to an adjacent maize field of equal size (0.27 ha) without such a shielding trap line. Immigration and emigration events take place predominantly within a flight space ranging from 0 to 3 m above ground as we can prove by IRC traps mounted at vertical distances of 1 m along tall poles standing at the perimeter of the field. A deflecting/shielding trap line of sufficient density mounted at ear height of the very late planted maize field therefore will be a promising management tool for reducing *D.v.v.* beetle fluctuation across this line. *D.v.v.* egg numbers recovered from soil in the "shielded" field are also lower (17 vs. 93) than in the unshielded control plot.

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Towards Markers for Western Corn Rootworm

Frey **GARABAGI**, Chris **KNIGHT**, Nenad **MIHELICIC**, Art **SCHAAFSSMA**, and Peter **PAULS**

Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada N1G 2W1

With assistance from: Eli **LEVINE**¹ and C. Richard **EDWARDS**²

1) Illinois Natural History Survey, Champaign, Illinois 61820-6917, USA; and

*2) Department of Entomology, Purdue University, W. Lafayette, Indiana 47907-2089, USA; and
EU Project QLK5-CT-1999-01110*

We have conducted several studies to identify molecular markers for the soybean-adapted form of the western corn rootworm (WCR), *Dibrotica virgifera virgifera* LeConte. The initial study screened several populations of insects from affected and nonaffected areas in the USA, as well as from Canada, with RAPD markers. DNA was isolated from 40 normals and 40 variant insects collected in Illinois plus samples from Ontario and samples of northern corn rootworm. The soybean-adapted biotypes were collected from corn fields after rotation with soybean in a problem area in east central Illinois (Counties Champaign and Iroquois) in the beginning of July 2001. Normal WCR beetles were collected from fields in a no-problem area in northwestern Illinois (County Warren) grown to continuous corn. Several hundred RAPD primers were screened with bulked DNA (10 normal vs. 10 variant) to identify polymorphic primers. Seven primers were identified that generated 14 RAPD markers at different frequencies in the normals vs. variant insects (UBC 352, UBC 560, UBC 580, UBC 615, UBC 622, UBC 627, UBC 664). These were used to screen all of the individual samples and identified 14 markers that occurred at different frequencies in the variant versus the normal population. In a subsequent study the markers of interest were cloned and sequenced. The sequences were used to develop SCAR markers.

The RAPD marker work was extended to include a collection of insects from Europe. Seven RAPD primers used in the previous study were tested on samples of 20 insects each from Nebraska, Ontario (Canada), Indiana from first-year corn (presumed variant), Indiana (normal population), Illinois, and several European countries. A total of 81 marker bands were scored for the tested primers. An Analysis Of Variance (ANOVA) showed 32 of the 81 scored loci to be significantly different among the six insect populations that were tested. A Least Significant Difference (LSD) test identified 13 markers (from primers UBC352, UBC560, UBC580, UBC 615, UBC 627) that could be used to distinguish one population from the other five populations. The variant population and the European population of insects were found in several clusters of a UMPGA dendrogram of genetic distances calculated from the occurrence of significant markers in RAPD patterns obtained from the 120 insect samples. Average genetic distances between individuals in Europe and Indiana and Europe and Ontario are significantly smaller than genetic distances between individuals in Europe and Nebraska, Europe and Illinois (normal) and Europe and Illinois (variant). These preliminary results suggest that the European insects are not from the affected population in North America.

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Session III – GM MAIZE

Genetically enhanced maize as a management option for corn rootworm: YieldGard® rootworm maize

Jay C. PERSHING, Dennis P. **WARD**, Todd A. **DeGOOYER**, Ty T. **VAUGHN** & Graham P. **HEAD**
Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, Missouri 63167 U.S.A., jay.c.pershing@monsanto.com

Maize (*Zea mays* L.), the world's third leading cereal crop following wheat and rice, is grown commercially in over 25 countries. In 2002, worldwide production of maize was approximately 594 million metric tons. In the United States (US) its production covered 32 million hectares that yielded 229 million metric tons and had a net value of US\$21.2 billion. Maize, also referred to as corn, has been a staple of the human diet for centuries. Maize grain and processed fractions are consumed in a multitude of food and animal feed products. Hybrid maize is an extremely productive crop, yielding an average of 8.16 metric tons ha⁻¹ in the US during 2002. High yield makes maize one of the most economical sources of usable energy for feeds and of usable starch and sugar for food and industrial products. The majority of maize harvested is fed to livestock.

Maize yields are negatively impacted by a number of insect pests. One of the most pernicious in the US Corn Belt is the corn rootworm. Corn rootworm larvae damage maize by feeding on the roots which reduces the ability of the plant to absorb water and nutrients from soil and causes harvesting difficulties due to plant lodging. Corn rootworm is the most significant insect pest problem for maize growers in the US Corn Belt from the standpoint of chemical insecticide usage. An estimated 5.7 to 10.1 million hectares of maize in the US are treated annually with organophosphate, carbamate, pyrethroid, and phenyl pyrazole insecticides to control this pest. Corn rootworms have been described as the billion-dollar pest complex, based on costs associated with the application of conventional soil insecticides and crop losses due to pest damage. Incomplete protection of maize root systems with larval insecticides, the development of resistance to adult control insecticides, and the biological adaptation of corn rootworms to crop rotation have diminished the effectiveness of currently available pest management practices.

Future management strategies for the control of corn rootworms will include the planting of genetically enhanced maize that resists larval root feeding and protects grain yields. This case study examines current management strategies and their limitations in US maize production and the potential benefits of managing these pests with corn rootworm-protected maize developed by Monsanto Company.

Assessing the risks of Bt-transgenic maize for non-target arthropods

Jörg ROMEIS, Anna **DUTTON** & Franz **BIGLER**
Swiss Federal Research Station for Agroecology and Agriculture (FAL), Reckenholzstr. 191, 8046 Zürich, Switzerland

One of the primary concerns related to the adoption of insect resistant transgenic plants in the environment is the detrimental effect that these may pose on non-target organisms, including entomophagous arthropods (parasitoids and predators) which play an important role in natural pest regulation.

We propose a framework for pre-release risk assessment to evaluate the effects of insect resistant plants on entomophagous arthropods. Using maize expressing the *Bacillus thuringiensis* gene, which codes for

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the Cry1Ab toxin as an example, we illustrate the procedure necessary for assessing the risks. As a first step, it is required to identify the economically and/or ecologically important entomophagous arthropods in the agricultural system in which the transgenic crop will be deployed. Since the risk that a transgenic crop poses for entomophagous arthropods depends on both, their exposure and their sensitivity to the insecticidal protein, it is necessary to determine, as a second step, if and to what extent the organisms are exposed to the transgenic product. Exposure will be associated with the feeding behaviour of phytophagous and entomophagous arthropods together with the tissue and cell specific temporal and spatial expression of the insecticidal protein. For those entomophagous species that could potentially be exposed to the insecticidal protein, the toxicity of the compound has to be assessed. A tiered testing approach should be applied, starting with 'worst case' toxicity tests (1st tier) using both the pure transgenic compound (dose-response tests) and transgenic plant material, followed by semi-field (2nd tier) tests that assess toxicity at exposure levels representing more closely the field situation and eventually field (3rd tier) tests in cases in which a potential risk is indicated by lower tiered tests. Taking the green lacewing *Chrysoperla carnea* as an example, we propose a procedure on how to perform tests and give evidence that Bt-maize poses no risk to this predator.

Dutton A, Romeis J & Bigler F (2003) Assessing the risks of insect resistant transgenic plants on entomophagous arthropods: Bt-maize expressing Cry1Ab as a case study. *BioControl* 48: 611-636.

Regulation of genetically modified crop plants in Switzerland - environmental aspects

Andrea RAPS

*Swiss Agency for the Environment, Forests and Landscapes, Biotechnology and Flux of Substances Section,
CH - 3003 Bern; Tel. +41 31 322 22 38, andrea.raps@buwal.admin.ch*

Genetically modified crop plants get authorised for cultivation by the Swiss Federal Office for Agriculture based on the authorisation procedure laid down in the Ordinance on Seeds, which for the environmental assessment refers to the Ordinance on the Release of Organisms into the Environment (Release Ordinance, RO). According to the Release Ordinance the authorisation application must include data required for the assessment of the risks posed to people and the environment and a permit may only be issued if:

- the requirements of the authorisation procedure are fulfilled,
- examination of the environmental data leads to the conclusion that given the current status of knowledge and experience, the placing on the market cannot endanger people and the environment, and
- the Federal Office for Public Health (FOPH) and the Swiss Agency for the Environment, Forests and Landscape (SAEFL) give their consent to the placing on the market.

Up to now, the environmental assessment has to be made according to the procedure laid down in the Release Ordinance. However, on January 1, 2004 a new law on gene technology - The Federal Law relating to Non-human Gene Technology (Gene Technology Law, GTL) – entered into force specifying the requirements for an authorisation. The GTL in its core is an environmental protection law including additional provisions related to the protection of production without genetically modified organisms, product flow segregation, freedom of choice, labelling and public information. According to the GTL genetically modified organisms (GMO) shall be handled in such a way that they, their metabolites or wastes cannot endanger humans, animals or the environment and do not impair biological diversity or the sustainable use thereof. Authorisation for a GMO intended for use in the environment can only be given if experiments in contained systems of field trials have shown that

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- it does not impair biodiversity;
- it does not cause severe or permanent impairment of the material balance of the environment;
- it does not cause severe or permanent impairment of important functions of the ecosystem in question, in particular the fertility of the soil; and
- it does neither disperse, nor spread its traits in an undesired way.

Further, GMO containing inserted resistance genes to antibiotics used in human or veterinary medicine may not be placed on the market at all.

Currently, the public administration is working on the implementation of these provisions into the ordinances affected (Release Ordinance, Ordinance on feed, Ordinance on Seeds etc.).

All laws and ordinances can be found on

http://www.umwelt-schweiz.ch/buwal/eng/fachgebiete/fg_biotechnologie/national/lois/index.html.

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Session IV – BASIC ECOLOGY

The impact of areawide pest management on Carabids in Indiana/Illinois, USA

C. Richard EDWARDS, Corey K. GERBER, Ann RADAVID & Larry W. BLEDSOE

Department of Entomology, Purdue University, West Lafayette, IN 47907-2089, USA, edwards@purdue.edu

The Areawide Pest Management Program (AWPMP) was carried out over a 6-year period in a 41.4 km² contiguous area located in Indiana and Illinois. The primary target of the program was the western corn rootworm (WCR), *Diabrotica virgifera virgifera* LeConte. This study was designed to test the feasibility of using semiochemical (cucurbitacins) insecticide-baits as the primary management tool for WCR on an areawide basis. Carbaryl, at 10% the normal rate, was used as the toxicant in the baits.

In the study area, the WCR has adapted to the corn/soybean rotation system by laying a significant number of eggs in soybean fields. This development has virtually eliminated crop rotation as an effective tool for managing this WCR "variant".

The AWPMP enlisted the partnership of 44 growers and approximately 4,658 ha of land under corn and soybean production. A 3,726-ha "managed" area was treated with an insecticide-bait whenever populations of rootworm beetles exceeded set levels. Several fields, either adjoining or within 3.22 km of the managed area, were also monitored for rootworm beetle populations; however, treatments were not applied. These fields comprised the control area. Comparisons between managed fields and control fields were used to determine the effectiveness of treatment applications.

In the first 3 years of the AWPMP, the behavior-modifying semiochemical bait, Slam[®], was used. In the following 3 years, Invite[®] was used. Both are cucurbitacins, where as Slam was derived from the buffalo gourd, *Cucurbita foetidissima*, Invite was derived from the Hawkesbury watermelon, *Citrullus vulgaris*. Observations made in 2000 indicated that the Invite semiochemical insecticide-bait might be negatively impacting some non-target organisms. As a result, a study was undertaken in 2001-2002 to determine the impact of the bait on non-target organisms. The study was carried out in 8 fields (4 within the WCR managed area and 4 within the control area). Four sampling methods were utilized to gauge impact on non-targets; pitfall traps, sweep-net sampling, Pherocon[®] AM traps, and direct counts of non-targets on plants. Although non-target data were taken on all sampling methods, primary emphasis was placed on collections from pitfall traps. Six pitfall traps were placed in each field. Carabid species (pooled) were the most abundant species observed. The data showed that significantly lower numbers of carabids were found within the managed area following treatment when compared to the control area. This indicates that the AWPMP had a negative effect on this non-target group. However, heavy rainfall confounded the results to some degree and the impact of rainfall on carabids needs to be examined. It is not known at this point whether the toxic effect observed was the result of the semiochemical alone, the combination of the semiochemical with the insecticide, the insecticide alone, or one of the previous in combination with rainfall. Additional studies need to be conducted to determine the exact cause(s).

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Using augmentative biological control against an invasive maize pest in Europe: Testing susceptibility of *Diabrotica* to entomopathogenic nematodes

Ralf-Udo **EHLERS**¹, Christine **GÜLDENZOPH**², Stefan **TOEPFER**², Regina **BURGER**³
& Ulrich **KUHLMANN**²

¹Institute for Phytopathology, Klausdorfer Str. 28-36, 24223 Raisdorf, Germany, ehlers@biotec.uni-kiel.de; ²CABI Bioscience Centre, Rue des Grillons 1, CH-2800 Delémont, Switzerland; ³Landi REBA, Basel, Switzerland

The western corn rootworm, *Diabrotica virgifera virgifera* (LeConte) (Coleoptera: Chrysomelidae), was first introduced in Europe in 1992. It is considered a severe pest in maize production and causes high yield loss in infested areas every year. It spread at a rapid pace from Serbia throughout Central Europe, and is invading most of the major maize producing countries in Europe. The larvae of *Diabrotica* feed on the roots of maize plants, with high infestations of larvae causing significant physiological damage to the root system resulting in instability and lodging of the plants. In addition, adults feed on the cobs, silks and leaves, further contributing to the damage caused by these insects.

According to studies carried out in 2000 to 2002, no European natural enemies attacking *Diabrotica* larvae or adults have been reported. However, existing literature on biological control of the *Diabrotica* with entomopathogenic nematodes (EPNs) raises the possibility that nematodes could be implemented as potential biological control agents to suppress *Diabrotica* populations.

To assess the virulence of EPN strains, several European and eastern European nematode strains, supplied by the collaborating company *e-nema* GmbH, Raisdorf, Germany, were tested under quarantine laboratory conditions in order to evaluate their potential to attack *D. virgifera* larvae and adults. Since a high potential to successfully infest *Diabrotica* larvae has been found among the eight tested EPN strains, an implementation of EPN applications as a management tool for *Diabrotica* control in Europe appears to be possible. It might be economically feasible for smallholder Polenta maize production but also of economic interest for seed maize production in Europe. It is suggested that the most successful EPN strains, *H. bacteriophora* and *S. feltiae*, are further tested in the open field, most likely in Hungary, where economic infestations of *Diabrotica* beetles have been reported.

Evaluation of the potential efficiency of maize rotation with other crops on *Diabrotica virgifera virgifera* oviposition based on plant surface metabolite analyses

Sylvie **DERRIDJ**, Ingrid **ARNAUD**, Philippe **COUZI** & Franck **MULLER**

INRA Unité de Phytopharmacie et des Médiateurs Chimiques, Route de St Cyr, 78046 Versailles Cedex, Derridj@versailles.inra.fr

The efficiency of crop rotation against *D. virgifera virgifera* (*D.v.v.*) populations is linked to the specificity of females to lay their eggs in cornfields and of larvae to feed on corn (*Z. mays* L.) roots. There was no problem in USA until the insect adapted himself to the rotation corn/soybean used in Illinois. As the insect has been introduced in Europe an important question was to evaluate the risk of oviposition out of cornfields and the efficiency of corn rotation as a pest management.

Feeding and orientation of *D.v.v.* and sensorial physiology experiments in USA showed that the insect is stimulated by sugars and some free amino acids. In our laboratory we demonstrated that these metabolites are present on the plant surface by passing through the cuticle. Corn leaf surface washings stimulate oviposition of *D.v.v.* (wild insects from Hungary). The leaf washings of vegetative stages (V8, V14-15 BBCH) from two hybrids (Borbala and LG 2447) were less stimulant than VT and R3 stages. PCA

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(principal component analyze) based on soluble carbohydrate and free amino-acid quantities and ratios present in the leaf surface washings of the different corn stages cultivated in 2001 discriminate the stages in a similar way as *D.v.v.* for oviposition.

Assuming the hypothesis that these primary metabolites may be concerned in the *D.v.v.* oviposition we analyzed these metabolites in leaf surface washings of different crops at several stages on the whole plants. Plant crops and growth stages chosen were those which may be present during the period of *D.v.v.* oviposition in Hungarian fields studied simultaneously by Pr Kiss J.: for corn *Borbala* at V 8-9, VT, R3, R4 (BBCH) stages, *LG 2447*: V8-9, VT, R3; for soybean: *Borostyan* and *Urloa* varieties at 70, 76, 80 (BBCH) growth stages; for winter wheat *Audace* variety, 22-23 growth stages (BBCH); for sunflower variety *Sunrisa 75* growth stage (BBCH).

Results on year 2002 showed clearly that the quantities of 18 metabolites present on leaf surface discriminate corn whatever the growth stages from sunflower and winter wheat (axe 1: 71.9%, axe 2: 15% of the explanation). Soybean at the stage 80 is not discriminated from corn. Within corn growth stages we can say that those, which stimulate *D.v.v.* oviposition, are still separated from the others as in 2001.

Surprisingly free amino acids do not discriminate corn from soybean 80. Our experience on composition of leaf surface washings showed that they usually permit to discriminate plant species one to the others. This may be an explanation of *D.v.v.* host shift for oviposition from corn to corn and soybean...

The results corroborate those obtained by Pr Kiss J. in rotation essays in Hungary. They showed that the insect present in this country, prefer to lay eggs in corn but according to the season period may lay eggs in other crops (in less number). This is also demonstrated by damages of corn after rotations observed in 2003 in Hungary.

We did not still demonstrate that these metabolites are the key factors for *D.v.v.* oviposition. When this step will be reached it would be rather useful to analyze them on different crops for prediction of rotation success against *D.v.v.* as a pest management.

Nutritional ecology of *Diabrotica virgifera virgifera* LeConte in Europe

Joachim **MOESER**¹, Bruce **HIBBARD** & Stefan **VIDAL**¹

¹Institute for Plant Pathology and Plant Protection, Grisebachstrasse 6, 37077 Göttingen, Germany, jmoeser@gwdg.de

A thorough understanding of the ecological background is mandatory for a successful management of invasive species. The nutritional ecology is one of the key factors in invasive herbivore insect pests. In the case of the invasion of Europe by the Western Corn Rootworm *Diabrotica virgifera virgifera* the relationship of this maize pest to European varieties of its main host plant maize as well as to alternative hosts that occur in its new expansion range needed to be investigated.

We therefore studied the impact of maize varieties from different European countries as well as monocot weeds and crops on the larval development. Significant differences were found with regard to larval weight gain, amount of ingested food and food conversion efficiency on the various hosts tested. Biochemical parameters such as the C/N ratio and phytosterols were used to explain the differences in larval performance. Moreover, we compiled the information on the nutritional ecology in North America and compare the potential host plant spectrum of WCR in North America and Europe. Based on these data sets we will discuss management strategies for WCR in Europe.

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Below-ground herbivory affects above-ground tritrophic interactions

Ted TURLINGS & Sergio RASMANN

LEAE-Zoology Institute, University of Neuchâtel, 2007 Neuchâtel, Switzerland, ted.turlings@unine.ch, sergio.rasmann@unine.ch

The release of volatiles by plants in response to insect attack can function as an indirect plant defence by attracting natural enemies of the herbivores. Such tritrophic interactions have been studied for simplified systems with the plant usually being attacked by just one herbivore. Under natural conditions plants are likely to be attacked by multiple antagonists, each of which may induce a specific plant response and potentially affect the emission of volatile signals.

We studied the consequence of a simultaneous attack of maize plants by an above- and a below-ground herbivore for the production of induced leaf volatiles and their attractiveness for the parasitoid *Cotesia marginiventris*. The common maize pests *Spodoptera littoralis* and *Diabrotica virgifera virgifera* served as the respective above- and below-ground herbivores. *C. marginiventris* is highly attracted to volatiles emitted by maize plants under *Spodoptera* attack. Olfactometer assays in which wasps were given a choice between the odours of singly (*Spodoptera* only) and doubly (both herbivores) infested plants revealed that the wasps' responses largely depended on their previous experiences with the odours. Wasps that had oviposited in a host on a singly infested plant afterwards significantly preferred the odour of such a plant, whereas naïve wasps and wasps with an oviposition experience on doubly infested plants did not show a preference. This first demonstration of an effect of below-ground herbivory on above-ground tritrophic interactions corroborates the complexity of plant-insect interactions and the experience-dependent responses illustrate the adaptability of natural enemies to deal with this complexity.

New tools to study below ground tritrophic interactions – The example of *Diabrotica virgifera virgifera* (Le Conte)

Sergio RASMANN & Ted TURLINGS

LEAE-Zoology Institute, University of Neuchâtel, 2007 Neuchâtel, Switzerland, sergio.rasmann@unine.ch, ted.turlings@unine.ch

Plants under attack by arthropod herbivores have been shown to employ a strategy of indirect defence by attracting natural enemies of the herbivores. Such interactions may also occur below ground when insects-damaged roots release compounds that attract entomopathogenic nematodes.

We investigated this for maize plants under attack by larvae of *Diabrotica virgifera virgifera*. With the use of a newly developed below ground olfactometer we found that the nematode *Heterorhabditis megidis* was highly attracted to *Diabrotica*-damaged maize roots, compared to mechanically damaged roots or healthy roots. Additional experiments showed that water extracts of *D.v.virgifera* damaged roots are also very attractive, indicating that the roots release a compound or a blend of compounds in the soil and that these compounds are used by entomopathogenic nematodes to locate phytophagous larvae near the roots. Interestingly, there are dramatic differences in the attractiveness between different maize lines, suggesting a different response of the plants under attack. The identification of these below ground plant signals should help us enhance the efficacy of nematodes as biological control agents against *Diabrotica*.

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Session IV – FREE THEMES

Discovery of an inhibitor of response to pheromone in western corn rootworm and study of possible interactions between the pheromonal and kairomonal communication channels

Miklós TOTH¹, István UJVARY², Zoltán IMREI¹ & Géza VÖRÖS³

¹Plant Protection Institute, HAS, Budapest, Hermann O. u. 15, H-1022, Hungary; h2371tot@ella.hu; ²Ctrl. Chem. Inst., HAS, Budapest, Pusztaszeri út 59/67, H-1025, Hungary; ³Plant Protection and Soil Conservation Serv., Tolna county, Szekszárd, Keselyüsi út 7, H-7101, Hungary

Compounds closely related structurally to the WCR pheromone molecule were screened for biological activity in the field, presented alone or in combination with the pheromone. None of the compounds showed attraction when presented alone. However, when presented in combination with the pheromone, catches in traps containing 8-methyldecane-2-yl acetate as a second component were dramatically reduced, suggesting strong inhibitory activity for this compound. To our knowledge this is the first discovery of an inhibitor of response to pheromone in WCR. 8-Methyldecane-2-yl acetate is a sex attractant of *Diabrotica cristata* (Guss et al, 1983, Environ. Entomol. 12:1296-1297) so its inhibitory activity towards males of WCR may reflect a role in maintaining reproductive isolation among the two taxa.

In case the inhibitory effect was a result of general repellence, by presenting the new inhibitor together with the floral WCR lure males could be repelled, resulting in more selective female captures. When testing this hypothesis however, the presence of the inhibitor in the same trap together with the floral bait did not influence male catches, suggesting that the inhibitor might exert its action through interference with the perception of the pheromone molecule. Our results suggested that in this respect there was no interaction between the pheromonal and floral channels of chemical communication in WCR. This supported our earlier findings, where we failed to show out any interference in male captures when pheromone and floral baits were placed together in one trap.

Since the above results indicated a total independence of the two communication channels, as supplementary data we recorded the daily rhythm of beetle responses towards the floral and the pheromonal WCR baits, resp. Mean hourly captures at the floral bait occurred exclusively during daytime hours. On the other hand, captures at the pheromone bait were recorded also well into the night. These supplementary observations support the idea that there is no interaction whatsoever between the pheromonal and kairomonal chemical communication channels in WCR.

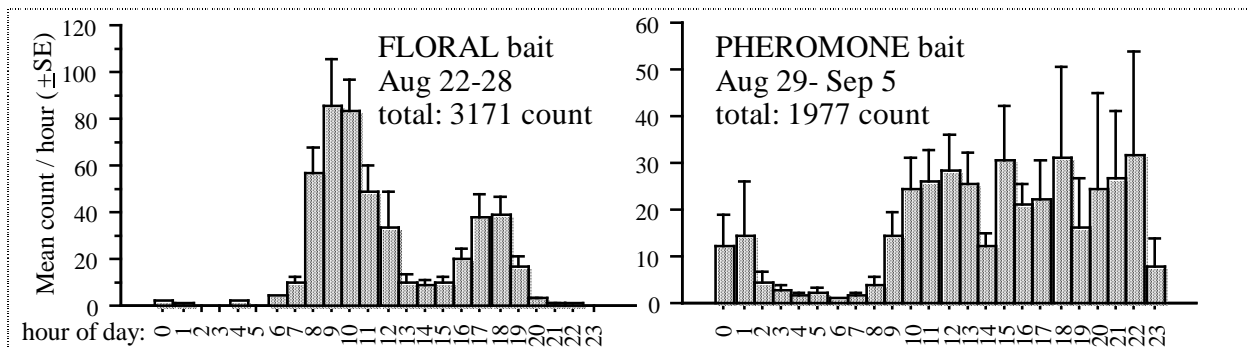


Fig. Mean hourly catches of WCR in floral- or pheromone-baited traps as recorded by an automatically counting trapping device in Hungary (Szekszárd, Tolna county, 2003)

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Supercooling capacity and chilling mortality in corn rootworm eggs

Michael. M. **ELLSBURY**¹ & Richard E. **LEE, Jr**²

¹USDA, ARS, Northern Grain Insects Research Laboratory Brookings, South Dakota 57006; ²Department of Zoology, Miami University, Oxford, Ohio 45056

Oviposition by northern corn rootworms, *Diabrotica barberi* Smith and Lawrence, and western corn rootworms, *Diabrotica virgifera virgifera* LeConte (Coleoptera: Chrysomelidae), key pests of corn in the Great Plains of the United States occurs in the soil during late summer. Overwintering eggs are exposed to variable soil moisture and temperature below -5°C . Winter mortality of eggs in the soil is a primary factor that determines the potential for larval injury to corn the following spring.

The objectives of our studies were to determine the comparative supercooling capacities of northern and western corn rootworm eggs and to assess egg mortality following brief exposure to extreme cold temperature, ranging from -12.0 to -21.5°C , under three moisture regimes. Cohorts of 200 eggs for each rootworm species were placed on 7-cm filter paper discs and distilled water was applied to simulate a variable soil moisture environment. Mean \pm s.e. moisture content (% wet mass) of eggs was determined for both species. Eggs subjected to a one-hour exposure to subzero temperature treatments were incubated at 25°C to determine hatching rates. Supercooling points were determined for egg cohorts subjected to moisture treatments. Groups of three to five eggs from each moisture treatment were attached to the tips of 36-gauge copper-constantan thermocouples with a light coating of petroleum jelly and positioned in two nested 10-ml disposable pipette tips. Pipette tips with thermocouples and eggs were placed in a refrigerated ethanol bath that was initially set at 0°C , and cooled at 1.5°C per min until all eggs froze. The temperature at which an exotherm was first detected was recorded as the supercooling point.

Eggs of northern corn rootworm supercooled to a temperature as low as -27°C and survived supercooling to a greater extent than did western corn rootworm eggs. Moisture treatment prior to supercooling had little effect on northern corn rootworm eggs. Western corn rootworm eggs were more resistant than northern corn rootworm eggs to effects of desiccation followed by supercooling. Survival of northern corn rootworm eggs was better than western corn rootworms under dry conditions, followed by exposure to temperatures of -12.0 and -17.5°C , but was very low at -21.5°C , regardless of moisture regime.

Results suggest that moisture and temperature may interact in the soil environment to determine overwintering survival of corn rootworms. It is evident from these studies that both rootworm species experience mortality at temperatures well above the supercooling points of the eggs, but that differences exist in the effects of substrate moisture treatments on the cold-hardiness of eggs from the two species.

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Spatial distribution of *Diabrotica* in the South Dakota areawide management site

B. Wade **FRENCH**

Northern Grain Insects Research Laboratory; USDA, ARS; 2923 Medary Ave. Brookings, SD 57006, wfrench@ngirl.ars.usda.gov

Western corn rootworms (WCR, *Diabrotica virgifera virgifera* LeConte) are serious economic pests of maize (*Zea mays* L.) in the U.S. Corn Belt, and have adapted to traditional management strategies such as crop rotation and insecticides. Even so, soil insecticides often are used indiscriminately to control WCR. In order to minimize the use of insecticides and protect the environment, the United States Department of Agriculture, Agricultural Research Service implemented a corn rootworm areawide pest management program in 1996. This program was established in five geographic locations, four in the U. S. Corn Belt (Iowa, Illinois/Indiana, Kansas, and South Dakota) and one in Texas.

We used Geographical Information Systems (GIS) to study the spatial relationships of WCR in the South Dakota Areawide Management Site from 1997 – 2001. Each field was georeferenced using global positioning systems (GPS). Pherocon AM yellow sticky traps were used to capture WCR. We also used GPS to georeference all sticky traps. For each year, we calculated landscape metrics on continuous maize, first year maize, and all maize. These metrics included number of patches, percent of landscape, cumulative area, mean area, proximity index, and nearest neighbor distance. Based on WCR captured in the sticky traps, we used the inverse distance weighted interpolation technique to create raster map layers of WCR spatial distribution, and focused our analyses on the interpolated maps in relation to topography, soil type, crop type, and landscape metrics.

We found significant relationships of WCR spatial distribution with crop type, soil type, and elevation. We also found significant correlations of WCR distribution with several landscape metrics. Our research emphasizes the potential role for GIS and landscape analyses in insect pest management. Larger geographic areas can easily be incorporated into GIS and managed by finding patterns in the landscape that promote high pest population densities.

Transboundary spreading scenarios of western corn rootworm for FRANCE, SWITZERLAND and GERMANY under the new situation

Peter BAUFELD¹ & Siegfried ENZIAN²

Federal Biological Research Centre for Agriculture and Forestry, ¹Department for National and International Plant Health, ²Institute for Technology Assessment in Plant Protection, Stahnsdorfer Damm 81, 14532 Kleinmachnow, Federal Republic of Germany

The dispersal rate of the Western corn rootworm (WCR) in Europe was analysed starting with the introduction to Serbia in the beginning of the 90ies. The dispersal rates of the WCR differed from year to year. The spreading of the WCR ranged from 60 to 100 km per year without and from 0 to 37 km with containment measures (FAO programme TCP/RER/6712). The simulation model used as average a maximum spreading rate of the population of the WCR of 80 km per year without and of 20 km per year with containment measures. The maximum spreading rate is reached by WCR in the succeeding year only if continuous maize is available in the infested area. The concentration of maize in crop rotation is the main factor in the simulation model. In case of low maize concentration, the multiplication factor and

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spreading pressure are very low. In that case we reduced the spreading rate by a correction factor **K** which is defined as follows: In case of ≥ 50 % of maize in crop rotation **K = 1** and

$$\text{in case of } < 50 \text{ \% of maize in crop rotation: } \mathbf{K} = \frac{\text{concentration of maize in \% x 2}}{100}$$

The following formula was used in the simulation model to calculate the spreading rate of the WCR:

$$\mathbf{AR} = \mathbf{FD} \times \mathbf{K}$$

where **AR** = spreading rate of the WCR

FD = distance of flight with (20 km/year) or without containment measures (80 km/year)

K = correction factor (see above)

Furthermore, the topography was analysed in the infested areas of Southeast Europe. Analysis showed that the WCR is not able to fly regularly above altitudes of 900 m, which was considered in the simulation model. The lowest mountain chain in Western Europe is up to 800 m and has valleys (often with maize) which favour progressive dispersal. Tunnels (like in Switzerland) could have also an influence on the spread but were not considered.

All information is utilised in the simulation model on the spreading of the WCR. Calculations are carried out on the basis of GIS software ArcView/ArcInfo. The model was used to simulate the spreading rate of WCR over ten years. Starting from the newly infested location Blotzheim, near airport Basel-Mulhouse (located 4.7 km from Germany and 4.8 km from Switzerland), in Alsace (France) in 2003, the spread was simulated with and without containment measures („natural spread“). Simulation showed the dramatically ongoing spread, despite the borders of France, Switzerland and Germany, along the high concentration of maize in Alsace and in the Rhine valley in Baden-Wuerttemberg without any measures. In this region WCR find ideal conditions for multiplication, and the spreading pressure would be high in case of failure of eradication. On the other hand containment measures would significantly reduce the ongoing of the spread according to simulations.

Geostatistical analyses of distributions of *Diabrotica virgifera virgifera* within maize fields in Central Europe

Stefan TOEPFER¹, Michael M. ELLSBURY² & Ulrich KUHLMANN¹

¹CABI Bioscience Switzerland Centre, Rue des Grillons 1, CH - 2800 Delémont, stoepfer@gmx.net; ²Northern Grain Insects Research Laboratory, USDA-ARS, 2923 Medary Avenue, Brookings, USA - 57006 South Dakota

Recently, the chrysomelid *Diabrotica virgifera virgifera* LeConte became a serious pest in European maize production, and farmers or researchers have to measure its population dynamics for pest forecasting or analysing economic thresholds. Both often face the problem of clumped distributions of *D. v. virgifera* larvae in the soil as well as of adults on the maize plants in a field. Reasons for such clumped distributions might be (a) spatial differences in the soil conditions of a field that influence oviposition, larval movement, and mortality or (b) spatial vegetation patterns, that influence search for food and choice of oviposition sites by adults.

In this three-year study, the influence of spatial soil and vegetational parameters on the distribution of *D. v. virgifera* larvae and adults was investigated in continuous maize fields in southern Hungary. Larval distributions were analysed by determining numbers of larvae in four randomly taken soil-root samples in each of 24 plots (12 x 12m) of each maize field. Adult distribution was measured by visually searching for

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beetles at four randomly chosen maize plants in the same plots once a week. Soil bulk density and soil humidity were determined twice in four randomly taken soil cores in the same plots. Total numbers of plants and plant species, the vegetation coverage, and densities of each weed species were recorded in 5 rows of each of the 24 maize plots in each field.

Neither a correlation between the distribution of *D. v. virgifera* larvae and the distribution of adult *D. v. virgifera* of the previous year, nor a correlation of larval distributions between subsequent years was found. Adults of *D. v. virgifera* were mainly found in maize plots, where higher larval densities also were recorded in early summer of the same year.

The distribution of *D. v. virgifera* larvae showed that lower numbers were correlated with higher soil bulk density. The larval distribution was correlated neither with the soil humidity distribution nor with the vegetation parameters in the studied field. The adult distribution was not correlated with the soil humidity or bulk density or distribution of vegetation parameters.

We acknowledge the technical support of Szucs Marianna and the Plant Health Service of Csongrad Country in southern Hungary. The BBW Switzerland financed this work within the framework of the EU project DIABROTICA (QLK5-CT-1999-011110).

IPM knowledge transfer – current developments and needs in farmer training for IPM implementation

Janny VOS

CABI Bioscience, Bakeham Lane, Egham, Surrey TW20 9TY, UK, j.vos@cabi.org

To become successful producers, farmers need access to information that helps them make better and more open choices about their own livelihoods. Globalisation poses a threat to smallholders unless they get more effective support in accessing new technologies and markets, and in meeting new standards of quality and reliability. The extension role needs to move towards a mode ranging from advice and training on specific technologies to facilitation in relation to technologies (e.g. improved access) but also in relation to a wider service context (including credit, input supply, processing, marketing). The research role needs to be linked and move towards a mode of seeking to solve farmers' problems and addressing their needs. Examples are given of tackling pest problems through farmer participatory training modes. Farmer Participatory Training (FPT) focuses on transfer of knowledge through discovery learning, facilitated by field staff from extension or elsewhere. Farmer Participatory Research (FPR) focuses on knowledge generation through novel farmer experimentation, with resource persons and facilitators. The focus in FPR is on meeting farmers' needs and demands in appropriate knowledge generation through local technology development and/or validation. The focus of knowledge transfer and generation is indirectly to achieve food security in the widest sense, but first and foremost to improve smallholder producers' livelihoods. Impact assessments of participatory training programmes show more stable production with improved product quality and increase in farmers' incomes. However, for these programmes to move beyond pilot stages, it is concluded that a wider focus would be needed to involve more stakeholders in the IPM knowledge system.

The Summary of the Farmer Participatory Training (FAO – Project) and of the Poster Session will be content of IWGO – NEWSLETTER XXV / 2

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IWGO ITEMS

It might be interesting to hear – especially for the elder IWGO – member - that the convenor received Christmas Greetings from the previous IWGO Convenors Prof. H.C. **CHIANG** (USA) and Dr. Pierre **ANGALDE** (F). Both are in good health and enjoying their retirement. Prof. Chiang will be 90 years of age this year. Also Dr. Marcel **HUDON** (CDN) sent greetings.

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Plans for the next *Diabrotica* Subgroup meeting (2005) are made already. IWGO received an invitation from Bratislava, Slovak Republic for a meeting early in 2005. But the negotiations are not finished yet so we can not give you the definite time of the meeting.

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As mentioned already in the “Editorial” the last Subgroup meeting was attended by 110 participants out of 25 countries (Albania, Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Hungary, Ireland, Italy, Norway, Romania, Serbia & Montenegro, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, United Kingdom and USA) as well as one representative of USDA/APHIS and EPPO.

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After having been Convenor of IWGO for more than ten years, and before for 11 years IWGO Secretary General and editor of the IWGO NEWSLETTER it seems to me time for a change; new, younger colleagues should take over the leadership of IWGO. For that reason Prof. Edwards and I agreed to adopt Ulrich **KUHLMANN** from CABI BioScience in Delemont Switzerland – the organizer of the meeting in Engelberg – in the leading team of IWGO in order to take over the group in the near future. I hope this decision will find the agreement of all IWGO – colleagues and friends. Final decisions will be made at the meeting in Bratislava next year.

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The “colleagues and friends” of IWGO presented a plaque at the end of the Engelberg-Meeting to the Convenor as a thank for more than 10 years convenorship of IWGO. The eldest IWGO members – being present in Engelberg – Franja BACA (Serbia) and Prof. John TSITSIPIS (Greece) supported Prof. EDWARDS by handing over this award.



“Presented to
Harald K. BERGER
Global IOBC/IWGO Chairman
In Recognition of Your
Dedicated
Service To The IWGO
Working Group
Ostrinia And Other Maize
Pests And
The Sub-Group *Diabrotica*
1994 – 2004
From Your IWGO
Colleagues And Friends
Engelberg, Switzerland
January 2004”

Prof. Edwards handing over the plaque to Harald Berger
(f.l.t.r. Rich Edwards, Harald Berger, Franja Baca, John Tsitsipis)

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The IWGO – Group in front of the hotel and meeting place of the Xth Diabrotica - Subgroup Meeting in Engelberg, Switzerland

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