C-IPM workshop on:

"Breeding for IPM in sustainable and low-input agricultural systems" 4-6 July 2016, IHAR-PIB Radzikow, PL

Final report

A two and half day joint international workshop entitled "Breeding for IPM in sustainable and low-input agricultural systems" was organized at IHAR-Radzikow from 4th to 6th July 2016. The workshop was co-organized by the ERA-Net C-IPM (Coordinated Integrated Pest Management in Europe; http://c-ipm.org/) and Plant Breeding and Acclimatization Institute (IHAR; http://ihar.edu.pl/). For further details about the presentations, please refer to the website of the workshop (http://ihar.edu.pl/C-IPM_workshop.php).

Fifty-seven scientists, governmental officials, and breeding company representatives, from 16 European countries **(Annex 1)**, met to discuss: i) whether for IPM we need to adopt a different type of breeding than that commonly used by classical breeding aiming only at inserting resistance genes in *sensu strico*, ii) if there are already ongoing R&D programs on breeding for IPM, both at national and European level, and iii) how can we promote diversification of crops and crop types by combining agronomic practices with the newly-deployed breeding materials.

The main objectives of the workshop were:

1. Provide an overview of the existing national programmes on topics related to breeding relevant to IPM; to this aim, a short questionnaire was designed and circulated pre-workshop to C-IPM partners and other workshop participants to collect relevant information whose synthesis was presented at the workshop),
2. Gather international experts and stimulate exchange of information and expertise on the ongoing development of resistant/tolerant germplasms that adapt to IPM system,
3. Review whether the focus on IPM requires breeders to take a different approach than the traditional one and seek experts' opinion in this regard,
4. Discuss how the plant resistance to diseases, pests and weeds can be improved in its durability and stability when introduced within the context of when combined with complementary approaches which are part of IPM (cultivation practices, plant and landscape architecture),
5. Identify research priorities for National, transnational and European programmes related to breeding and IPM.

The workshop comprised of both the plenary sessions, field visits and a roundtable discussion. The plenary oral presentations focused on i) New and well-documented technologies and plant traits that are suitable for IPM, and ii) Combining breeding

material with cultivation practices for an improved integrated pest management. During the field visit, several ongoing trials at IHAR experimental sites were demonstrated including a large number of screened lines of wheat and barley.

4th July:

Edward Arseniuk, director of IHAR in Radzikow, opened the workshop by welcoming the participants. He mentioned that IHAR was delighted to organize such an important workshop involving many European experts. He also briefly explained about the ongoing activities of the institute including ones relevant to breeding for IPM.

Bogusław Rzeźnicki, director of the Department of Plant Breeding and Plant Protection at the Ministry of Agriculture and Rural Development of Poland, highlighted the main tasks and responsibilities of his department. The aim of sustainable use of pesticides cannot be fulfilled without new and resistant varieties. In Poland, scientists and breeding companies are encouraged to develop new varieties with a good level of resistance to pests and pathogens, which is in line with IPM strategies. The Ministry also funds breeding research aimed to reduce reliance on conventional pesticides.

Antoine Messéan, the ERA-Net C-IPM coordinator**,** thanked IHAR for volunteering the organization of the workshop and welcomed the participants. He introduced C-IPM to the participants and the following the major points were highlighted:

- The ERA-Net C-IPM has been granted by the EC for 3 years (2014-2016) and has 34 Programme funders and managers as partners who will decide soon about its future;
- The ERA-NET aims to step up the cooperation and coordination of research activities carried out at National or regional levels;
- Besides setting up and funding transnational calls on IPM strategies and developing IPM tools, C-IPM has a focus on implementation and adaption in practice;
- Several thematic workshops were held and others are planned by C-IPM to enhance networks of infrastructures. A next workshop will be held in September on Drosophila suzukii in Greece;
- C-IPM has foreseen two calls, one organized in 2015 (funding 2016) and another ongoing in 2016 (funding 2017), each with about 6-7 million of Euros;
- The strategic research agenda (SRA) document has been finalized and it will be disseminated very soon. This document contains several relevant information including future challenges for IPM, overlaps and gaps and added value of working together on topics of common interest and setting up a long term collaboration;
- Defragmentation and systems challenges are key for IPM and there is added value of coordinating IPM research to address these challenges.

The welcome discussions were followed by the plenary talks by the following speakers.

Antoine Messéan gave a talk entitled "Role of crop diversification to boost IPM and implications for breeding". His talk illustrated some examples of breeding criteria that would facilitate crop diversification including: adaptation to intercropping, aboveground vs. belowground competition with weeds, competitiveness of minor crops, and deployment of varieties at the landscape level. The following were the key conclusions:

- There has been a strong trend in regional specialization of cropping systems over the years, which led to the cultivation of only a few number of crops (e.g. winter wheat in central France);
- Shorter rotations adopted for arable crops over the years led to higher pest pressure with consequent higher reliance on conventional pesticides;
- If we want to reduce reliance on pesticides significantly we should rethink about crop rotations and diversification of cropping systems;
- There are several barriers along the value chains (upstream & downstream levels) and leverages need to be understood and adopted to promote crop diversification.
- The current agricultural system is locked-in (path-dependency effects) and all its components (public policies, regulation, upstream industry, farmers, cooperatives, downstream industry, retailers, consumers) should be considered as a whole ; the lack of coordination along the supply chains is an important obstacle to crop diversification; a "change in paradigm" is therefore needed;
- As for plant breeding, there is a need to adapt plant breeding to crop diversification & IPM and not just adapt crop management to resistant varieties; overall, co-designing of varieties and cropping systems are needed to promote IPM.

Jay Ram Lamichhane presented a summary of the analysis on the feedback of the questionnaire, which was designed and circulated prior to the workshop. The following were the conclusions:

- While there are not many R&D programs in Europe for breeding for IPM, some examples of transnational projects clearly show the trend toward this approach;
- A number of initiatives at national levels emphasize that there is focus on breeding for IPM;
- Several factors need to take into account to promote "breeding for IPM" at the European level (development of varieties for specific pedo-climatic conditions, focus on minor crops etc);
- Three strategies to integrate existing breeding technologies in a wider IPM context
    - Deployment of resistant and/or tolerant plant varieties (traditional breeding)
    - Focus on breeding for minor crops
    - Integration of such varieties with other management tactics
- Breeding for IPM R&D programs should prioritize not only on crop resistance traits but also to other parameters (e.g. modification of crop canopy

architecture);

- Targets of breeding for IPM R&D programs differ from one region to another (e.g. diseases in humid regions, insect pests along coastal regions);
- Crop tolerance and resilience are reported as the most important traits for breeding for IPM R&D programs;
- Crop rotation is the most important lever of IPM but intercropping and multiple cropping are equally important.

Edward Arseniuk gave a talk entitled "Resistance breeding programs of arable crop varieties for sustainable and low-input agriculture to boost IPM in Poland". In particular, the following approaches are adopted:

- Sampling of diseased crop materials from different geographic regions of the country (if spores of a given pathogen are dispersed by air, spore samplers are being used);
- Deriving of monospore isolates from the sampled material;
- Determination of occurrence of new virulence/pathogenicity frequencies on a set isogenic crop lines/varieties with known resistance genes;
- Identification of effective resistance genes against the monitored pests;
- Search for sources of resistance to develop germplasm with new resistance gene.

Akos Mesterhazy talked about "Breeding for resistance against toxic fungi in wheat and maize combined with updated fungicide technology to reduce effectively toxin contamination in grain". The following were the major points discussed:

- The use of resistant cultivars is a prerequisite to preventing toxin contamination and ensure food safety;
- The breeding approach should be adapted to the new requirements and more resistant and site-specific cultivars needed to be developed;
- Crop resistance integrated with best agronomic practices could provide effective management of these problems.

Morten Lellemo gave a talk entitled "Breeding for partial disease resistance in wheat – and how this can reduce the need for chemical disease control". The following were the major points discussed:

- There is over a 100 year of breeding history on powdery mildew of wheat in Norway but still we have no available resistance as all previously resistant cultivars have become susceptible;
- The re-emergence of stripe rust, caused by Puccinia striiformis f.sp. tritici which has created a new challenge for Norwegian wheat farmers since no resistance is available for this pathogen ;
- Stripe rust, leaf blotch, Fusarium head blight are major wheat diseases in Norway;
- VIPS (www.vips-landbruk.no.) is a web-based decision support system for plant protection in Norway which have a great potential to promote IPM.

Pedro Revilla gave a talk entitled "pest management for sustainable agriculture in Spain" and the following were major issues highlighted:

- While there is no comprehensive research program including all aspects of IPM, several research activities are oriented towards a sustainable pest management from different perspectives including plant breeding, biological control and agronomic practices;
- The SWOT analysis of IPM research in Spain showed that the abundance of resources for pest management for conventional agriculture, an in-depth knowledge of pests management, and the social relevance of sustainable agriculture are the strength. Likewise, the weaknesses consists of few public investments on sustainable agriculture, little efforts on integrated pest management, and limited scientific stimuli for research on sustainable agriculture. The opportunities are social interest on sustainable production, through a progressive reduction of pesticides in the EU, increasing awareness of the scientific community, and increasing pest resistance to active principles;

Piet Boonekamp talked about "Experience of more than ten years blight research on potato with a cis-genesis approach and final results and communication achievements". The following were the major points highlighted:

- This project was business, government and science collaborative example which yielded many useful results about the potential of cis-genesis, a versatile molecular assay which can be integrated in an advanced decision support system to boost IPM;
- Cis-genesis has a potential to preserve the limited plant resistance genes available to date and it is also very sustainable for resistance management;
- Ecological sustainability, robustness of the system, and healthy products were three sustainability issues addressed.

Ewa Zimnoch-Guzowska gave a talk entitled "Search for resistant germplasm to major pathogens in potato" and the following points were highlighted:

- The pre-breeding program research was conducted on genetic characterization of applied sources of resistance to Phytophthora infestans, major potato viruses (PVY, PVM, PLRV and PVS) or resistance to potato soft rot;
- Cost of breeding is an issue although in Poland it is much lower than in many other countries;
- Relation between resistance to phytopthora and other traits is important for production but often there is a negative correlation between taste and resistance;

Jakub Danielewicz provided an overview about Polish National Action Plan to reduce the risks arising from the use of plant protection products. The following were key messages presented:

- IPM practices have been increasingly developed and implemented in Poland;

- Knowledge dissemination activities on a safer use of plant protection products and creation of advisory services and training to farmers promoted the implementation of the principles of IPM;
- By the end of 2015, over 70 best management practices were listed and posted on the website of the Ministry of Agriculture and Rural Development;
- The use of decision support systems is spreading rapidly via the development of a network of meteorological stations and a network of spore traps (Burkard type).

Elżbieta Kozik talked about Breeding for resistance to biotic stresses of vegetable crops and the following were major issues discussed:

- breeding for resistance against economically important vegetable pathogens is one of the main research themes at InHort, Skierniewice;
- Both fundamental (exploratory and methodological) and applied research (breeding) are covered at the institute. The former focuses on cucumber-*Pseudoperonospora cubensis* and tomato-*Phytophthora infestans* while the latter focuses on tomato (under protected and field conditions) and field cucumber;
- Development of detection methods for identification of resistance genes to tomato pathogens are also of strong focus at the institute.

Edward Żurawicz, gave a talk entitled "Breeding for resistance to diseases and pests of fruit crops at the Research Institute of Horticulture, Skierniewice, Poland" and the following were the major points highlighted:

- Research Institute of Horticulture in Skierniewice focuses on breeding for resistance to pests and diseases of fruit crops given their economic importance in Poalnd;
- The basic breeding method used is the traditional cross-breeding relying on crosses between selected parental lines and selection among the progeny of obtained seedlings of F1 generation;
- Traditional methods of breeding are supported with deep dissection conducted using molecular and biotechnological tools (MAS, HTS, genetic mapping, in vitro-based techniques).

Zbigniew Dąbrowski gave a general overview about breeding for resistance to insects and the following were major points discussed:

- Breeding priorities of private enterprises are driven by market size and restricted only to major field crops;
- Logistic problems related to interdisciplinary research involving entomologists with breeders is the main obstacle for a sustainable breeding;
- Absence of evidence about global suitability of genetically modified crops with resistance to major field crop pathogens is an obstacle which does not allow this technique to integrate into IPM.

5th July

Clemens van de Wiel gave a talk entitled "New Breeding technologies to support Integrated Pest Management" and the following were major points discussed:

- Genome editing can be used to efficiently knock out genes targeted by pathogens to infect plants;
- Cis-genesis enables stacking resistance genes (R genes) to render it difficult for the pathogen to overcome resistance as often happens with single R genes;
- A transgenic rootstock can provide resistance to soil-borne diseases, while products harvested form the scion do not contain the transgene. Therefore, these techniques have a strong potential for IPM.

Bogumił Leszczyński talked about Molecular mechanisms underlying induced cereal resistance to aphids and the following points were discussed:

- While resistance genes have been a major focus by research, other potential factors which may confer resistance to aphids are not well-known;
- Phenolic compounds, polyamines and oxidative stress play an important role in cereal resistance to aphids.

Olga Scholten gave a talk entitled "breeding for insect resistance for organic and conventional farming systems" and the following points were discussed:

- Agricultural research in the Netherlands is almost always funded in the form of public-private partnerships;
- Landscape affects the amount of natural enemies although this approach is not easy to apply in the NL. However, natural enemies can be applied in apple or even better in pepper (in the greenhouse);

Marja Jalli talked about Barley breeding in Nordic countries: effects on nitrogen use efficiency, disease resistance traits and genetic diversity and the following were major points highlighted:

- Nitrogen use efficacy in Norway has increased with plant breeding;
- Seed treatment, crop rotation and breeding for resistance are major IPM measures deployed in Finland;
- A significant improvement in the net blotch resistance level was found in the European barley cultivars released in the last 4 decades. European barley cultivars and Syrian landraces have the highest level odf resistance against the net blotch pathogen.

Jean-Pierre Jansen presented a work on Assessment of wheat cultivar resistance to orange wheat blossom midge, Sitodiplosis mosellana (Géhin) (Diptera: Cecidomyiidae) using a phenotyping method under controlled conditions and its implication for IPM. The following were the conclusions:

- Sixty-four wheat cultivars were assessed for their resistance to and 17 of them showed a good level of resistance against wheat blossom midge offering to the farmers a large set of resistant wheat cultivars adapted to the local agricultural conditions;
- Phenolic acid production may be a feature conferring resistance to midge.

Tine Thach gave a talk entitled "The challenges in breeding for disease resistance arising from dynamic pathogen populations" and the following were the conclusions:

- Breeding for resistance to rusts is a real challenge due to the dynamic nature of the fungi, including long distance spore dispersal combined with the huge capacity of asexual reproduction within the crop season;
- Development of multi-resistant wheat varieties, based on a combination of resistances, is the focus for a sustainable and durable management of yellow rust disease. However, combination of resistances for a bio-trophic pathogen may have a deleterious effect on yield;
- Positive correlation between Nitrogen content and disease severity was observed which highlight the importance of cultural practices in managing diseases;
- Wheat rust toolbox has been built up within the IT framework aiming at a better communication and information exchange;
- Pathogen surveillance via coordinated efforts is the best way to collect information about the changes in populations of rust pathogens and to deploy appropriate measures of disease management;
- Because the rapid pathogen changes occur over large spatial scales, effective and rapid communication and information exchanges with the stakeholders are essential.

Jerome Enjalbert talked about new challenges for breeding varieties adapted to mixed cropping systems and the following were major conclusions:

- A positive correlation between the number of species deployed and productivity has been observed in the grassland system which could serve as a lesson for agricultural systems as well;
- Diversification of crops at the field scale is needed by adopting mixed cropping systems although they systems raise major questions and challenges for breeders;
- While mixed cropping systems are already practiced, no specific co-breeding programs have been developed so far to this objective which advocates for the development of renewed breeding efforts;
- There is a strong need of participatory breeding approach to promote IPM.

Veronique Decroocq gave a talk entitled "plant-Pathogen(s) interactions in natural environment: How can this knowledge pro-vide novel and durable strategies for breeding and sustainable disease management?" The following were the conclusions:

- Understanding of what is ongoing in plant's natural environment provides useful insights for the development of a "sustainable" agricultural systems given a high genetic diversity of plants in the wild;
- A combined effort of studying the plant/pathogen interactions in their natural habitat could markedly help understand how plant pathogens occur and evolve and what should we do to reduce epidemic developments.

6th July:

Bettina Klocke talked about testing breeding aims in German winter wheat in the field with respect to cropping systems and fungicide strategies. The following were the conclusions:

- Susceptible cultivars often have higher yields compared to resistant ones but they also rely on higher frequencies of fungicide treatments. Therefore, susceptible cultivars have no potential to reduce the use of fungicides;
- No clear-cut correlation between resistance and yield was found among the tested varieties;
- Yellow rust is the dominant fungal disease across Germany and some cultivars are likely to be resistant to the yellow rust pathogen.

Roma Semaškienė gave a talk entitled "Suggested cereals and Oilseed rape varieties for Integrated Pest Management under Lithuanian conditions" and the following were the key points discussed:

- Lithuanian farmers grow a wide range of oilseed rape, winter and spring wheat and spring barely varieties adapted to local conditions across different regions;
- No or short rotations and reduced tillage practices enhanced disease pressure in arable crops;

Several screened varieties showed a wide range of resistance to major diseases and they are available on the national market.

Main conclusions of the sessions

- There are a lot of research projects on pest and disease resistance across Europe, mostly focussing on a specific crop/pest;
- Some attempts to consider IPM in breeding programmes:

Partial resistance used in combination with other tools;

Durability of R genes through IPM.

- **However, breeding is currently clearly not driven by IPM strategies**

There is an overall agreement that one should broaden the scope (change of paradigm) but it is a huge challenge;

High interest has been expressed about in crop diversification (e.g., mixtures, intercropping, rotation) but technical constraints and market acceptability are a challenge;

There is a need to identify other IPM measures/targets that could be complementary to breeding for resistance.

Conclusions of the round table discussions:

How to account for IPM when breeding disease/pest resistance

- The plasticity of resistance is very useful for IPM, especially to know what would be the reaction of pathogens due to a deployment of a new cultivar. Indeed, some plant genotypes favor the evolution of pathogens in space and time while other do not. That is why it is important to assess this effect prior to deploying a given crop genotype;
- Push-pull strategy for example is an important way of deploying cultivars/mixtures within an IPM context. Therefore, breeding for crops (minor) which can be deployed for this purpose will help promote IPM;
- Detailed information on deployed resistance gene, which is often not known, are needed to have a better view about what is really deployed instead of only looking at the catalogue of the cultivars;
- Most commercial farmers prefer resistance but we should promote tolerant varieties within the frame of IPM as they do react better and have potential. However, tolerance is understood differently which may work for fungi, bacteria but not for viruses because tolerant crops act as a reservoir of viruses so is not recommendable;
- Resistance is needed but the better focus should be on how to maintain that resistance (durability over time) and make them sustainability (for growers especially). Because, durability is a combination of strategies, competitiveness among breeders is a problem to achieve durability. Breeders just want to release new resistant varieties (market-driven approach) and do not prioritize durability and sustainability issues;
- If breeders adopt right variety testing methods during the breeding phase it will help to select suitable varieties for IPM. Therefore, post-registration variety testing system should be modified;
- Farmers like resistant varieties because it allows them to reduce reliance on pesticides and they can comply in such a way with IPM policy.
- There is a need to demonstrate that crop diversification may have even a higher potential to reduce reliance on pesticides and to increase yield potentials.

How can breeding help foster adoption of other IPM strategies?

- Ideotype breeding is the standard practice while trait-based approach (architecture, competitiveness etc.) is the one needed for IPM and we would need to combine these approaches;

- Weeds should be of better focus when it comes to variety development to reduce weed pressure by promoting competitiveness of crop varieties. The environmental and soil conditions need to be well-understood before to start breeding for traits;
- Architecture is very important for fruit trees. Modern breeding practices favor erected varieties to avoid competition between plants (i.e. no trait variation) which goes against the need to manage weeds as it decreases crop competitiveness toward weeds;
- Breeding for minor crops having a higher allelopathic effects against weeds and their adoption have a strong potential to promote IPM.
- We should shift from breeding for gene to breeding for ecosystem for a better agricultural sustainability;

Which breeding strategies for crop diversification?

- Create the market as a low market size is an obstacle for minor crops to be practiced. In the current situation, growers might not accept to cultivate different genotypes in the same field due to the lack of market. Therefore we need to focus on how to create market and promote acceptance of variety mixtures. This is especially true when we talk about products intended for food or processing; Encourage public breeders to focus on minor crops by supporting them with appropriate strategies;

Role of new breeding techniques

- New breeding techniques could be used to boost IPM but their public perception is an issue, those considered as GM would be difficult to develop in Europe;
- Trade-off between preservation of diversity in a landscape and deployment of a single gene is needed;
- Regulation and IPR (intellectual property rights) are obstacles for instance for new technologies and there need solutions to address this issue;
- Genome editing techniques could speed up breeding techniques but that would not necessarily increase the resilience of our cropping systems or agriculture in general;

Co-design breeding and IPM strategies: impact on regulation and organization

- There is a need to review the catalogue of varieties and for some diseases such as Fusarium head blight we need to remove highly susceptible varieties from the catalogue.
- Participatory breeding is the best way especially for organic crops. However, only a few efforts are made to promote local production farming systems adapted to site specific conditions.

Annex 1. List of participants

Surname	First name	Country	Institution
Arseniuk	Edward	Poland	IHAR-PIB
Boonekamp	Piet	Netherlands	Wageningen UR Plant Breeding
Brylińska	Marta	Poland	IHAR-PIB O/Młochów
Chrpova	Jana	Czech Republic	Crop Research Institute
Czembor	Jerzy	Poland	IHAR-PIB
Czembor	Elżbieta	Poland	IHAR-PIB
Czembor	Paweł	Poland	IHAR-PIB
Danielewicz	Jakub	Poland	IOR
Dąbrowski	Zbigniew	Poland	SGGW
Decroocq	Véronique	France	INRA
Dixelius	Christina	Sweden	Swedish University of Agricultural Sciences
Enjalbert	Jérôme	France	INRA
Gacek	Edward	Poland	COBORU
Gautier-Hamon	Gerard	France	Ministry of Agriculture, Agrifood and Forestry
Góral	Tomasz	Poland	IHAR-PIB
Grzeszczak	Iga	Poland	IHAR-PIB
Thach	Tine	Denmark	Aarhus University
Jalli	Marja	Finland	Natural Resources Institute Finland (Luke)
Jansen	Jean-Pierre	Belgium	Walloon Agricultural Research Centre
Kamiński	Piotr	Poland	HZZ Zamarte
Kiełkiewicz-Szaniawska	Małgorzata	Poland	SGGW
Klocke	Betina	Germany	JKI, Julius Kühn-Institut
Korbin	Małgorzata	Poland	Insitute of Horticulture (IO)
Kozik	Elżbieta	Poland	Insitute of Horticulture (IO)
Kudsk	Per	Denmark	Aarhus Unversity
Kumar	Jiban	Czech Republic	Crop Research Institute
Lamichhane	Jay Ram	France	INRA, ECO-INNOV
Leszczyński	Bogumił	Poland	Siedlce University
Lillemo	Morten	Norway	Norwegian University of Life Sciences
Messean	Antoine	France	INRA, ECO-INNOV
Mesterhazy	Akos	Hungary	Cereal Research Center
Niewińska	Małgorzata	Poland	DANKO Hodowla Roślin Sp. z o.o.
Nowacki	Wojciech	Poland	IHAR-PIB O/Jadwisin
Ölmez	Fatih	Turkey	Central Research Institute for Field Crops
Ochodzki	Piotr	Poland	IHAR-PIB
Pietraszko	Milena	Poland	IHAR-PIB O/Jadwisin
Płonkowski	Bartłomiej	Poland	IHAR-PIB
Revilla	Pedro	Spain	INIA

Rokicki	Michał	Poland	Poznanska Hodowla Roslin
Scholten	Olga	Netherlands	Wageningen UR Plant Breeding
Semaškienė	Roma	Lithuania	LRCAF
Skowroński	Adam	Poland	Plant Breeding Smolice Ltd.
Sosnowska	Danuta	Poland	IOR
Starzycki	Michał	Poland	IHAR Poznan Division
Teakle	Graham	UK	University of Warwick
Troczyński	Mikołaj	Poland	Polish Seed Trade Association (PIN)
van de Wiel	Clemens	Netherlands	Wageningen UR Plant Breeding
Warzecha	Roman	Poland	IHAR-PIB
Woś	Henryk	Poland	DANKO Hodowla Roślin Sp. z o.o.
Zimnoch-Guzowska	Ewa	Poland	IHAR-PIB O/Młochów
Zaremba	Ludwik	Poland	Agro Serwis
Zarzyńska	Krystyna	Poland	IHAR-PIB O/Jadwisin
Żurawicz	Edward	Poland	Insitute of Horticulture (IO)
Żurek	Monika	Poland	IHAR-PIB
Paczyńska	Karolina	Poland	przewodnik - Żelazowa Wola
Borawski	Wojciech	Poland	IHAR-PIB
Mitura-Nowak	Karolina	Poland	IHAR-PIB