European Cooperative Programme for Plant Genetic Resources

ECP//GR

Report of a Working Group on *Avena*

Sixth Meeting, jointly held with the Final Meeting of project AGRI GEN RES 061 on "*Avena* Genetic Resources for Quality in Human Consumption" (AVEQ), 19-22 October 2010, Bucharest, Romania

C. Germeier, L. Maggioni, A. Katsiotis and E. Lipman

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Cover illustration
Avena sativa var. *tristis* "Ungarischer", probably an old Hungarian landrace – these types were popular at the end of the 19th century (accession from IPK: DEU146 AVE 3366) grown 2007 in the multiplication plots for the AVEQ project in Quedlinburg. Courtesy © C. Germeier, JKI, Quedlinburg, Germany.

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SUMMARY REPORT OF THE MEETING

Introduction

The sixth meeting of the Working Group on *Avena* of the European Programme for Plant Genetic Resources (ECPGR) was held on 21-22 October 2010 in Bucharest, Romania, at the Ministry of Agricultural and Rural Development. The meeting, jointly organized by the Vegetal Genetic Resources Bank of Suceava, Romania, the ECPGR Secretariat, Rome, Italy and the Federal Research Centre for Cultivated Plants – Julius Kühn-Institut (JKI), Quedlinburg, Germany, was jointly held with the final meeting (19-21 October) of the project of Council Regulation (EC) No. 870/2004, GEN RES 061 on "*Avena* Genetic Resources for Quality in Human Consumption" (AVEQ).

Daniela Giurca, General Director of the Agricultural Policy Department of the Romanian Ministry of Agricultural and Rural Development, opened the meeting and welcomed the participants on behalf of the local organizers.

Welcome addresses were also given by Olivier Diana on behalf of the European Commission (EC), Lorenzo Maggioni, ECPGR Coordinator, and Andreas Katsiotis, University of Athens, Greece, Chair of the *Avena* Working Group.

O. Diana (EC DG AGRI) briefly described the primary interests and instruments at European Union (EU) level for genetic resources work.

L. Maggioni noted that this was officially the sixth meeting of the ECPGR *Avena* Working Group (WG), while the fifth meeting dated back to 1998, when it was held in Lithuania. Nevertheless, the Group had had several opportunities for ad hoc meetings (e.g. meetings of the Cereals Network, the latest (third meeting) held in Foça, Turkey, 2008; the Seventh International Oat Conference, Helsinki, Finland, 2004). He expressed his appreciation for the complementarities of ECPGR as a network and discussion forum, and for the funding opportunities for implementation of work that were offered by the EC GEN RES programmes. In relation to this, the participation of O. Diana as a representative of the AGRI GEN RES Team was highly appreciated.

A. Katsiotis welcomed the Group and gave an outline of the agenda, with the first day mainly dedicated to presenting the results of the AVEQ project and the second day dedicated to ECPGR activities. Short introductions of the participants followed. The core *Avena* WG was reinforced and enlarged by the presence of experts among the AVEQ partners. Special thanks were due to Prof. Antonio Michele Stanca, former Director of the Genomic Research Centre of Fiorenzuola d'Arda, Italy, who volunteered to chair most of the sessions of the first day and to give an exciting introduction to the frost tolerance Work Package of the AVEQ project.

Part I. AVEQ project

Aurel-Florentin Badiu, Director of Research, Romanian Ministry of Agricultural and Rural Development, presented the activities of his Department and opened the meeting.

Overview of the AVEQ project, working collection and field work

Avena Genetic Resources for Quality in Human Consumption (AVEQ) – A European project on nutritional quality in oats

Christoph Germeier, AVEQ Project Coordinator, gave an overview of the project, introducing the unique qualities of oats for human health, as well as being a crop that is environmentally and agronomically friendly, even though unfortunately oat production is decreasing in all parts of the world. He explained the breeding aims for the development of technical quality traits (grain size, shape, colour, absence of hairiness and awns, groat content and dehulling efficiency) and the factors of nutritional quality (dietary fibre, anti-oxidants, fat, proteins and risks from mycotoxins). He then described the objectives of the project, including the characterization, evaluation and documentation of oat genetic resources, with the focus on relevant traits for the quality of oats for human consumption and for cold tolerance. The geographical distribution of field test sites and the project partners were listed. The working collection under evaluation finally consisted of 567 accessions of hexaploid cultivated oats, 46 accessions of *A. strigosa*, 5 accessions of *A. abyssinica* and 34 wild species accessions of different ploidy levels.

C. Germeier outlined the workplan including field experiments, quality assays and mycotoxin analyses. A specific aim of this project was to bring the expertise of highly specialized analytical labs together with the genetic resources community in order to evaluate traits of high relevance for human welfare. He concluded with some aspects of data management and open source software development in the project and introduced a few questions which were expected to be answered by the project results: How have complex quality traits been affected by breeding and development? Do we see tradeoffs between quantity (yield), technological and nutritional quality? Can we expect interesting variability for complex quality traits in European germplasm collections, and are they related to the structure of collections in terms of taxonomy and geographical provenance?

Field experiments for quality analysis – yields and technical quality

Danela Murariu (Suceava Genebank, Romania) presented the field experiments carried out to harvest samples for quality analysis. These experiments were performed in seven countries (Bulgaria, Estonia, France, Italy, Poland, Romania and Sweden) on plots of 2-2.5 m^2, with distance between rows of 12-17 cm and a density of 400 seeds/m^2. They were planted in an augmented design of 5 blocks including 11 standard cultivars. Cultivation techniques and plant protection followed local practices, which included manual sowing and harvest. Sixteen descriptors were observed in the field. Results were shown for 2009 experiments. Winter types were recognized by little or no heading in France, Poland and Romania (BGR001 A7BM0003; DEU146 AVE 846, AVE 1016, AVE1714; GBR011 00037, 01088, 01636; FRA040 19276; POL003 PL52107; RUS001 200111466)[1] but not consistently in all countries. Diseases observed were *Puccinia coronata* and *Erysiphe graminis* in Estonia, Italy and Poland; *Puccinia graminis* in Bulgaria, Estonia and Italy; *Fusarium* sp. in Estonia and Italy; and *Drechslera* sp. and *Septoria avenae* in Estonia and Romania. Analysis of variance was

[1] In this list and throughout the whole text, accessions are identified by the Institute Code according to FAO (e.g. BGR001), followed by Accession number (e.g. A7BM0003).

presented for harvest data (yield, seed weight, test weight (hectolitre weight) of the standard cultivars from four locations. Main effects (site, genotype) and interaction were highly significant (P<0.001); also highly significant were the deviations from normal distribution of residuals and homogenous variances. Cultivars 'Belinda' and 'Ivory' produced high yields in all locations (Estonia, France, Poland and Romania). Maximum yield, range and differentiation of standard cultivars were highest in Poland and lowest in Romania. Average yields of modern cultivar accessions were comparable; those of obsolete cultivars were lower, especially in the high-yielding situations of Estonia and Poland. The best modern and obsolete cultivars could out-yield the standards. Yields of *A. strigosa*, *A. abyssinica* and wild species were considerably lower at all sites. Maximum 1000-seed weight (49 g for 'Ivory'), range and differentiation for standard cultivars were found in Estonia. In Romania it was the lowest (35 g for 'Ivory'), but the remaining differentiation of the standards was more pronounced for this trait compared to yield. 'Ivory' again was the superior standard cultivar everywhere. Modern cultivar accessions were comparable to the standards, obsolete cultivars on average lower. Maximum seed weights were mostly comparable, while low minimum values were found in some obsolete cultivars. *A. strigosa* and *A. abyssinica* showed considerably lower 1000-seed weight (15-20 g on average). Seed weights of *A. sterilis* were relatively high, those of other wild species low. Test weight was highest in Estonia, second in France, third in Romania and lowest in Poland. Each difference between countries is statistically significant. Seeds without hull of hull-less cultivars ('Saul', 'Mina') result in higher test weight than hulled seeds. For the hulled cultivars differences were not very consistent across the sites. In France, Poland and Romania some obsolete cultivars were observed with higher test weight than the standard and modern cultivars. *A. abyssinica* and *A. strigosa* had on average lower test weights, but maximum values approached those of the hexaploid oats. For wild species this trait was not determined. Very different hull contents were found in different environments. On average it was lowest in the North (Estonia 33%) and highest in the South (Italy 54%).

Discussion

It was noted that different environments and farming conditions made the results not fully comparable, but the project wished to verify the results under several varying local conditions.

It was asked whether shedding in wild species had been a problem and D. Murariu confirmed that this was the case, but bags were used to prevent shedding and seed was harvested by hand.

Fusarium *in oat genetic resources*

Michele Stanca introduced the session with some remarks on the aim of breeding which is to design plants for the future in order to ensure the production of food for life. Breeding is currently moving from ideotype breeding to crop design breeding, and it is inspired by new approaches of phenotyping and genotyping, new breeding techniques and pyramiding of traits.

Background: *Fusarium* discussion at EU level

In a presentation introducing the *Fusarium* topic, Ole Winkelmann (Eurofins WEJ Contaminants, Germany) highlighted the background discussions on *Fusarium* mycotoxins at EU level. He introduced the different classes of toxins as trichothecenes Type A (T-2, HT-2) produced by *Fusarium poae, F. sporotrichioides* and *F. langsethiae*, trichothecenes Type B (deoxynivalenol, zearalenone) produced by *F. graminearum* and *F. culmorum,* and fumonisins

B1 and B2 produced by *F. verticilloides* and *F. proliferatum*. Trichothecenes T-2 and HT-2 are of major concern, especially in oats. They are more toxic than the well-known Type B trichothecenes. According to Regulation (EC) No. 1881/2006 no maximum limits have been set for these toxins. It has been noted that more data and an agreed reference method are still needed.

Fungal species which seem to be the main toxin-producers in Europe were identified as *Fusarium langsethiae* and *F. sporotrichioides*.

With regard to infections of commodities, risky cereals are mainly oats, but also barley, wheat and maize. Range and type of contamination mainly depend on climatic conditions during the growth period. Raw oats are frequently highly contaminated by T-2/HT-2, but the main relevance with regard to toxin contamination is connected with the outer parts (hull). Dehulling and sorting of oats can reduce the amount of T-2/HT-2 contamination by up to 90%. High levels of T-2/HT-2 are frequently found in by-products that are used as feed ingredients. Oats for direct human consumption are usually cleaned and dehulled, therefore the level of contamination to be monitored is very different from that at the screening of raw materials. However, a possible limit at EU level will apply to unprocessed cereals.

Rapid and cheap validated enzyme-linked immunosorbent assay (ELISA) test kits are available, but most of them determine only T-2, while determination of the sum of both toxins is needed. High-performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS) can detect several toxins in one run but it is an expensive and time-consuming method. There is no agreement on analytical methods. For the AVEQ project, simultaneous determinations were made of T-2, HT-2 and other contaminants by HPLC-MS/MS, in comparison with ELISA results.

Fusarium inoculation and field experiments with *Fusarium* on oats

Matthias Herrmann (JKI, Germany) continued with a presentation on inoculum production and field experiments with artificial inoculation as part of Work Package (WP) 04 of the AVEQ project. Objectives of this WP were the field evaluation for resistance against *Fusarium* infection and mycotoxin contamination, and the relationship with agronomic traits under different environmental conditions across Europe. This evaluation was carried out for 350 accessions in 2008 and for 334 accessions in 2009, including wild species accessions in both years. They were grown in augmented designs, with 11 standard cultivars in 5 replications (augmented blocks) and spring wheat 'Aranka' for comparison. A control experiment without inoculation was set up with the standard cultivars in two replications. The environmental and agronomic conditions were very different at the sites in Groß Lüsewitz (Northern Germany), Kroměříž (Czech Republic), Suceava (Romania) and Fiorenzuola d'Arda (Italy). At the latter site, no artificial inoculation was carried out; only natural infestation was observed. The highly diverse material showed wide variation in agronomic traits. Correlations between sites were relatively high for highly heritable traits such as plant height and heading date. Considerable correlations were also observed for yield between Groß Lüsewitz, Kroměříž and Fiorenzuola d'Arda in 2008. Suceava and Fiorenzuola d'Arda in 2009 showed more differences in yields. A mixture of *Fusarium* species (*F. culmorum*, *F. sporotrichioides*, *F. avenaceum*, *F. langsethiae* and *F. graminearum*) was used for inoculation in most experiments. Kroměříž in 2008 used only an *F. culmorum* strain, which is known to be very aggressive in wheat. This strain was integrated into the inoculum mix used in 2009 in all experiments and replaced a strain which had not proved to be very aggressive. The inoculum was multiplied on autoclaved wheat (*F. culmorum*) or oat seed (all other species). The isolates were characterized for their mycotoxin production. It was confirmed that the inoculum contained high level producers of zearalenone, T-2 and HT-2. For the isolates multiplied for inoculation a species-specific quantitative polymerase chain reaction (QPCR)

assay was designed. Inoculation was done by spraying spore suspensions for three days during flowering of the crop. Visible symptoms in the field were not generally observed, except in 2008 in Suceava, Romania, after extremely disease-conducive weather conditions. Visual scoring of damaged kernels gave only limited results. Higher infection rates could be detected with a freezing blotter test used in Groß Lüsewitz. Comparing freezing blotter results and visual scores showed an overestimation of the infection of naked seeds compared to hulled seeds by visual scoring. Obviously symptoms are more easily detected on naked seeds. Correlations of symptoms with agronomic traits were low.

In conclusion, experimental screening for resistance to *Fusarium* among more than 600 accessions displayed genetic variability for resistance to kernel infection. The level of infection was lower in oats than in wheat. Influences of environmental conditions and genotype x environment interactions indicated that resistance testing for *Fusarium* needs more replications and environments. Low coefficients of correlation were registered between plant height, heading time, panicle length, plot density, lodging or other traits and *Fusarium* infection. Visible symptoms in the field or on seeds were not reliable methods of assay and it was concluded that mycotoxins need to be analytically determined to assess resistance to *Fusarium*.

Analysis of *Fusarium* on oat samples – methodology and results

Ivana Polisenska (Agrotest Fyto, Czech Republic) presented the results of *Fusarium* and mycotoxin analysis in the samples derived from the field experiments. Target toxins analysed were mainly those of primary concern at EU level and considered by Regulation EC 1881/2006, as outlined by O. Winkelmann. The bulk of samples, 100 inoculated accessions from each of three locations (Czech Republic, Germany and Romania) and 100 non-inoculated accessions from one location (Italy) were analysed with ELISA tests with a level of detection (LOD) of 20 ppb for deoxynivalenol (DON) and of 5 ppb for T-2. These were complemented with HPLC-MS/MS analysis detecting simultaneously T-2, HT-2, DON, zearalenone (ZON), nivalenol (NIV), 3-acetyl-deoxynivalenol (3-ADON), 15-acetyl-deoxynivalenol (15-ADON) and diacetoxyscirpenol (DAS), carried out by Eurofins WEJ Contaminants GmbH on inoculated and non-inoculated standard cultivars from all locations, to confirm ELISA results and add information on HT-2 and other mycotoxins. Further comparative analyses were made to harmonize the results from different labs and *Fusarium* species were determined by PCR. According to Regulation EC 1881/2006, analysis needs to be done with unprocessed (= not dehulled) material. This favours the detection of mycotoxins, which are mainly present in the outer part of kernels and in the hulls. In 2008 results for DON were high (up to 4000 µg/kg) in the Czech field experiment, while in the German and Romanian field experiments the limit of 1750 µg/kg was never reached. This was probably due to the use of a highly aggressive *F. culmorum* isolate in Czech Republic, which was added to the inoculum for all experiments in 2009. T-2 was higher in the Czech and Romanian experiments (up to 400 µg/kg and 350 µg/kg, respectively) and lower in the German field experiment (up to 200 µg/kg). Accessions with comparably low mycotoxin contents at all three inoculated locations were 'Rauhhafer aus Neustadt', an *A. strigosa* variety; 'Samuel', a modern German naked oat; 'Atego', 'Miku' and 'Typhon', modern varieties from the Czech Republic, Estonia and Germany respectively; 'Joanette', an old French cultivar, and 'Garton Supreme', an old British cultivar (bot. variety *pugnax*).

Valeria Terzi (Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Centro di ricerca per la genomica e la postgenomica animale e vegetale (CRA-GPG), Italy) presented results on *Fusarium* DNA traceability as a diagnostic tool in small grain cereals, which is used to complement mycotoxin results with data on *Fusarium* species representation in the oat

accessions. It is based on wide genomic information available for *Fusarium* species (see the *Fusarium* Comparative Database, http://www.broadinstitute.org/annotation/genome/fusarium_graminearum/). A number of PCR assays were selected according to their sensitivity to the strains used for inoculation in AVEQ. These were applied to inoculated and non-inoculated standard cultivars. Correlations were found between DON and *F. culmorum* and *F. graminearum* (0.75-0.84), between T-2 and *F. langsethiae* (0.53), between T-2 and *F. avenaceum* (0.43-0.53) and between T-2 and *F. sporotrichioides* (0.30-0.44). Negative correlations were found between DON and the T-2 producers (-0.17 to -0.49), but not between T-2 and the DON producers, indicating higher competitiveness of T-2 producers, especially *F. langsethiae*. These relationships were similar for artificial or natural infestation. Low values for all species were found in naked oats ('Saul', 'Mina'), while high values were found particularly in cultivars 'Argentina' and 'Evora'. While in the oat samples all *Fusarium* species were equally represented, representation in the wheat 'Aranka' was highly biased to *F. culmorum* and *F. graminearum*, which resulted in low T-2, but high DON contamination. PCR results also showed the presence of *F. poae*, with higher presence in inoculated compared to non-inoculated samples. The possibility of diagnosis of *Fusarium* in the field at a very early plant growth stage was confirmed. Further applications of the PCR methodology were indicated for better understanding of the dynamics of infection, sensitive growth stages, *Fusarium* traceability in agro-food chains, early determination and monitoring.

Discussion

It was remarked that the toxic effect of the mycotoxins was the inhibition of protein production, resulting in skin problems, tooth problems and many others. It was pointed out that it would make sense to set different rules for raw vs. dehulled seeds and that discussion in this direction was ongoing at EU level.

No explanation could be given for the increase of the mycotoxin problem, even though this is a rather new problem for oats and not for wheat and barley and it is weather-dependent. It was remarked that several *Fusarium* species are mainly seed-borne, which explains the low correlation with agronomic traits assumed to be of importance. Other *Fusarium* species come from infected crop debris, especially of maize. These are promoted by reduced soil tillage and higher frequency of maize cropping. Another point of interest was the performance of marginally cultivated and wild species. The wild species are currently being analysed. Resistance is considered to be under quantitative trait locus (QTL) control. *A. strigosa* ('Rauhhafer aus Neustadt') was found to be among the most resistant genotypes but not more resistant than the best hexaploid oats, which include some modern cultivars.

Thanks to early molecular detection, it will soon be possible to monitor the health of grain fields for that particular disease during the season and to monitor the use of fungicides.

Nutritional quality of oats

Background

The session on oat nutritional quality was introduced by Lena Dimberg (Swedish University of Agricultural Sciences, SLU). The health benefits of oats relate to a metabolic syndrome caused by oxidative stress, high triglyceride acid and cholesterol levels and obesity, in turn related to fat cells, insulin resistance and glucose/insulin imbalance. These "western diseases" risk factors lead to chronic inflammation, hypertension, diabetes Type II and coronary vascular diseases. Oats, besides starch and energy, have high contents of vitamins (B and E), minerals, a high protein content of the globulin type with well-balanced amino-acid composition, sufficient lysin and no gluten, a high lipid content with 80% of unsaturated fatty acids, which decrease LDL-cholesterol and increase HDL-cholesterol, a high content of

dietary fibre and high content of bioactive phytochemicals. The high content of soluble β-glucan within the dietary fibre is unique for oats and barley. While lipids are spread all over the kernel including the endosperm, vitamins, anti-oxidants and β-glucan are mainly in the aleurone and subaleurone layers. The health effects due to β-glucan have been considered the most important. They are related to its viscosity and are thought to work as follows: weight control against obesity is achieved through the encapsulation of fat and sugar resulting in less energy supply, bulky filling of the intestine and feelings of satiety, inhibited constipation and low glycemic index. Further effects are the improved glucose/insulin balance by lower absorption of glucose, improved insulin sensitivity and decreased blood cholesterol level by excretion of bile acids. Forming a dietary complex with attached bioactive components like anti-oxidants, the β-glucan may also decrease the development of colon cancer by dilution and binding of carcinogenic agents and decreasing pH. On the other hand it may cause energy and nutrient deficiencies, dehydration and gas production, which is of major concern in animal feeding. Oxidative stress is caused by a surplus of free radicals. They destroy the arterial wall and induce repair mechanisms by cell proliferation, migration, accumulation and attachment, finally leading to plaque formation and the danger of infarct (heart attack). Anti-oxidants in oats such as tocopherols, tocotrienols, hydroxycinnamic acids and avenanthramides protect from free radicals. Avenanthramides are anti-oxidative substances unique to oats. They were recently discovered. Thirteen different types are known. They have anti-oxidant, anti-inflammatory, anti-arteriosclerotic and anti-cancer effects, acting chemically as hydrogen donors, radical scavengers, metal ion chelators and lipogenase inhibitors, thereby inhibiting LDL oxidation and formation of pro-inflammatory compounds. Because of these anti-inflammatory effects, oats have long been used for skin disorders and in anti-ageing treatments. Anti-arteriosclerotic effects are assumed from inhibited proliferation of vascular smooth muscle cells, decreased cell adhesion and reduced release of adhesion molecules. This is also indicated by the similarity of avenanthramides to Tranilast metabolites. Tranilast is an anti-allergic and anti-proliferative drug. Anti-cancer effects are also assumed from inhibited cell proliferation. In summary, oats decrease the risk of the metabolic syndrome probably thanks to a dietary complex of soluble β-glucan and bioactive compounds.

Analysis for protein, fat and minerals

Jean Koenig (Institut National de la Recherche Agronomique (INRA), France) presented the status of WP 06 on protein and oil contents, micronutrients and avenins. Near Infrared Spectra analysis (NIRS) and calibration analysis are still ongoing, as well as micronutrient analysis. Results were presented for avenin patterns. Avenins are storage proteins similar to glutenins and their polymorphism can be used by acid polyacrylamide gel electrophoresis (PAGE) for the analysis of relationships between *Avena* genotypes. Three loci have been described: *Ave1* with 5 alleles related to the A genome, *Ave2* with 6 alleles (B genome) and *Ave3* with 10 alleles (D-genome). The avenin analysis revealed heterogeneity in 22.4% of the accessions used in AVEQ. The loci were represented with different frequency. Nearly 30% of the accessions had alleles of all three loci. Different alleles were unevenly distributed, with one or two alleles dominating with 30-50% frequency.

Analysis for fibre and β-glucan

Rita Redaelli (Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Unita di Ricerca per la Maiscoltura (CRA-MAC), Italy) presented results of β-glucan and fibre analysis. For three sites representing the whole range of Europe from North to South (Estonia, Poland, Bulgaria samples from 2008; Sweden, France, Romania samples from 2009), quality analyses were performed comprising total β-glucan analysis for all samples and soluble β-glucan,

fibre, starch and anti-oxidants for a selected set of 70 samples (in total 210 analyses). The harvest material from 2008 contained 247-259 accessions (depending on availability of sufficient harvest material for analysis) and 55 standard samples. Seventy accessions were selected for a diversity analysis based on NIRS data from one site provided by WP 06. All species available were represented. The selected sample set contained 59 hexaploid oats, 5 *A. strigosa* accessions, 1 accession of *A. abyssinica* and 1 accession each of the wild species *A. barbata*, *A. damascena*, *A. fatua*, *A. hirtula*, *A. sterilis* and *A. wiestii*. Data from Bulgarian and Estonian samples were presented. To include replicated standards into the analysis set the number of accessions was reduced to 59. Standard methodology was used to determine total, insoluble and soluble fractions of β-glucan. Results showed ranges of 2.36–5.36% dry matter (dm) total and 1.17–4.25% (dm) soluble β-glucan. The soluble fraction represents 47.6–82.4% of total β-glucan in samples of cultivated species from Estonia and Bulgaria. Genotype effects and the interaction of genotype x location were significant at 0.01 probability level, location effects only at 0.05 level. Wild species from the Estonian and Polish field experiments were in a similar range. Extraordinary high levels were found in *A. wiestii* (AVE 2781: 6.76% total and 5.23% soluble β-glucan) and in *A. damascena* (PL 52345: 6.77% total and 5.29% soluble β-glucan). Standard cultivars ranged from 2.92% ('Ivory') to 4.44% ('Auteuil') total β-glucan. 'Belinda' (4.08%) and the naked cultivar 'Mina' (4.38%) were comparably high. Results are being used for a NIRS calibration on β-glucan. Predictability of β-glucan by NIRS is still low.

Danuta Boros (Plant Breeding and Acclimatization Institute (IHAR), Poland) presented further results on carbohydrates: starch detected with the amylase methods (ICC Standards No. 128/1 and 168) and dietary fibre analysed with the Uppsala method (AOAC 994.13), a combination of methods for non-starch polysaccharides (NPS), uronic acid and Klason lignin. Results were presented for 60 samples of cultivated oats from Bulgarian and Estonian field experiments, 53 additional samples of standard cultivars grown in Estonia, 2 wild accession samples from Estonia and 6 from Poland. Starch content ranged from 49 to 65%, total dietary fibre from 9 to 18%. The largest amount of total dietary fibre is NPS, followed by a variable amount of lignin, possibly caused by insufficient dehulling and a very small fraction of uronic acids. The NPS form the dietary fibre. Its hemicellulosic fraction is formed to the extent of about 50% by β-glucan. High contents of total dietary fibre (NPS>10%) were observed (i) in the Bulgarian experiment for old cultivars or landraces from Poland ('Pulawski Sredniorychly' POL001 PL 50406), France ('Noire Semi Nuda Orientalis' FRA040 19300), Czech Republic ('Irbit' CZE047 03C0700006), and for 'Jaugila', a modern Lithuanian cultivar (LTU001 25); (ii) in the Estonian experiment for *A. barbata, A. sterilis* and *A. hybrida* (DEU 146 AVE 586, AVE 446 and AVE 1426 respectively) and for AVE 544 (*A. sativa* var. *macrantha* from Greece). All wild species samples from Poland (AVE 1426, AVE 1758, AVE 2671, AVE 2804, AVE 2781 and PL 52345) contained more than 10% NPS, the highest contents were found again for AVE 2781 (*A. wiestii*) and PL 52345 (*A. damascena*) already mentioned in relation to β-glucan. They have around 15% NPS and around 20% total dietary fibre. The starch content was reduced to 41–44% in these samples. Starch contents in standard cultivars ranged from 57 to 63%, both extremes represented by naked oats ('Mina' and 'Saul' respectively).

Analysis for anti-oxidants and avenanthramides

Lena Dimberg (SLU, Sweden) presented results on avenanthramides in *Avena* genetic resources. Samples to be analysed were the same 70 accessions as those selected for carbohydrate and fibre analyses. Avenanthramides were found in all samples. In samples from the Bulgarian field experiment contents ranged from 90 to 3870 mg/kg. Highest contents – higher than ever seen by L. Dimberg (from 6000 to 13 000 nmol/g = 3870 mg/kg),

were expressed by four accessions of *A. strigosa*. A fifth *A. strigosa* accession gave results within the bulk of accessions but was still among those with relatively high contents. Twenty modern oat cultivars ranged from 337 to 4947 nmol/g and on average were not significantly different from 36 obsolete cultivar accessions (313–3013 nmol/g). Significant negative correlations (-0.34 to -0.43) were found between avenanthramides, yield, seed and test weights. No significant correlations were observed between avenanthramides and husk content and other chemical quality traits (starch, β-glucan, preliminary protein and fat data based on a standard calibration at partner P02 (Svalöf Weibull AB). Avenanthramide contents for most of the analysed wild species accessions were comparably high (*A. fatua*: 1119 and 600, *A. hybrida* 894, *A. sterilis* 860, *A. wiestii* 674, *A. damascena* 640 mg/kg), while another *A. fatua* and an *A. barbata* accession showed comparably low contents (244 and 171 mg/kg respectively). Estonian samples showed lower extremes but confirmed high contents for two *A. strigosa* accessions. High variability between years can be expected from earlier results, which have been produced in Sweden with various oat cultivars, but at much lower levels (5-150 mg/kg). It is known that avenanthramides play a role as phytoalexins in crown rust resistance. Thus it was considered interesting to compare non-inoculated and inoculated standard samples from the *Fusarium* experiments. On average significantly higher content could be found in inoculated compared to non-inoculated plots. The range was different for the different cultivars. Generally high content of avenanthramides (in inoculated and non-inoculated plots) were found in cultivars 'Argentina' and 'Evora' for which PCR results had shown high presence of *Fusarium* species. The highest response to inoculation was shown by 'Saul', one of the naked oat cultivars for which PCR showed low presence of *Fusarium* species. This indicates some relation between avenanthramides and interaction with *Fusarium*, but not a simple one. Consequently no consistent or significant correlation between avenanthramides and DON contamination could be found.

Rita Redaelli (CRA-MAC, Italy) concluded the session on nutritional quality with results on tocols. Like avenanthramides, these are anti-oxidant agents and considered to be Vitamin E. The method of analysis used is an accelerated procedure of normal-phase high-performance liquid chromatography (NP-HPLC) developed at CRA-MAC in 2004. Four different types of tocopherols and tocotrienols were determined. Accessions from Bulgaria and Estonia were analysed and higher contents of tocopherols and tocotrienols than expected were found, higher in Bulgarian samples than in Estonian samples. Among the wild accessions, high quantities were found in *A. barbata* and *A. strigosa*.

Discussion

With regard to β-glucan in chicken feeding, the comparison was made with barley, which contains 8-10% β-glucan and resistant starch (waxy mutants not attacked by amylases). High β-glucan or highly resistant starch mutants that could reduce the glycemic index are not known in *Avena*, but it should be possible to find them.

Regarding tocols, it was remarked that the γ-tocoferols would be of highest nutritional value, but *Avena* does not contain them, since it has the same tocols as wheat.

Cold tolerance in oat genetic resources

Background: Cold tolerance in oats – state of the art

Session four on frost tolerance was introduced by Michele Stanca (Department of Agricultural and Food Sciences, University of Modena and Reggio Emilia, Italy) with a presentation on improvement of cold tolerance in oats to design the plant for the future.

Winter hardiness is a complex of many quantitative traits including frost resistance, vernalization requirement and photoperiod reaction. To increase grain yield, oats should be shifted from spring to winter types. About 30% yield increase is expected from winter oats, but in 90% of the growing region winter oats are damaged by frost stress. Until now field selection has been dominated by breeding spring oats. Fast physiological tests have been recently developed. Techniques available for use are germplasm evaluation, updated agronomic techniques, traditional breeding integrated with physiological tests, analysis of phenotypic and genotypic responses with the aid of marker-assisted selection, plant transformation and molecular dissection of stress traits. An incremental association mapping approach of different population types (cultivars, landraces and wild types) was explained. Several physiological agents are involved in cold tolerance, e.g. osmoprotection by glycine betaine, mannitol, trehalose, proline or fructane. The plants can protect themselves from a cold stress by eliciting a very fast molecular reaction. This consists in an activation of molecular mechanisms (signal perception and transduction), identification of gene products (transcription) and gene expression (production and accumulation of stress-related molecules – functional and regulatory proteins). Plant breeding for stress resistance uses physiological tests that can simulate the stress event, together with molecular markers associated to resistance traits. Dehydration is a common factor of drought and cold stress and an electrolyte test can detect membrane disruption. The chloroplast with chlorophyll–xanthophyll is the first transmitter of events in plants. A rapid, reliable, sensitive and non-destructive photosystem test has been developed, based on chlorophyll fluorescence during hardening (4 weeks at 1-3°C) and after freezing. It can be shown that during acclimatization new proteins are formed and allocated to different parts of the plant. These processes can be followed also with expressed sequence tag (EST) sequences from cold-acclimatized oat – 9792 sequences have been described, about 450 of these are specific to oats. Fifty-one transcription and four core binding factors (CBF) regulated by cold acclimatization are considered of special importance. Oats CBF and barley CBF correspond and synteny has also been found in *Triticum monococcum* and bread wheat. An oat biochip (microarray technique) is now available and revealed 400 simple sequence repeat (SSR) markers. During acclimatization 1500 genes are activated, most of which are located in the chloroplast. Based on this knowledge, numerous new breeding approaches can be used in order to create the plant for the future through pyramiding of appropriate transcriptional factors. De novo recombination, dynamization of the genome by transposons and methylation, gene expression regulation, transcriptional factors and useful gene functions up to artificial chromosomes and micro-RNA techniques could be used.

Cold tolerance in field experiments

Nadeshda Antonova (Institute for Plant Genetic Resources "K. Malkov" (IPGR), Bulgaria) presented field results on frost tolerance in the AVEQ project. Field experiments were set up in Bulgaria and Italy in winters 2008-09 and 2009-10 with 11 standards and 317 and 309 accessions, respectively (excluding wild species). In Italy the 2008-09 experiment was repeated in 2009-10 because of unfavourable weather conditions in the first year. However, in the second year also, conditions in Italy were not severe enough to select frost-tolerant accessions. Romania then offered to set up additional experiments with selected accessions (104 in 2009-10). While in Sadovo, Bulgaria, average temperatures during winter months remain close to 0°C, they can be lower than -5°C on average with minimum temperatures below -30°C in Suceava, Romania (2009-10). Only a few plants of most accessions survived these conditions. The most frost-tolerant accessions were a local type from Iceland (RUS001 200113379: 25 plants survived out of 50), a breeding line from Bulgaria (BGR001 A7BM0005: 17), some modern cultivars from United Kingdom ('Millenium': 11) and Italy ('Donata': 9 and 'Ava': 8, the standards 'Genziana': 5 and 'Argentina': 4), an *A. strigosa* accession

(BGR001 BGR 7982: 7) and a Hungarian cultivar ('Gagybatory K Tajfajta': 6 survivors). The two different methods that were used to score accessions in the Bulgarian field gave contradictory results, comparing years 2008-09 and 2009-10. Autumn 2008-09 was very dry in Bulgaria. It allowed no hardening and, in addition, deep snow cover during January distressed the plants, resulting in high damage and mortality for the majority of accessions (ca. 180). In winter 2009-10 most accessions were only slightly to moderately damaged. During January 2010, the radiation temperature in Sadovo went down to -21°C, causing sensitive leaf damage. Correlation of the two types of scores was low in 2008-09 and high in 2009-10. Accessions slightly to moderately damaged according to both scores in Bulgaria in 2008-09 were the Bulgarian breeding line 'Ava' and the *A. strigosa* accession, confirming the results from Romania, along with a cultivar from Moldova ('Chernosemyannyi'). In 2009-10 they included Bulgarian winter cultivars 'Dulo' and 'Kaloian' and breeding lines, along with some accessions from the John Innes Centre (UK) ('Feltwell', 'Penrhyn', 'Beljska 200' and 'Luilbreg' from Yugoslavia). Negative correlations were found between cold tolerance and number of panicles and days to heading.

Cold tolerance evaluation by chlorophyll fluorescence measurements

Fulvia Rizza (CRA-GPG, Italy) presented results from the laboratory tests for frost tolerance. The test is associated with a hardening process at low non-frost temperatures. During the test, a hardening treatment at 1-3°C is applied over three weeks. Hardened plants are subject to freezing at -10 to -13°C. The tests consist in measurements of chlorophyll fluorescence, which responds to changes in PSII photochemistry and therefore represents a convenient and rapid tool to evaluate the functioning of the photosynthetic machinery at low temperature. About 100 accessions were tested in 2008 and 2009. The most tolerant accessions in the first set were a Romanian breeding line, a local type from Iceland, and cultivars 'Donata', 'Gagybatory K Tajfajta' and 'Millenium', confirming the above-mentioned field results and, additionally, cultivars 'Kinelskjj', 'Vendelin', 'Lüneburger Kley Neue Zucht', 'Novella Antonia' and local types from Russia and Greece (RUS001 200107910 and 200111655). Correlations were significant (0.447**) with field results under severe frost conditions in Romania, lower with results in Bulgaria under less severe conditions (0.224*) scored by the methodology suggested by Rizza et al. (2001)[2] and not significant with results of the traditional IBPGR (1985)[3] scoring method. In the second set, Bulgarian cultivars ('Dulo' and 'Kaloian'), breeding lines (A7BM006, BGR 24983), 'Beljska 200' and 'Luilbreg', and the standard cultivar 'Argentina' were confirmed to be frost-tolerant. Additionally, 'Cimarron', 'Evora', 'Kulsovati B' and 'La Gaillarde' were identified as frost-tolerant. Correlation with the Bulgarian field data was higher (0.476**) than in the previous year.

[2] Rizza F, Pagani D, Stanca AM, Cattivelli L 2001. Use of chlorophyll fluorescence to evaluate the cold acclimation and freezing tolerance of winter and spring oats. Plant Breeding 120:389-396.

[3] IBPGR. 1985. Oat descriptors. International Board for Plant Genetic Resources, Rome, Italy.

Part II. ECPGR

ECPGR activities

Avena Working Group: Chairperson's report

The session was opened by Andreas Katsiotis, presenting the Chairperson's report. He explained that the activities in the *Avena* Working Group were largely determined by the EU GEN RES projects AVEQ and AEGRO.[4] Jointly with the latter project, prospection and collecting trips to Cyprus, Italy and Spain were organized. A further collecting trip to Spain had been funded by ECPGR in 2007. The priorities, as set at the *Avena* WG session during the Cereals Network meeting in Foça, Turkey (2008)[5], were: 1. Task sharing and capacity building, especially regarding the status of wild species accessions in genebanks and procedures for their regeneration; 2. Characterization and evaluation as carried out in the framework of the AVEQ project; 3. Generation of information to support *in situ* conservation as done in the AEGRO project; 4. Documentation.

Update on ECPGR

Lorenzo Maggioni continued with an update on ECPGR. The Programme is currently in its Phase VIII (2009-2013), with a budget of €2.76 million, of which the Network operations funds (€1.46 million) should be used for meetings (75%) or actions (25%). It is currently owned by 43 member countries contributing funds, implementing activities and coordinating national programmes within their countries. Two new Working Groups have been founded within the *In situ* and On-farm Conservation Network, making up a total of 20 Working Groups. A new publication strategy has been decided: meeting reports as books with articles are no longer printed. They are now presented as electronic documents containing the minutes. There will be no interference in the management of Networks' workplans, including prioritizing or not prioritizing Working Groups.

L. Maggioni further reported on the Independent External Review of ECPGR, which was completed in July 2010. The Review Panel consisted of Thomas Gass, Marianne Lefort and Orlando de Ponti. The Review resulted in 25 recommendations, which were distributed to all National Coordinators. Main recommendations were as follows: objectives should be more accountable; ECPGR should become a legal entity; an executive committee with a president, two vice-presidents and an executive director should be established; the perceived duplication and competition between the European Plant Genetic Resources Catalogue (or European Internet Search Catalogue, EURISCO) and the Central Crop Databases (CCDBs) should be resolved; characterization and evaluation (C&E) data should be included in EURISCO; *in situ* and on-farm activities should be integrated into AEGIS. Triggered by the External Review, the mid-term Steering Committee meeting will be advanced to December 2010 to agree on a transition roadmap.

L. Maggioni concluded his presentation with an update on EURISCO, which is developed by Bioversity International on behalf of the ECPGR. EURISCO currently contains passport data on more than one million accessions from 41 countries, including 34 069 *Avena* accessions. As a service to the International Treaty, EURISCO registers accessions for the multilateral system (MLS) and for standard material transfer agreement (SMTA) reporting

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4 AEGRO: An Integrated European In Situ Management Workplan: Implementing Genetic Reserves and On Farm Concepts (http://aegro.bafz.de/index.php?id=95)

5 http://www.ecpgr.cgiar.org/publications/publication/issue/report_of_a_cereals_network-1.html

(currently 210 755 accessions). He presented a picture of a global infrastructure with the global information system according to Art. 17 of the International Treaty (http://www.genesys-pgr.org/), including the System-wide Information Network for Genetic Resources (SINGER) of the Consultative Group on International Agricultural Research, EURISCO and the Germplasm Resources Information Network (GRIN, USA) covering information at regional level, and the National Inventories providing national level information, as a compilation of institutional databases. The CCDBs were not mentioned in this picture.

L. Maggioni also mentioned the concept developed by the ECPGR Documentation and Information Network of including C&E data into EURISCO, to provide information on experiment, trait, genotype and a score.

The available budget of the Cereals Network, to which the *Avena* WG belongs, is €104 725 (90 500 for meetings). Further meetings of relevance for the *Avena* WG will be one meeting on capacity building for conservation of precise genetic stocks, and an AEGIS meeting for *Avena*.

Future perspectives for genetic resources work in the framework of EU programmes

Olivier Diana (DG Agriculture and Rural Development, European Commission) continued with a presentation on the EU policy context and perspectives for plant genetic resources conservation and use. He mentioned the Göteborg declaration (2001) and the Biodiversity Action Plan (2006), which aimed to halt loss of biodiversity until 2010. This aim was not achieved. A new EU Biodiversity Strategy (2010) is now under construction. In the field of genetic resources a main focus in future will be on climate change. A principle of the engagement by the EC is co-funding. For genetic resources as part of the Biodiversity Action Plan, policies on agriculture, environment, regions, development, research technology development, and plant health legislation are relevant. The two GEN RES community programmes have been recognized as the most relevant up to now. It will be important to integrate agricultural and research policies. According to land use statistics, agriculture is of high importance for biodiversity in Europe. Major threats are intensification and marginalization (land abandonment). The Environmental Integration Strategy (1999) aims at integrating environment policy into the Community Agricultural Policy (CAP). Pillar I of the CAP (market and income policy) demands respect of basic requirements (cross compliance) while Pillar II of the CAP (Rural Development Policy 2007-2013, €42.5 billion available for Axis 2 on Environment and Land management) encourages the provision of environmental public goods by incentive measures. Challenges for CAP post-2013 will be food security (including food quality), ecosystem services, development in rural areas and monitoring indicators.

O. Diana recommended a better use of opportunities given by Rural Development Regulation 1974/2006 (cf. Articles 39(1), 39(4), Article 27(4)) and Regulation 1638/2005 (Articles 39(5), 28 (3)). These opportunities can allow for operating at national and regional levels. Examples of successful use were mentioned for Italy (Sicily), Hungary and Portugal. Proposals are submitted to the Rural Development Network via a National Contact Point. Another option would be to apply to the Seventh Framework Programme (FP7) for research activities. Several plant projects have already been successful: Solibam ("Strategies for organic and low-input integrated breeding and management" in wheat, barley, maize and vegetables) supported with €6 million, PGRSecure ("Novel characterisation of crop wild relative and landrace resources") supported with €3 million, and Fruit Breedomics (€6 million). An option, especially for database development, would be to apply to the FP7 programme to improve infrastructure capacities. Life+ as a funding instrument for the environment could also be an option. Another field of importance for genetic resources is the

legislation on marketing of conservation varieties by Commission Directives 2008/62/EC, 2009/145/EC and 2010/60/EC. There is an ongoing impact assessment until the end of 2010 for a review of this legislation. Finally, O. Diana made some comments on the GEN RES programme, which had 17 plant and 4 animal projects in the first programme co-funded with €9 million, 12 plant and 5 animal projects in the second programme with €10 million. The aim is also to develop synergies between the different actions and to improve communication between the scientific community and national authorities (e.g. in the GEN RES Committee meetings). After closure of the 17 actions and an evaluation by independent experts, it will be a political decision, whether a third programme will be set up. In future more emphasis should be focussed on the analysis of diversity at plant, crop and agro-ecosystem levels, phenotypic and genotypic characterization, conservation and documentation, links with breeding activities, awareness and communication policies.

Discussion

G. Ladizinsky asked which programme would be appropriate for protecting an agro-ecosystem in favour of *A. murphyi* in Spain. O. Diana responded that this would be possible through the Rural Development Programme. The first step would be to access the national Ministry in charge of the Rural Development Programme. Of course this issue could compete with other issues as the total budget for rural development is limited for each country.

Avena *collection and wild species issues*

An account of the *in situ* AEGRO project: Wild species prospection in Cyprus, Sicily and Spain

Andreas Katsiotis gave an overview of the *in situ* AEGRO project, which included prospecting for wild species in Cyprus, Sicily and Spain. The crop case study for *Avena* in AEGRO has to prioritize species and populations, to identify sites suited for the establishment of genetic reserves and to develop guidelines for management and monitoring of genetic reserves. The methodology used was taxon delineation, selection of target taxa, ecogeographic diversity analysis and selection of target sites.

Species prioritization was based on actual or potential use, considering the genepool concept, and on threat or distribution. Species within the primary genepool are common weeds (*A. sterilis*, *A. fatua*) and are not considered under threat. Thus species were selected from the secondary (*A. murphyi*, *A. insularis*) and tertiary (*A. hirtula*, *A. longiglumis*, *A. prostrata*, *A. ventricosa*) genepools. *A. ventricosa* is considered to be the donor of the C genome of cultivated oats. The relationships of these species were shown using molecular markers. They are distributed over the South European and North African Mediterranean.

Sites selected for prospection were: (i) Cyprus and Crete, where it was expected to find *A. ventricosa* and *A. hirtula*; (ii) Sicily, where *A. insularis* was expected; (iii) South East Spain for *A. prostrata* and (iv) South West Spain (Andalucia) for *A. murphyi*, *A. longiglumis* and *A. hirtula*.

In Cyprus *A. hirtula* and *A. ventricosa*, together with *A. eriantha* were found in areas protected in the Natura 2000 framework or by the Forestry Department. In Sicily the Lago Columelli district, where *A. insularis* is found, is now protected by the Forestry Department. In Andalucia *A. murphyi* was found in meadows, mostly as a few plants at the edges of the fields. In one field *A. murphyi* was abundant. It was found that the farmer deliberately brings his cows there only after June to protect this species, which he considers valuable for the nutrition of his animals. *A. longiglumis* and *A. hirtula* were found in the National Park of Donana.

Discussion

G. Ladizinsky commented that *in situ* conservation is the best way to go, but many sites are needed to conserve all the genetic diversity. In Cyprus an ideal situation was found, with the presence of *A. ventricosa* in different protected ecosystems. The situation is different in the other countries, where there is lack of awareness. In Sicily, pine trees were planted at the *A. insularis* site; this will result in the loss of the *A. insularis* habitat. The situation is even worse in Spain, where *A. murphyi* has vanished, except for plots in hilly areas where the grazing regime can make a difference. The management and monitoring of the grazing regime, with incentives being offered to farmers to comply with the instructions, would be beneficial to all.

The situation of wild species collections at IBERS

Tim Langdon (Institute of Biological, Environmental and Rural Sciences (IBERS), UK) presented an update on the wild species collection formerly curated by Mike Leggett and some additional information about oat work in Aberystwyth. Oat breeding, with field books and records dating back to 1919, continues with a focus on winter oats. Uncatalogued historic material in cold storage (e.g. landraces from Gatersleben) is catalogued on an ad hoc basis as funds allow. Of primary interest to ECPGR is the material collected by M. Leggett in Morocco, Spain and the Canary Islands, the Canadian *A. sterilis* accessions, and accessions used in European projects. Species lists show that the main contributions are to *A. agadiriana* (19 accessions), *A. atlantica* (10), *A. canariensis* (20), *A. hirtula* (16), *A. longiglumis* (10), *A. magna* (15), *A. murphyi* (14), *A. prostrata* (8) and crosses *A. sativa* x *A. macrostachya* (19). The numbers of accessions may be underestimated because they may represent populations. Extensive studies have been made with *A. canariensis* collected in 1985 on Lanzarote and Fuerteventura (Canary Islands) to analyse the sympatric speciation under way, cytomixis and population-specific reciprocal translocations, and isozyme polymorphism. High variability for agronomically interesting traits (e.g. lipids) was found in wild species of all ploidy levels. Today the phylogeny of wild species is used to prospect for candidate genes, and diversity screens are made with SSRs. The dynamics of mobile elements in the evolution of wild species genomes could be exploited as markers for hybridization, introgression and geographic origin. A mapping population has been created from a cross *A. strigosa* x *A. atlantica* – a comparatively simple diploid system in *Avena* for phenotyping and genotyping.

The QUOATS project ("Harnessing new technologies for sustainable oat production and utilisation") was mentioned. This £5 million-project, sponsored at 50/50 by private and public funds, aims to develop genomic tools and resources in *Avena* during five years (2009-14) (www.quoats.org).

Domestication of tetraploid *Avena magna*

Gideon Ladizinsky (Faculty of Agriculture, Hebrew University of Jerusalem, Israel) presented his project on domestication of *Avena magna*. This tetraploid wild species, occurring in Morocco, has very high protein content (25-31%) associated with large kernel size and tolerance to the dry conditions of Morocco. After difficulties with introgressing these interesting traits into *A. sativa*, he decided to try transferring the domestication syndrome from *A. sativa* into *A. magna*. During the last 20 years 5 hybridization/back-crossing cycles have been made and a form acceptable as a domesticated type is now available, but with lower protein content. This is now being back-crossed with the wild type to achieve higher protein contents again. About 1000 F2 progeny strains are available. G. Ladizinsky was seeking a successor to continue this work in the long term. In the short term he was seeking some support for the protein analysis in the progeny.

Wild species management and experiences in the Canadian Genebank

A. Diederichsen (Plant Gene Resources of Canada (PGRC); now at the Nordic Genetic Resource Center (NordGen), Alnarp, Sweden) gave an introduction on handling of wild *Avena* species in the Canadian Genebank. PGRC holds about 27 000 *Avena* accessions with nearly 11 500 accessions of *A. sterilis*, 2100 accessions of *A. barbata*, 581 *A. fatua* and 1485 accessions of 24 other wild *Avena* species. During collecting missions in the 1960s-70s by B. Baum in the Mediterranean and Near East, a comprehensive collection of wild species (24% of the collection) has been built with the aim of using it for crown rust resistance programmes. In *A. sterilis* 90 resistance genes have been found. The applied strategy of vertical resistance required extensive use of this wild germplasm. The collection was declared a World Base Collection for *Avena* by the International Board for Plant Genetic Resources (IBPGR, now Bioversity International), and duplications from several genebanks were added into the active collection. Currently world genebanks preserve about 20 000 wild accessions, of which over 15 600 are in the Canadian genebank. A. Diederichsen highlighted some of the taxonomic problems. In the case of the diploid level, 16 species could be lumped to 6 based on genome information; at the tetraploid level it was possible to reduce from 8 to 6, and at the hexaploid level from 8 to 1 species. Since 1998, 4800 accessions have been regenerated in the field and 3180 in the greenhouse. Wild species need to be covered with perforated bags after panicle emergence. In the field they were surrounded by a shelter of sunflower or maize. Main problems of regeneration in Saskatoon are overwintering (*A. macrostachya*), too late flowering and maturity in diploid and most tetraploid species, and high costs for greenhouse regeneration. On the other hand, danger for establishment as a weed is limited to *A. fatua*. A reference set has been created for managing the oat collection, consisting of herbarium sheets, seed herbarium, photographs of diagnostic traits of two accessions for each taxon, verified by chromosome counting. In summary, A. Diederichsen noted that oats is a crop in decline; no international research centre has a mandate for it, which strengthens the importance of national genebanks for this crop. Centres of diversity do not overlap with present cultivation areas, which makes it difficult to motivate the countries on the importance of wild genetic resources diversity preservation. The species identification can also be challenging and it is important to agree on a common language regarding taxonomy, identification and nomenclature.

Discussion

It was clarified that unique material in the collection will be prioritized for duplication at the Svalbard Seed Vault. Herbarium sheets are only taken at taxon level, but the German genebank (Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben) conserves herbarium samples for each accession.

The AVEQ working collection – Structure and experiences with multiplication

Zofia Bulinska (IHAR, Poland) presented the work done on the working collection for the AVEQ project. The plan had been to incorporate 100 wild species accessions, 200 landraces, 200 obsolete and 100 modern cultivars into the working collection. Seventy of these accessions should have been selected from the results of the previous project (GEN RES CT 99106). All other accessions were selected from passport data in an attempt to maximize diversity by equal representation of European countries in a broad sense, by using available information on the time of acquisition, collecting and registration, by including different botanical varieties, and geographical information (latitude, longitude, altitude) with a special emphasis on higher elevations to promote inclusion of frost-tolerant types. This approach, based on passport data, favours accessions with the more complete passport information. From the total 1433 accessions selected for the working collection and ordered

from the holding genebanks or breeders, 897 were received. Of these, 652 were multiplied in sufficient quantity for the field experiments. Acquisition of accessions was most difficult for the wild species. Comparison of numbers of wild species accessions in the European *Avena* Database (EADB) (containing old accession data) and EURISCO (limited to accessions reported by National Inventories) already showed that many wild species accessions reported in the past were probably no longer available. Finally, 67 accessions of 10 species could be acquired – about half of those from the primary hexaploid genepool (*A. fatua* and *A. sterilis*). Of marginally cultivated *A. strigosa* and *A. abyssinica*, 61 and 9 accessions were received, respectively. Of hexaploid cultivated oats, 758 accessions were received. Of the wild species only 34 accessions of 8 species (*A. canariensis*, *A. damascena*, *A. hirtula*, *A. wiestii*, *A. barbata*, *A. fatua*, *A. hybrida* and *A. sterilis*) could be multiplied to sufficient amounts for the field experiments. From cultivated species, 5 accessions of *A. abyssinica*, 46 of *A. strigosa*, 24 of *A. byzantina* and 543 of *A. sativa* went into evaluation. The accessions originate from 49 countries. Equal representation of countries was not achieved. Some countries with longer histories of oat breeding or collecting were more represented in the final collection used for evaluation (Poland 76 accessions, Spain 71, France 61, Germany 58 and United Kingdom 57). The Nordic countries (Denmark, Iceland, Finland, Norway and Sweden) are represented altogether with 77 accessions. Accessions with non-European origin mainly represent wild species. While 17 accessions date back to before 1900, 52 are from 1900-1930, 110 from 1930-60, 172 from 1960-90, and 147 were registered after 1990 (modern material). A total of 126 commercial cultivars were acquired from breeders in Austria, Czech Republic, Estonia, Finland, France, Germany, Italy, Lithuania, Poland, Romania, Spain, Sweden and United Kingdom. Multiplication was performed at three sites (in France, Germany and Poland), and accessions were sown in rows spaced 25 cm apart with low seed density to maximize multiplication rates. Plant protection was oriented towards production of disease-free seeds, especially free from *Fusarium*. Seed cleaning procedures varied according to the different institutes. This had much influence on yield and germinability and some compromises had to be made to get sufficient seed from such a diverse set of accessions. Multiplication rates (number of seeds harvested from a single plant) were determined in Germany. They ranged from 63 to 285 for hexaploid oats, from 116 to 291 for *A. strigosa* and from 70 to 132 for *A. abyssinica*. Wild species gave very different results. *A. barbata*, *A. damascena* and *A. fatua* showed comparably high multiplication rates (34-134), while *A. wiestii* and *A. canariensis* remained below 50 seeds/plant. The rest of the species were in between.

Regeneration and multiplication protocols for wild *Avena* species

Zofia Bulinska continued with a presentation on regeneration protocols for wild *Avena* species in Europe, especially referring to the Polish genebank practice. In Radzików 96 accessions of wild species are conserved, including *A. sterilis* (37 accessions), *A. fatua* (20), *A. macrostachya* (10), *A. damascena* (9), *A. insularis* (7), *A. hirtula* (6), *A. longiglumis* (3), *A. barbata* (3) and *A. atlantica* (1). Of these, 500–1000 seeds should be always available. Seeds which do not require vernalization are sown manually at the beginning of April (400 seeds/m^2). Seeds with vernalization requirement are treated with fungicide (Funaben T) and are pre-germinated in Petri dishes for 5-10 days at 20°C. For vernalization, the germinated seeds are placed in filter paper with plastic foil at 4°C for 42 days. The vernalized plantlets are planted at the beginning of April under plastic tunnels or in pots. Panicles are covered with plastic bags after heading. Seeds are harvested manually, dried down first to 15% moisture content, and after cleaning to 4-6% for storing.

Discussion on regeneration and multiplication protocols for wild* Avena *species as part of the AEGIS quality system

A discussion started on quality standards for wild species. G. Ladizinsky reminded the Group that the collecting standard is to collect seeds from a minimum of 50 plants (1 spikelet per plant, 50-100 seeds) to ensure at least representation of common alleles with more than 5% frequency. From the point of view of a collector this would be the minimum number of seeds to start regeneration. G. Ladizinsky suggested keeping the harvest from each plant separate and to compose each accession of 50 sub-accessions (potentially 50 different genotypes). An accession would then represent a collecting site. In this way the danger of selection would be reduced and the diversity maximized. Genebank curators thought that it would not be feasible to keep accessions from individual plants and that in reality accessions in genebanks are a mixture of various genotypes.

Regarding the improvement of germination, G. Ladizinsky gave the advice to dehull the seed before planting. If the spikelet is the dispersal unit, only the lower seed will germinate, the upper stays dormant because of inhibitors in the husk – in those cases, dehulling can increase germination. Another approach would be to keep the upper one as a reference. Literature is available on genebank management dealing with these issues and it should be consulted. This will be done by a task force as defined below.

Workplan

It was agreed that a task force composed of Gideon Ladizinsky, Igor Loskutov, Christoph Germeier, Axel Diederichsen, Zofia Bulinska and Dionysia Fasoula will consult through email and prepare a draft protocol on regeneration of wild accessions, taking into consideration the existing literature as well as the results of the AEGIS sub-group on Avena *(report of 2008[6]). An ad hoc meeting on AEGIS issues will be organized by the* Avena *WG in autumn 2011 to reach a conclusion.*

Reports from the countries

(The presentations corresponding to the reports summarized below are available online, as well as a paper on Avena *activities at the N.I. Vavilov Research Institute (VIR, Russian Federation) provided after the meeting by I. Loskutov, who was unable to attend the meeting.)*

Dionysia Fasoula (Cyprus) mentioned the new collection of wild species originating from the AEGRO mission. A further focus in Cyprus lies on phenotyping.

Noel Collins (Ireland) informed the meeting about the *Avena* collection in the National Crop Evaluation Centre. It consists of 24 old cultivars from the now closed oat breeding programmes in Ireland (University College Dublin) and one accession of *A. strigosa*. Genetic resources work in Ireland since 1996 is supported by a national genetic resources grant aid scheme. In 2009 the oats accessions were characterized morphologically according to the IBPGR oat descriptors list. Within the Irish Cereal Crop Landrace Project *in situ* occurrences of *A. strigosa* were described on the Aran Islands.

Peter Hozlar (Slovakia) introduced characterization and evaluation of a collection of 1073 hexaploid cultivated oats held in the Slovak genebank. Genebank accessions are sown together with nursery collections; 27 descriptive and 44 technical descriptors are recorded. A classification is made in comparison to registered varieties. Yield was determined in four replications of 10 m^2-plots. Husk content, test weight, seed weight, carbon, nitrogen and crude fibre were determined. Ranges were 40-160 cm for crop height, 0.5-10 t/ha for yield, 16-40% for husk contents, 10-50 mg for seed weight, 40-70 kg/hl for test weight, 8-21.5% for protein and 2.5-16.5% for crude fibre. P. Hozlar concluded that genotypes were found with

[6] Available from http://aegis.cgiar.org/index.php?id=1917

trait expressions superior to the registered varieties and with extreme character expressions. The former are useful for breeding, the latter for research purposes.

Elina Kiviharju (Finland) presented molecular work done at MTT: production of double haploids; use of this technology in a mapping population of 'Aslak', a β-glucan-rich cultivar and 'Matilda', an oil-rich and leaf-blotch-resistant cultivar to create a linkage map based on double haploids. Results were 28 linkage groups, 625 markers, a major gene for grain cadmium accumulation and single nucleotide polymorphism (SNP) markers for short straw.

Danela Murariu (Romania) presented the involvement of the Romanian genebank in the South East European Development Network on Plant Genetic Resources (SEEDNet). The Suceava Genebank, recently merged with the Romanian Seed Testing Institute, holds 560 oat accessions. For 75% of them morphological characterization is already available; for 60% biochemical studies have been made. In Romania 206 000 ha (4% of the agricultural area) is cropped to oats, mostly for animal feed. Danela Murariu, from the Suceava Genebank, is Chair of the Cereals and Maize working group of SEEDNet. The objective of the network, which was established in 2004, is the long-term conservation and sustainable utilization of plant genetic resources at national and regional levels. It assembles one thematic and six crop-oriented working groups, is planned and monitored by a regional steering committee and financially supported by Swedish agencies. The secretariat is located at the Swedish University of Agricultural Sciences. Genebanks have been established in all member countries. SEEDNet has an observer status in ECPGR and in the FAO Commission on Genetic Resources for Food and Agriculture, and is a member of EUCARPIA. In the Cereals and Maize WG 13 countries work together on agreed mandate species and priority crops. Three regional projects have been set up on collecting, multiplication and conservation of local landraces of maize and cereals. Together with other crops, 31 oat accessions have been collected. They are prepared for long-term storage and characterized morpho-physiologically

Sharing of tasks and responsibilities

An update on AEGIS

Lorenzo Maggioni gave an update on AEGIS. He mentioned the background of a multitude of genebanks worldwide and in Europe and an estimated proportion of only about 30-40% unique accessions. Difficulties include the lack of conservation facilities, insufficient safety-duplication, regeneration backlogs and heterogeneous quality. These should be overcome by the sharing of responsibilities formalized in "A European Genebank Integrated System" (AEGIS) with long-term formal commitment, improved quality standards and improved sharing of information. The aim is to conserve the genetically unique and important accessions for Europe, store them under conditions which ensure genetic integrity in the long term and make them available. Up to now a *Strategic Framework Policy Guide*[7] has been agreed and a Memorandum of Understanding (MoU) developed and signed at ministerial level with Bioversity by 26 countries. Next steps are the establishment of an AEGIS Quality System (AQUAS) and the compilation of the European collection. There is a small grant scheme of €100 000, with about €10 000 available per proposal. A proposal called EUROGENEBANK was submitted to the FP7 Research Infrastructure call, but was not selected for funding. EURISCO will be the information system for AEGIS. The flag "AEGIS status" was added to its structure. There is no fixed procedure for the selection of the European accessions, but it should be the result of a process involving the Crop Working Groups and the countries. A proposed simplified procedure has been suggested, consisting of the development of

[7] Available from http://aegis.cgiar.org/index.php?id=1917

crop-specific selection criteria to be used for the selection of a list of accessions. Selection requirements have been approved by the Steering Committee, as: the selected accessions have to be in the public domain, genetically unique, plant genetic resources in the sense of being of economic use, and with importance for Europe. The suggestions of the Crop WGs are implemented by the National Coordinators in consultation with the holding institutes. The quality system (AQUAS) is based on the principle of making procedures transparent and letting them be checked by an independent body. Operational genebank manuals should describe the ongoing procedures, as a matter of transparency (generic and crop-specific technical procedures on collecting/acquisition, regeneration/propagation, drying and other preparatory steps, storage/field genebank maintenance, seed quality and viability monitoring, distribution and characterization). Crop-specific minimum standards should be agreed by the WG and then implemented by the participating genebanks. Capacity building will play a key role. Monitoring will be an AEGIS internal matter, to be implemented by the Crop WGs (first level) and the AEGIS Advisory Committee (second level).

Discussion

The Group started a discussion on the selection of accessions for the European collection as part of AEGIS. It was considered that all the wild species could be AEGIS accessions, and that all the material that has been selected for the AVEQ project could be included. It was also noted that collections hold many accessions which look like duplicates as they share the same name, but are in fact different. The Group thought that the definition of the accessions for AEGIS should be the topic of an ad hoc meeting to be held in autumn 2011.

The European *Avena* Database and the situation and future of the Central Crop Databases

Christoph Germeier reported on the current activities in the European *Avena* Database (EADB) and commented on the perceived future of the Central Crop Databases (CCDBs). He mentioned the activities carried out in the AEGRO project, which are focused on geographic identification and monitoring of wild populations and the integration of Global Biodiversity Information Facility (GBIF) data (historically observed occurrences of wild *Avena* species). Tools are also being developed for *in situ* field monitoring. He showed the connecting entities between *ex situ* and *in situ* databases, which are the observation/collecting site, and the occurrence, which in the case of collecting is the origin for one accession or a group of duplicate accessions. He showed some of the features of the AEGRO Web portal, which allows for searching according to different taxonomic views, downloading of result sets, and the display of occurrence/collecting sites with Google maps. A function for editing online for obviously mistaken localization information will also be implemented. He mentioned the function for distributed management of field experiments in the AVEQ project. The online tool for the generation of field plans according to an agreed randomization scheme ensures the orthogonality of field and lab work and will facilitate the inclusion of the results into the database. PDF documents (scoring lists) and Excel sheets are downloadable, including the description of observation methodology to input observation results. Upload facilities will be available for Excel spreadsheets and photographs. Currently both projects have their own databases and a lot remains to be done to integrate these with the EADB. An overall renovation of hard- and software for the EADB is needed, because the old technologies used cannot be maintained any longer. For this a two-year technical position was acquired in the JKI. Synergies are expected from a national programme for characterization and evaluation (EVA2), for which a software development project could be acquired, funded with €400 000 from the German Economic Stimulus Program. The software will be implemented by an external company specialized in open source model driven software development (itemis AG). All source code will be openly available for the interested community.

Nevertheless Christoph Germeier sees now a point reached, where decisions regarding the CCDBs have to be taken. The PGR documentation landscape is changing, with a tendency towards centralized multicrop information systems hosted by CGIAR centres. The more these intend to take over functions currently available at (some of) the CCDBs (e.g. C&E information), the more difficult it will become to justify the activity of the CCDBs to administrators at those institutes holding them. This is aggravated by the fact that at the ECPGR Steering Committee level (cf. the presentations on the Independent External Review of ECPGR and the central role of EURISCO in AEGIS during this meeting) implicitly, and some National Coordinators also explicitly, do not support the idea of the CCDBs any more. In this situation it will be the task of the Crop WGs to identify the role of the CCDB for their work and to find a way for their continued maintenance and funding, that is if they should continue at all. One way could be to develop them more into scientific information systems like the crop-specific genomics portals MaizeGBD, SoyBase etc. This would give the opportunity to integrate their development as information work packages into larger third-party-funded projects, like EU framework projects. If in this way the CCDBs could attract third party funding, their maintenance might also be easier to justify at the institutional administrative level. In the currently developed central PGR information systems (GENESYS, EURISCO) an open source development strategy is not apparent. Design and development of these systems will be restricted more or less to CGIAR development teams, which normally are far away from the practical work in the Crop WGs. Christoph Germeier stressed the advantages of a decentralized information landscape and open source development, and also of the direct access of the Crop WGs to the databases, the more handy size of a crop-specific database in case of crop-specific interest, the broader involvement of developers, including students in PGR information and biodiversity informatics in the development of the information systems, and an ongoing broad standardization of approaches developing in an open source developer community in "agreement by laziness" (available approaches are used and enhanced instead of re-inventing the wheel). He concluded that regarding the EADB, thanks to the success in acquiring a two-year position, it will be upgraded to remain in operation for the next three to four years. During this time the decisions discussed above will have to be taken and implemented.

Discussion

Lorenzo Maggioni remarked that he did not see a lack of interest in the CCDBs at the ECPGR Steering Committee level. Very recently project proposals for Fruit CCDBs have been accepted by the Steering Committee. L. Maggioni thought that the response to the external evaluation regarding the perceived competition between EURISCO and the CCDBs will be resolved by ECPGR by stressing their complementarities and not by replacement of the CCDBs by EURISCO.

The Group thought that the dynamism of the EADB and of its manager were very useful and should be encouraged and supported.

Discussion on future projects: proposals for collaborative research activities

The final session of the meeting focused on future project proposals. Valeria Terzi mentioned the wealth of phenotyping data becoming available from AVEQ, which will need complementation with genotyping data. Molecular tools are available to bring together phenotype and genotype. She mentioned currently available calls in the EU Framework Programme on biotic and abiotic stresses and on functional food, which would fit perfectly. But it was felt in the Group that the current projects AVEQ and AEGRO should be fully completed before starting with a new proposal. There was a suggestion to organize a COST

project to make better use of the data and to develop a new proposal. But it has to be kept in mind that COST provides money solely for meetings. It could be a four- or five-year project with one meeting per year. *A. strigosa* could play an important role in a new action. A mapping population is already available for *A. strigosa* covering nematode resistance. *A. strigosa* has some importance also in organic farming and it shows quite interesting results in AVEQ. As a diploid, it is much more convenient for genomic research. The tetraploid species could be included as well, e.g. the continuation of the *A. magna* domestication presented by Gideon Ladizinsky or using the perennial *A. macrostachya* for introgression of frost resistance. *A. magna* in Morocco outperforms cultivated oat in drought resistance, which is also relevant in relation to climatic changes. *A. insularis* grows in relatively dry regions as well. The Focused Identification Germplasm Strategy (FIGS) approach, using ecogeographic data to identify potential occurrences of interesting germplasm, could be used. Another proposal suggested using the double haploid technology to describe genetic distances and the history of landraces with molecular markers. Another suggestion was to take more into account questions of oat quality for animal consumption: xylan, protein and oil contents would be major issues there.

Workplan
Valeria Terzi agreed to draft a proposal as coordinator of a COST action, to be developed on the basis of the ideas that have been proposed.

Conclusion

The Chair of the WG, A. Katsiotis, expressed satisfaction with the progress made through the successful projects and encouraged all participants to seek new project funds for the future. Regarding progress on the workplan for Phase VIII of ECPGR, the definition of European accessions and the standards for conservation on wild species are still in the "to do list", but a task force and a dedicated ad hoc meeting were planned to take care of that.

The Group re-confirmed Andreas Katsiotis as Chair and Elina Kiviharju was elected as Vice-Chair.

The Romanian Ministry of Agricultural and Rural Development and the Genebank of Suceava were thanked for their kind support for the organization of the meeting.

APPENDICES

Appendix I. Workplan

(Agreed at the Sixth Meeting of the *Avena* Working Group, 21-22 October 2010, Bucharest, Romania)

Action	**Carried out by**	**By when**
Prepare a draft protocol on regeneration of wild accessions, taking into consideration the already existing literature, as well as the results of the AEGIS sub-group on *Avena* (report of 2008)	A task force composed of Gideon Ladizinsky, Igor Loskutov, Christoph Germeier, Axel Diederichsen, Zofia Bulinska and Dionysia Fasoula	Before the ad hoc meeting to be organized in autumn 2011
Organize an ad hoc meeting on AEGIS issues to make progress regarding crop-specific standards and definition of European Collection accessions	Chair and Vice-Chair	Autumn 2011
Draft a proposal as coordinator of a COST action, to be developed on the basis of the ideas proposed during the meeting	Valeria Terzi	Autumn 2011

Appendix II. Acronyms and abbreviations

15-ADON	15-acetyl-deoxynivalenol
3-ADON	3-acetyl-deoxynivalenol
AARI	Aegean Agricultural Research Institute, Izmir, Turkey
AEGIS	A European Genebank Integration System
AEGRO	An Integrated European *In Situ* Management Workplan: Implementing Genetic Reserves and On Farm Concepts *(EU project)*
AGES	Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH (Austrian Agency for Health and Food Safety), Austria
AOAC	Association of Analytical Communities
AQUAS	AEGIS Quality System
AVEQ	*Avena* Genetic Resources for Quality in Human Consumption *(EU project)*
CAP	Community Agricultural Policy
CBF	Core binding factor
CCDB	Central Crop Database
CGIAR	Consultative Group on International Agricultural Research
CRA	Consiglio per la Ricerca e la Sperimentazione in Agricoltura (Agricultural Research Council), Italy
DAS	Diacetoxyscirpenol
DON	Deoxynivalenol
EADB	European *Avena* Database
EC	European Commission
ECPGR	European Cooperative Programme for Plant Genetic Resources
ELISA	Enzyme-linked immunosorbent assay
EST	Expressed sequence tag
EU	European Union
EUCARPIA	European Association for Research on Plant Breeding
EURISCO	European Internet Search Catalogue
FAO	Food and Agriculture Organization of the United Nations, Rome, Italy
GBIF	Global Biodiversity Information Facility
GRIN	Germplasm Resources Information Network, USA
HPLC-MS/MS	High-performance liquid chromatography tandem mass spectrometry
IBERS	Institute of Biological, Environmental and Rural Sciences, UK
IBPGR	International Board for Plant Genetic Resources, Rome, Italy *(now Bioversity International)*
ICC	International Association for Cereal Science and Technology
IHAR	Plant Breeding and Acclimatization Institute, Poland
INIA	Instituto Nacional de Investigação Agrária, Portugal
INRA	Institut National de la Recherche Agronomique (National Agronomic Research Institute), France
IPGR	Institute for Plant Genetic Resources, Sadovo, Bulgaria

IPGRI	International Plant Genetic Resources Institute, Rome, Italy *(now Bioversity International)*
IPK	Leibniz Institute of Plant Genetics and Crop Plant Research, Gatersleben, Germany
JKI	Federal Research Centre for Cultivated Plants – Julius Kühn-Institut, Quedlinburg, Germany
MLS	Multilateral System
MoU	Memorandum of Understanding
NIRS	Near Infrared Spectra analysis
NIV	Nivalenol
NordGen	Nordic Genetic Resource Center, Alnarp, Sweden
NP-HPLC	Normal-phase high-performance liquid chromatography
NPS	Non-starch polysaccharides
PAGE	Polyacrylamide gel electrophoresis
PCR	Polymerase chain reaction
PGRC	Plant Gene Resources of Canada
QPCR	Quantitative polymerase chain reaction
QTL	Quantitative trait locus
SEEDNet	South East European Development Network on Plant Genetic Resources
SINGER	System-wide Information Network for Genetic Resources *(CGIAR)*
SLU	Swedish University of Agricultural Sciences
SMTA	Standard material transfer agreement
SSR	Simple sequence repeat
VIR	N.I. Vavilov Research Institute of Plant Industry, St. Petersburg, Russian Federation
WG	Working Group
ZON	Zearalenone

Appendix III. Agenda

***Sixth Meeting of the ECPGR Working Group on* Avena,**
jointly held with the Final Meeting of project AGRI GEN RES 061 on
"*Avena *Genetic Resources for Quality in Human Consumption" (AVEQ)
19-22 October 2010, Bucharest, Romania

Monday, 18 October 2010

Arrival of participants

Tuesday, 19 October 2010 – AVEQ Administration Meeting

08:30 **Welcome and opening of the meeting** *(Chair: C. Germeier)*
08:30 Opening addresses: local host, project coordinator
09:00 Introduction of project partners *(All)*
09:15 Organizational issues of the meeting

09:30 **Plenary session 1. Status of the project**
09:30 Technical status – Milestones and deliverables: going through milestones and deliverables and specify delays (*C. Germeier*, *All)*

10:00 *Coffee*

10:30 **Plenary session 1. Status of the project (continued)**
10:30 Technical status - Milestones and deliverables: going through milestones and deliverables and specify delays (continued) (*C. Germeier*, *All)*
11:00 Financial status – need for a final budget revision? (*C. Germeier*, *All)*

12:30 *Lunch*

13:30 **Plenary session 1. Status of the project (continued)**
13:30 WP10: Project documentation and internet portal
Demonstration of Excel upload
Discussion of data types: Avenin patterns, NIRS results, (HP)LC results
15:00 Short presentation of the guidelines for the final report

15:30 *Coffee*

15:45 **Work Package session**
Adapting timetable and budgets for remaining work – discussion on final report

a. Working collection and field experiments: WP2 (P0) WP3 (P1, P2, (P5), P8, P9(MI), P10, (P11))
b. *Fusarium*: WP4 (P3, P8, P9 (MI), P14), WP5 (P4, P6, P8, P15).
c. Quality: WP6 (P5, P9 (DP), P11), WP7 (P6, P2, P12), WP8 (P7, P6)
d. Frost tolerance: WP9 (P8, P9 (DM), P10).

Wednesday, 20 October 2010

8:30 **Work Package session (continued)**
Adapting timetable and budgets for remaining work – discussion on final report

a. Working collection and field experiments: WP2 (P0) WP3 (P1, P2, P5, P8, P9(MI), P10, (P11))
b. *Fusarium*: WP4 (P3, P8, P9 (MI), P14), WP5 (P4, P6, P8, P15).
c. Quality: WP6 (P5, P9 (DP), P11), WP7 (P6, P2, P12), WP8 (P7, P6)
d. Frost tolerance: WP9 (P8, P9 (DM), P10).

10:15 *Coffee*

10:30 **Work Package session (continued)**
Adapting timetable and budgets for remaining work – discussion on final report

a. Working collection and field experiments: WP2 (P0) WP3 (P1, P2, P5, P8, P9(MI), P10, (P11))
b. *Fusarium*: WP4 (P3, P8, P9 (MI), P14), WP5 (P4, P6, P8, P15).
c. Quality: WP6 (P5, P9 (DP), P11), WP7 (P6, P2, P12), WP8 (P7, P6)
d. Frost tolerance: WP9 (P8, P9 (DM), P10).

12:30 *Lunch*

13:30 **Plenary session 2. Decisions**
13:30 Update time schedule for final project activities *(C. Germeier, All)*
15.00 Agreement on the need and details of a final budget revision (*C. Germeier*, *All)*

15:30 *Coffee*

16:00 **Plenary session 2. Decisions (continued)**
16:00 Introduction to the final report and to future perspectives for genetic resources work in the framework of EU programmes *(O. Diana)*
16:30 Final discussion on reporting and dissemination of results

17:00 Wrap-up discussion, any other issues
18:00 Closure of the AVEQ administration meeting
19:00 Join welcome reception for AWG members

Thursday, 21 October 2010 – AVEQ + ECPGR *Avena* Working Group presentation meeting

08:30 Opening addresses: local host, ECPGR Secretariat, Chair of the *Avena* WG
09:00 Introduction of participants *(All)*
09:15 Organizational issues of the meeting

9:30 **Session 1. Overview of the AVEQ project, working collection and field work**
9:30 WP1-2. *Avena* genetic resources for quality in human consumption (AVEQ) – A European project on nutritional quality in oats (*C. Germeier)*

10:00 *Coffee*

10:30	WP3. Field experiments for quality analysis – yields and technical quality *(D. Murariu)*
10:50	Discussion
11:00	**Session 2. *Fusarium* in oat genetic resources** *(Chair: M. Stanca)*
11:00	Background: *Fusarium* discussion at EU level *(O. Winkelmann)*
11:30	WP4. *Fusarium* inoculation and experiences with *Fusarium* on oats in the field *(M. Herrmann, D. Murariu)*
11:50	WP5. Analysis of *Fusarium* on oat samples – methodology and results *(I. Polisenska, V. Terzi)*
12:10	Discussion
12:30	*Lunch*
13:30	**Session 3. Oats nutritional quality** *(Chair: M. Stanca)*
13:30	Background: Nutritional quality in oats (*L. Dimberg*)
14:00	WP6. Analysis for protein, fat and minerals *(J. Koenig)*
14:20	WP7. Analysis for fibre and β-glucan *(D. Boros, R. Redaelli)*
14:40	WP8. Analysis for antioxidants and avenanthramides (*R. Redaelli*, *L. Dimberg)*
15:00	Discussion
15:30	*Coffee*
16:00	**Session 4. Cold tolerance in oat genetic resources** *(Chair: M. Stanca)*
16:00	Background: Cold tolerance in oats – state of the art *(M. Stanca)*
16:30	WP9: Cold tolerance in field experiments *(N. Antonova)*
16:50	WP9: Cold tolerance evaluation by chlorophyll fluorescence measurements *(F. Rizza)*
17:10	Discussion
17:40	Closure of the meeting day
17:45-19:45	*City tour to Bucharest*
20:00	*Social dinner*

Friday, 22 October 2010 – ECPGR/AWG meeting

8:30	**Session 5. ECPGR activities**
08:30	*Avena* WG: Chairperson's report, including follow-up of activities since fifth meeting; overview of present meeting: aims and schedule *(A. Katsiotis)*
09:00	Update on ECPGR *(L. Maggioni)*
09:30	Future perspectives for genetic resources work in the framework of EU programmes *(O. Diana)*
10:00	*Coffee*
10:30	**Session 6. *Avena* collection and wild species issues**
10:30	An account of the *in situ* AEGRO project: Wild species prospection in Cyprus, Sicily and Spain *(A. Katsiotis)*
10:50	The situation of wild species collections at IBERS *(T. Langdon)*

11:10 Wild species management and experiences in the Canadian Genebank *(A. Diederichsen)*
11:30 The AVEQ working collection (WP2) – collection structure and experiences with multiplication (*Z. Bulinska, I. Kordulasinska, C. Germeier)*
11:50 Discussion on *ex situ* vs. *in situ* conservation, regeneration and multiplication protocols for wild *Avena* species as part of the AEGIS quality system *(A. Diederichsen, Z. Bulinska, A. Katsiotis, All)*

13:00 *Lunch*

14:00 **Session 7. Sharing of tasks and responsibilities**
14:00 Brief country reports *(All)*
14:30 An update on AEGIS *(L. Maggioni)*
15:00 The EADB and the situation and future of the Central Crop Databases *(C. Germeier, L. Maggioni, A. Katsiotis, All)*
Discussion on the selection of accessions for the European collection? How to move forward to have a first batch of AEGIS accessions designated? *(All)*

15:30 *Coffee*

16:00 **Session 8. Future funded project opportunities**
16:00 Discussion on future projects: proposals for collaborative research activities (*A. Katsiotis, V. Terzi, C. Germeier, All)*
17:00 Conclusions and recommendations (*A. Katsiotis)*
18:00 Closure of the meeting

Appendix IV. List of participants

***Sixth Meeting of the ECPGR Working Group on* Avena,**
jointly held with the Final Meeting of project AGRI GEN RES 061 on
"*Avena *Genetic Resources for Quality in Human Consumption" (AVEQ)
19-22 October 2010, Bucharest, Romania

N.B. Contact details of participants updated at the time of publication. The composition of the Working Group is subject to changes. The full list, constantly updated, is available from the Avena *Working Group's Web page (http://www.ecpgr.cgiar.org/networks/cereals/avena.html).*

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