5TH Workshop

of the EWRS working group

WEEDS AND BIODIVERSITY

INSTITUTE OF LIFE SCIENCES

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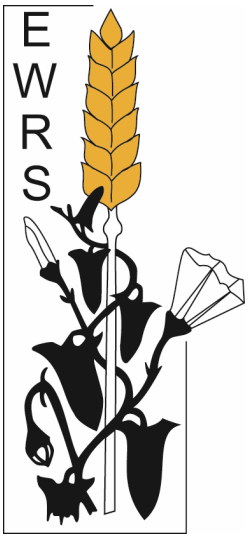

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Weeds and Biodiversity

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5TH Workshop of the EWRS working group 'Weeds and Biodiversity', Pisa, Italy, 17-19 November 2014

Local organizing committee

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Scientific committee

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Where do we come from?

Gerowitt B.

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The working group Weeds and Biodiversity was under this name founded in 2002 based on a proposal of Jon Marshall, UK to EWRS SciCom and board. Looking more back in EWRS-history the working group has ancestors: From about 1984 until 1992 (to my knowledge) a working group (WG) Weeds-Insects-Diseases-Interactions was active under the coordination of Rudolf Heitefuss, Germany. These days it was new and innovative to investigate how weeds interact with other organisms, with both positive and negative implications. Field margins as suitable sites for these interactions were in focus from the very beginning of the work. Thus it was only rational to concentrate on this subject under the next coordinator, Jon Marshall. Jon was engaged in the WG Field Margins from around 1994 until 2000. Activities and output during this period was extremely favored via a parallel EU-project “Field Margin Ecology” (1994-98).

From 2002 to 2005 the “new” WG Weeds and Biodiversity had a strong focus on activities in the UK. In 2005 Bärbel Gerowitt followed Jon Marshall as working group coordinator. At the EWRS Symposium 2005 in Bari/Italy >20 participants expressed their interests to contribute to this WG and common points of interests were derived. These points were further concentrated on the meeting 2007 in Salem/Germany. There, three major areas of interest and activities were identified: (1) diversity, (rare) species, communities, assemblages, (2) biodiversity, arable management, ecosystem services and (3) Conservation, programs, politics.

The working group regularly contributed to EWRS-symposia in sessions which were either organized by the WG (Hamar 2008) or jointly with other working groups (Kaposvar 2010, Weed mapping, Samsun 2013, Site-specific weed management).

The working group held conference-style meetings in Lleida, Spain 2009 and in Dijon, France, 2011. Both meetings included keynote addresses from the US (Matt Liebman, Jonathan Lundgren, Adam Davis) and Europe (Bruno Chauvel, Horst-Henning Steinmann) covering the WG interests in: arable management, food webs, seed predation, diversity management and politics and programs. In addition to these keynotes and presentation of WG-members, all meetings included interactive parts. In 2009 a focus group discussion on views of biodiversity revealed differences between members coming from South Europe, North America, Western or Eastern Europe. Some members of the WG had already experienced these differences on a pre-conference workshop at the IWSC 2008 in Vancouver. In 2011 a training day on field methods to measure weed seed predation brought

together 16 young and elder scientists – all profited in on-going or starting research from this way of exchange. However, the attempt to establish an own working group on Weed seed predation was not supported by the EWRS-board. Thus, weed seed predation remained as a branch in the WG.

As last reported activity two training courses in multivariate statistics in vegetation science were organized by the WG in Rostock, Germany in early 2014. They were attended by young scientists working with weed communities from nine different countries.

The major focus areas of the WG continuously adapted to the scope of the members and are in 2014 best described with (1) Diversity, (rare) species, communities, sampling; (2) Weed diversity and arable management and (3) Weed seed predation, food chains / webs.

Where are we going – research in 'Weeds and Biodiversity' and requirements of Horizon 2020

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The recently launched research framework programme 2014-2020 of the European Commission (Horizon 2020) has determined a paradigm shift in the way large research projects seeking funding from the EC should be built up and in the activities and end users they should address.

First, compared to the previous framework programme (FP7) the focus on research themes linked to societal needs has been sharpened. Seven 'Societal Challenges' (SC) have been identified, including Sustainable Agriculture (SC2), Climate Action and Resource Efficiency (SC5), and Inclusive, Innovative and Reflective Societies (SC6), all of which may potentially be relevant for weeds and biodiversity themes.

Second, great emphasis is placed on 'Innovation', now defined not only as the production of patents and related technological outputs but also as pathways through which novel ideas, approaches and deliverables would reach a variety of end users. A clear and thorough innovation plan is an absolute requirement for major projects. This would largely determine whether or not a project would achieve the type of impacts specified in the call text.

Third, a 'multi-actor' approach, i.e. the direct and active involvement of any major players (e.g. farmers, advisory services, manufacturers, policy makers, consumers) from the very beginning of the project is a must. Excellent science and an excellent consortium will not allow a project to go through should it have a weak multi-actor approach.

It is then clear that scientists seeking funding from Horizon 2020 should become aware that they need to interact with a variety of actors outside the world of research and academia, and that their outputs should go well beyond a series of scientific papers in highly ranked journals.

With this in mind, would there be any chance for topics related to weeds and biodiversity to access funds from Horizon 2020? My opinion is that there is ground to channel our topics through the meanders of the framework program, especially if we would be good enough to clarify the partly missing links between weeds, biodiversity and (agro)ecosystem services or disservices. Also, development of tangible deliverables like novel decision support systems or other problem-solving tools would probably be required.

Session ‘Agriculture and Biodiversity’

Crops and field margins of Poland as habitats of rare weed species and Crop Wild Relatives

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Thanks to the persistence of traditional farming systems, Poland hosts important reserves of environmental diversity and enriches diversity of European agricultural landscapes. The country supports very large populations of endangered plants, including many weed species and Crop Wild Relatives (CWR). We provide quantitative data on the occurrence of CWR and rare weeds in fields and field margins in two regions of Poland, and discuss some difficulties in the development of a national conservation strategy.

A floristic study carried out in fields of SE Poland in 1997-1999 revealed the occurrence of 180 weed species (12-46 species per 100 m^2 per field). The proportion of CWR reached almost 6%. A repeated monitoring conducted 10 years later also confirmed the occurrence of some rare weeds (e.g. *Caucalis daucoides* L.*, Bupleurum rotundifolium* L.), possibly due to the increasing area of organic farming in this region.

The second research conducted in SW Poland (2004-2007) focused on plant and animal communities inhabiting diverse semi-natural field margins. In 70 study plots a total number of 533 species of vascular plants were found. Share of CWR amounted to 7.5% (40 species), with a mean number of 9.7 CWR species per margin (range 3-23 species).

The results confirmed the importance of productive and non-productive habitats for CWR and rare weed species in Central Europe. This feature of Central European farmlands should be taken into consideration when solutions of EU Common Agricultural Policy and national strategies are discussed.

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The impact of management on weeds and aquatic plant communities in Hungarian rice paddy fields

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Hungary is situated at the northern most limit of rice production. It has about 300 years of history of rice cultivation. Before the intensification of rice production, flooded paddy fields provided a high diversity of wetland species.

This study aims to assess the management factors influencing the weed vegetation of Hungarian rice fields. We surveyed the weed flora and determined 25 potential explanatory variables in 100 rice fields. Data were analysed by redundancy analysis (RDA) after backward variable selection.

The net effects of nine variables on species composition were significant. Crop cover was found to be the most important explanatory variable, which was followed by the herbicides penoxsulam and azimsulfuron, tillage depth, phosphorous and potassium fertilisers, years after last rotation, water depth in May, sowing type, the herbicide pendimethalin and water conductivity. Including filamentous algae, 39 macrophyte species were recorded. Filamentous algae were both the most dominant and the most frequent weeds. Macrophytes belonged to 15 families, with Lemnaceae (17.5%), Characeae (11.7%) and Poaceae (8.7%) covering the largest surface area.

Our study indicated that Hungarian rice fields could have a relatively high conservation value, even today. The occurrence of red list species and charophytes in diverse micro-mosaic patterns deserves attention from a conservation perspective.

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Decline of arable weed species in Southern Germany – a comparison of vegetation recordings from the last 60 years

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Since the beginning of agriculture in Central Europe until the 1950s, the extensive cultivation of arable land has resulted in a wide variety of arable weed species on a large scale. Due to the intensification of crop production, the improvement of chemical and mechanical weed control and the loss of crop species diversity the number of arable weed species in Europe declined.

This trend was confirmed on fields in Southern Germany (Mehrstetten, Baden-Württemberg). We compared vegetation recordings of 1948/1949 and 1975-1978 to recent recordings (2011) and found a decline in weed species number by 64% (97 species). This corresponds to a loss of 1.5 species per year. From the previously found 23 rare or endangered arable weed species in 1948/1949 none were present in 2011.

Moreover, a plant sociological analysis was not able to determine a plant association more precisely than the order *Secalietalia*, due to a lack of characteristic plant species. According to the Ellenberg values the habitat characteristics have changed little during these 60 years. Supported by a survey among the local farmers, the reasons for this decline are mainly related to changes in crop cultivation techniques, especially herbicide use.

How climate change and the increasing cultivation of maize affects the arable weed species in the future remains to be seen. For this reason we now examine the behaviour of rare and endangered arable weed species dynamics under extensive cultivation.

Effects of poplar wood chips mulch on maize performance and the weed community

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In this study, we examined the effects of poplar wood chips, applied as a mulch (approx. 4 cm layer) immediately after maize sowing, on weed suppression, weed species diversity and crop performance. Experiments were carried out over two consecutive growing seasons (2013 and 2014) in the same organic field, with a short agronomic history, at the Interdepartmental Center for Agri-Environmental Research "Enrico Avanzi" at San Piero a Grado, Italy (latitude 43°40'N, longitude 10°20'E). The trial was arranged as a complete random block design and comprised six plots (3 x 5 m), with four blocks (replications). The plots consisted of two weed control treatments, namely mulch and hoeing, and a control (no weed control), and included two maize genotypes, namely composite cross populations (PC Composite) and a conventional hybrid (Pioneer® PR36Y03).

Our results show that mulch had a significant effect ($P \leq 0.001$) on density reduction of weeds (more than 60%) and caused a decrease in weed species richness ($P \leq 0.05$) and Shannon diversity index ($P \leq 0.05$). Of the variation in weed species composition at the early vegetative growth stage of maize, 13.7 % was explained by the mulch treatment ($P \leq 0.001$). Furthermore, mulch induced a decrease of weed shoot biomass by 50-60 % at the late vegetative stage of maize, but was less efficient than hoeing at crop harvest. In the second year, we observed an overall dominance shift of colony-forming perennial weeds (e.g. *Convolvulus arvensis* L. and *Cyperus rotundus* L.) to more annual species, such as *Amaranthus* spp. Maize growth was affected by treatment combinations ($P \leq 0.05$), but also by growing season. The highest biomass production was recorded for PC Composite under mulch in 2014. Dry grain yield production depended on weed control treatment ($P \leq 0.01$) and was highest under mulch.

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Hairy vetch cover crop affects weed diversity and composition in no-till sunflower

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Vicia villosa Roth, or hairy vetch, is one of the most productive cover crops (CC) in Mediterranean dry areas, with an interesting potential as dead mulch in no-tillage cropping systems. In low-input cropping systems, mechanical termination of hairy vetch could replace a glyphosate application to control weeds. Mechanical termination (e.g. with a roller crimper) of hairy vetch is ineffective until the late growing stages of vetch, leading to delayed sowing and yield reduction in the following crop.

To find the best compromise in timing between effective termination of vetch and reasonable yield of no-till sunflower, an on-farm experiment was carried out in Pisa (Italy) in 2012/13 and 2013/14 to compare three termination techniques (roller crimper with no, half and full dose of glyphosate) and three termination dates (before flowering, beginning of flowering, 70% of flowering of vetch). Data on weed biomass, species density and soil cover were collected at CC termination and during sunflower growth. Weed diversity and composition were analyzed through ANOVA, PERMANOVA and NMDS.

Weed abundance was significantly affected by the two factors and by their interaction, but only in the 2013/2014 season. The highest weed reduction was reached when 70% of the vetch was flowering, for the roller crimper and half dose of glyphosate treatments. Diversity, evenness and richness did not increase in mechanically-treated plots. Later termination dates reduced species richness in 2012/2013, while in 2013/2014 termination at the beginning of flowering had the lowest species richness. Weed composition in both years was mainly influenced by termination date (variance explained: 27.0% in 2013 and 47.4% in 2014). Roller crimper applied when 70% of the vetch was flowering showed results that were similar to standard herbicide-based techniques in any parameter considered. Therefore, roller crimper applied when 70% of the vetch is flowering may lead to a reduction in weed abundance comparable with standard herbicide-based techniques, without negatively affecting weed diversity.

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Factors affecting weed diversity and community composition in Latvia

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The aim of the present study was to search for factors affecting weed diversity and community composition under Latvian conditions. A weed survey in 306 arable fields, with different agricultural practices and crop rotations on conventional farms, was performed in 2013 and 2014, in different regions of Latvia. Weed species composition and density were recorded from 100 randomly selected points, in each field at least one month after herbicide application, at the end of June and at the beginning of July, when weeds were well developed and recognizable.

In total, 122 weed species were observed in 2013, and 133 species in 2014. Mean species richness ranged from 2 to 36 and from 3 to 42 species per field in 2013 and 2014, respectively. Five species were dominant in 2013: *Elymus repens* L.*, Viola arvensis* Murray*, Chenopodium album* L.*, Polygonum convolvulus* L. and *Equisetum arvense* L. In 2014, the dominant species were *V. arvensis, E. repens, Galium aparine* L.*, C. album* and *P. convolvulus.*

To test if the species richness is related to the relative level of intensification of land management, use of plant protection products and cultivation of the soil, the data were subjected to multivariate analysis using CCA. Preliminary results will be presented and discussed.

The present study was supported by the European Agricultural Fund for Rural Development (EAFRD) within the project “Integrated pest management for weed control in arable crops for sustainable use of the environment and resources”. The study was conducted in cooperation with State Stende Cereals Breeding Institute, State Priekuli Plant Breeding Institute and Latvia University of Agriculture.

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Weed diversity responses to conservation agriculture practices in a cereal-legume rotation

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Weed communities are known to be affected by crop management. However, not so much is known in relation to the relative effects of separate practices. We studied the effects of two techniques in conservation agriculture, namely reduced tillage (RT) and green manure (GM), plus the effect of fertilization, on weed diversity and community composition in the context of an organic Mediterranean system with a cereal-legume crop rotation. We carried out an experiment in an organic field in Gallecs (Barcelona, Spain). From 2011 to 2013, weed species abundances and the community richness and diversity were evaluated under each crop (spelt, green manure and chickpeas). The seedbank was characterized before the experiment started.

Our results suggest that community composition of the standing weeds can be significantly affected by tillage. The effects of tillage may depend, however, on how much the standing crop reduced available resources for weeds. As chickpea is a very open-canopy crop, tillage did not have a significant effect on community composition, diversity or species richness. Also, although species richness was similar throughout the field, the presence of green manure during the interval between main crops reduced weed diversity. We also observed a carry-over effect of the first year's fertilization during this phase. Finally, we found a certain spatial structure that should be further studied in order to better understand the effects of our treatments.

Session ‘Sampling and assessing biodiversity’

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Why and how should we study rare segetal plants?

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Rare arable plants were typical inhabitants of cropped fields since the origins of agriculture. Their cultural-historical value deserves they are considered part of human history. However, their survival is now threatened by last decades' agricultural intensification. Conservation concepts and public concern aim at considering these plants as different from other weeds. They have iconic value for European people, and there are national conservation plans, albeit with quite a great disparity between countries. However, rare segetal plants are minute part of the biodiversity, and even their biodiversity and ecosystem service are still not clearly demonstrated.

I wish to discuss here on the interest of studying such plants and the need to assess the relative success of different conservation measures with reference to the ecological requirements of different threatened species. I'll present two European research proposals, one for a research grant and the other for a research mobility and exchange program, and I examine the reasons for which they were unsuccessful and I will give indications on how we can improve the submission. In contrast, I'll show a successful but local grant based on the study of rare plants and agricultural services. The definition of common objectives with a high potential for media impact could be one of the strategies of the Weed and Biodiversity Working Group to get funding and rationalize research and management of these species.

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Functional diversity of weed communities:

a database of functional traits

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Within the context of the FP7 ERA-NET Core Organic II Project TILMAN-ORG, we developed a database of weed functional attributes with the aim of studying the effect of soil conservation practices (reduced tillage, green manure crops) on the functional diversity of weed communities in organic arable cropping systems.

The main goal of the database was to compile information on the potential detrimental effects of weeds on crop yield (disservices) as well as their potential ecological services, to allow a comprehensive assessment of the functional value of weed communities, and to help predict weed community shifts and their consequences from an agroecological perspective.

The weed functional traits database includes information on ca. 250 species recorded in 13 long-, mid- and short-term experiments carried out in different European agroecological zones (Continental, Mediterranean, Atlantic and Baltic) that had reduced tillage and/or green manure as main factors. The database focused on 16 functional traits, separated into (i) indicators of potentially troublesome effects of weeds from an agricultural viewpoint (Raunkiaer life-form, growth form, Grime's CSR strategy, lifespan — reproduction type, seed bank longevity, seed weight, canopy height, specific leaf area, beginning and duration of flowering, seasonality of germination, degree of nitrophily, root system type) and (ii) indicators of potential provision of agroecological services (support of arbuscular mycorrhizal fungi, atmospheric nitrogen fixation, support of pollinators, conservation value). Information on functional traits was obtained from several open access databases (e.g. Biolflor, Ecological Flora of the British Isles, LEDA Traitbase), as well as peer-reviewed literature, floras and National Red lists of plant species.

Application of the database to the functional analysis of weed communities, in no-till vs. ploughed fields, in fields treated or untreated with herbicides, using simple or more advanced (Community Weighted Mean, Functional Dispersion) analytical approaches is presented.

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Is the weed assembly of maize fields affected by maize cropping ten years before?

Redundancy Analysis and “manyglm” in comparison

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In the years 2011 to 2013, a weed survey took place on maize fields in northern Germany. On 224 fields, farmers established a ~100m² plot with at least 20m distance from the field edge, which was not treated with herbicides. In these plots, weeds were identified and counted on ten 0.1m² samples. Additional information about the field history allowed us to identify two types of fields, which were not cropped with maize in the last ten years. In the first case the surveyed year was the first year with maize on the field (“young”), in the second case maize had already been cropped but this happened more than ten years ago (“old”).

Here, we analysed the influence of these two “no-maize”-cases on the weed assembly, ignoring any other influencing parameters. Therefore, we used a classical Redundancy Analysis (RDA) approach and - in comparison to that - a new method called “manyglm”.

We found shifts in the weed assembly reacting on both “no-maize”-cases. The “old” maize fields showed differences in both methods, the “young” maize fields only in the RDA. In the RDA, the most reactive species, in a positive or negative way, were *Echinochloa crus-galli* (L.) Beauv., *Viola arvensis* Murray, *Stellaria media* (L.) Vill., *Poa spp.* and *Matricaria recutita* L.. In the ”manyglm”-method *Achillea millefolium* L., *Polygonum spp.*, *Capsella bursa-pastoris* L., *Echinochloa crus-galli* (L.) Beauv. and *Rumex acetosella* L. had the highest influence on deviance.

Both methods give similar results concerning the weed assembly, while “manyglm” provides better possibilities to tests assumptions of the method.

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Impact of weeds on the colonization of crops by pests and natural enemies: consequences for agro-ecosystem management

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Identifying management options that enhance ecosystem services has become a critical issue. As an important service that could reduce pesticide use, pest control is frequently cited. However, the link between management options, pest control and crop yield is still poorly understood. In particular, the role of weeds in cultivated fields requires more scientific support to identify the species that could favour pest population regulation without competition with the crop.

Movements of predators and parasitoids between crops and weeds imply that insects can colonize and develop on hosts with potentially contrasting characteristics. Weeds can also have an impact on the colonization of the crops by the insect pests and their natural enemies. We compared the suitability of two crops (*Brassica oleracea* L. and *B. napus* L.) and two weeds (*B. nigra* L. and *Sinapis arvensis* L.) as host plants for a common aphid species, the cabbage aphid (*Brevicoryne brassicae* (L.)) and for its main parasitoid (*Diaeretiella rapae* (M'Intosh)). We also recorded colonization of cabbage plants (*B. oleracea*) by aphids and natural enemies under field conditions.

Population growth rate of the aphid was smaller on the two cultivated plant species. Similarly, the performance of the parasitoid was affected by the plant on which the aphid was feeding. Unexpectedly, parasitism rate was lower on *B. oleracea*. Thus, pests and natural enemies may utilize crops and weeds with contrasting impacts on their fitness. Careful spatial and temporal management of weed populations could thus favour pest control in Brassicaceae crops. Other systems should be investigated.

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Sainfoin (*Onobrychis viciifolia* Scop.) as a beneficial crop increasing plant biodiversity and reducing weed infestations in following crops

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Sainfoin is a forage crop cultivated at altitudes higher than 600 meters. Intensification of animal production has caused a decrease in the sown surface so that agro-environmental schemes in the Spanish Aragón region are encouraging farmers to recover this crop aiming to increase steppe bird biodiversity. The present work aims to quantify weed infestations in sainfoin and the possible consequences on a subsequent cereal crop, as well as to measure plant diversity, as no other studies are available.

Sainfoin in the second year of cultivation (S2), sainfoin in the third year (S3), cereals sown after sainfoin (CS), cereals cultivated as monocrop (CM) and organic cereals (CO) were surveyed during the years 2011-2014. Weed flora presence and abundance (% soil cover) in six fields of each type was assessed in May, immediately before mowing. Main problem weeds in cereals (*Papaver rhoeas* L.*, Lolium rigidum* Gaudin and *Avena sterilis* L.) were generally most frequent in S2, lower in S3 and lowest in CS, confirming the theory of seed bank depletion due to the mowing of these weeds prior to seed set. Concerning biodiversity, S2 and S3 contained the highest species richness, CM the lowest. CS and CO had intermediate values. The proportion of perennial species was highest in S2 and S3 and lowest in cereal monoculture. These species probably provide high ecological value as they are present during the months of July-November, when sainfoin is recovering from mowing. This means that the soil is covered poorly and part of the cereal fields is bare.

Session ‘Seed predation’

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Pre-dispersal seed mortality in Centaurea cyanus

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Seed production is reduced by various kinds of pests, including those hosted by the fruit that impact seed ripening and viability indirectly, and those directly attacking the seeds before they are released. This results in pre-dispersal seed mortality, which may have strong effects on plant population dynamics. However, compensative evolution (or co-evolution) could select for fruits with adapted morphology. We wonder if pre-dispersal mortality could limit the population growth rate and contribute to the decline of *Centaurea cyanus* L. (also *Cyanus segetum*, Hill). The present study focused on the occurrence and abundance of seed-feeding insects of cornflower flower heads, and their relationships to capitula size, seed viability and germination.

Larger capitula had lower proportion of healthy seeds. Although no visible damage was observed to the seeds of *C. cyanus*, the presence of cecidomye larvae inside the capitula correlated with seed loss. It seems that gall midges could have a significant impact on ovule fertilization, seed abortion and viability of fully developed seeds of cornflower. A higher rate of aborted seeds in presence of gall midge larvae could have resulted from fewer visits by pollinators, which may have been repelled, or from the deprivation of resources (by the larvae).The viability of the apparently healthy seeds is lower when the capitulum contains aborted seed and/or larvae. In conclusion, pre-dispersal mortality could select against the evolution of the species toward larger capitula, and have detrimental consequences on seed number, viability and germination, which limit the spread of *C. cyanus* populations.

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The duration of seed burial in soil affects consumption rates by carabid beetles after exhumation

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After shedding from the plant and before germination or entering the soil seed bank, predators represent the main cause of seed mortality. Predation of seeds liberated from the soil seed bank is, however, largely unknown. This contribution provides preliminary data on the duration of burial in the soil for 26 species of herbaceous seeds, and how it affects the consumption rates and preferences by the model species of carabid seed predator, *Pseudoophonus rufipes* (DeGeer). Batches of seeds of each species mixed with fine soil particles spent 1-8 years (8 species) or 1-6 years (18 species) buried in the soil in nylon fabric bags. We used dry stored and frozen seeds as controls.

In the first experiment, we presented cohorts of seeds exhumed at particular years to *P. rufipes*, each species separately. In the second set of experiments, we presented all species of seeds from the same cohort simultaneously, using frozen control seeds and 6-yrs buried seeds.

In 13 species of seeds, the consumption of buried seeds was lower compared to controls. In eight species, palatability of seeds after burial was temporarily positively affected as consumption increased in the 1st and 2nd year after burial compared to controls. In four species, burial generally increased the palatability of seeds. Only in one species, there was no difference in consumption among the time cohorts. The order of preference for seeds by *P. rufipes* did not change prominently after the six year burial.

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5th Workshop of the EWRS Working Group: Weeds And Biodiversity
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Large-scale trends in the spatial distribution of harvester ant nests may facilitate weed persistence

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Harvester ants can be responsible for substantial losses of weed seeds in arable fields in semi-arid regions. Despite heavy predation pressure, weeds continue to persist. Apparently, mechanisms exist that allow seeds to escape granivory. A clustered distribution of the nests of harvester ants could be one of these mechanisms, because foraging intensities decline with distance from the nests. Therefore, we investigated variability in the distribution of nests of the harvester ant, *Messor barbarus* (L.), in a 50×150 m area in a cereal field in NE Spain, in 2009 and 2010.

Large-scale variability (up to 150 m), caused by habitat heterogeneity, was present in the data, but could not be explained by simple environmental variables, such as elevation and distance to the nearest field edge, or interpreted as trends across the area. Small-scale variability (up to 12 m), caused by interactions between colonies, was also present, indicating territoriality among nests. Exclusion and interaction zones were identified, with radii that were smaller for small than for large colonies, and smaller for 2009 than for 2010.

Large-scale spatial variability, but not small-scale interactions, may be responsible for the existence of areas with few or no nests, where weed seeds have a higher probability of escaping the ants and entering the seed bank. Large-scale variability in nest distribution could be one of the factors responsible for the occurrence of weed patches. Identifying and understanding the factors that influence the large-scale variability can be helpful in optimizing biological weed control.

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The impact of post-dispersal seed predation on weed population dynamics of *Echinochloa crus-galli* in maize monoculture

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The impact of post-dispersal seed predation on the population of the weed *Echinochloa crus-galli* (L.) P. Beauv. is examined via field experiments in minimally tilled, continuous maize fields in North-Eastern Germany. Post-dispersal seed predators, such as carabid beetles (e.g. *Harpulus rufipes* (DeGeer)) and mice (e.g. *Apodemus sylvaticus* (L.)), feed on newly produced seeds and could, therefore, reduce weed populations by preventing seed input into the weed seedbank.

The experiment is set-up as a complete randomized block design with 6 blocks of 10.5 m x 13.5 m and 12 subplots of 1.5 m by 1.5 m. Six subplots per block are enclosed by a 1.5 m x 1.5 m and 75 cm high plastic frame to prevent access to the subplots. The potential of post-dispersal seed predators to lower weed populations is examined over the course of two years by following the fate of a single seeding of *E. crus-galli* at different densities (0,300, 600, 1200, 2400 seeds m^{-2}) in the subplots. The experiment is repeated on three fields.

Important demographic rates, namely seed mortality, seedling recruitment, seedling survival, fecundity and viability of the newly produced seeds and seed predation rate will be estimated and used to parameterize a population model of *E. crus-galli*. Experimental and modeling results will demonstrate whether post-dispersal seed predation could play a role in lowering weed populations. If so, this would proof that seed predation is an ecosystem service and worthwhile to be promoted for enhancing seed predators as a tool for weed control.

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Interactive session on topics for collaborative research

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Collaborative work on ‘weed biodiversity’

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Discussion on collaborative works on rare plants protection

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During the session, I presented the interest of studying rare plants and the need to assess the relative success of different conservation measures. Besides its rationale and the diverse benefits for agriculture, biodiversity and human heritage, I discussed the hassle of getting money to setup programs and get money from national and European agencies. Being sexy for decision-makers and explaining key questions for reviewers was illustrated by deciders'' responses to three calls for public tender for research proposals in the area of agriculture and biodiversity.

One proposal was for a European research grant on restoration of arable plant communities. Ten of the 52 eligible projects were accepted. Feedback to applicants pointed out some "scientific weakness" such as 1) Data very specific to single field: wider soil, climate and management conditions; 2) Reasons to rely on specific weed species; 3) Reasons for regular farming rather than set-aside, organic or bio-energy fields. The response to these comments is obvious from our point of view, but this must lead us to carefully explain the pros and cons to the experts that are botanists or agronomists or ecologists but rarely handle all expertise together. Indeed, the main social impact weakness opposed to our project was the appropriateness of Botanical Conservatories involved as stakeholders.

A second proposal aimed at a grant for a research mobility and exchange program (COST) among ten countries on a similar topic. Only ten proposals get financial support. Comments pointed out that the description was too soft and hardly convincing or lacking scientific facts, scientific instruments were not adequately described and explained, and innovation need to be better explained in more depth, and the protection of genetic resources by strategy of sustainable use was not planned. All these items are not as easy to achieve when data and facts are lacking due to a poorly developed research domain, when previous cooperation to harmonize projects has been inexistent because of lack of support, and when readers are not aware of the specific status of rare weeds versus "regular" wild endangered species.

In contrast, unexpectedly, we get success at national-level for a research grant on the selection of cornflower (a weed !!!) as a provider of agroecosystem services. Of course, the topic was highly sexy in the framework of the Agroecology concept. Surfing on the agro-system green wave, showing evidence of segetal-specific eco-services and value as indicator of high environmental value are very important nowadays. Involving social actors and policy makers also is a valuable bonus to the project as it talks about common place of deciders. The definition of common objectives with a high potential for media impact could be

one of the strategies of the Weed and Biodiversity Working Group to prepare high value plug-and-play projects.

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Proposal for collaborative research on granivore identity

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It is known that seed predators (granivores) can consume large proportions of newly produced weed seeds. This way, they can prevent or strongly limit new seed additions to the seed bank, which can help reducing future weed problems.

The identity of the main seed predators varies strongly from region to region. Sometimes, a clear reason can be found for the presence/absence of a specific type of seed predator. For example, harvester ants are almost exclusively found in arid and semi-arid regions where the underground storage of dry seeds makes sense. The presence/absence of some granivorous farmland birds has been correlated with seed availability, in particular during the overwintering of the animals and the raising of chicks. However, often a clear explanation is lacking. In some regions, carabid beetles are the dominant seed predator, in others it is crickets, or granivorous rodents.

Knowing the identity of local seed predators is important for three reasons. Firstly, harvester ants and granivorous rodents, in general, seem to be able to eliminate a larger proportion of weed seeds than do carabid beetles or crickets. In the case that harvester ants and granivorous rodents are absent from a region, one could choose to implement measures that support the less effective seed predator that is present, or measures that enable the return of the more effective seed predator. Secondly, knowing the identity can help explain observed patterns in spatial and temporal variability in seed predation and seed preferences. Species of seed predators differ hugely in mobility, body size, daily and yearly activity patterns, overwintering strategy, habitat requirements, etc. Thirdly, because of these differences, seed predators are bound to respond differently to environmental conditions, management, or landscape complexity. When trying to enhance seed predation, approaches tailored towards a specific type of seed predator are likely to be more effective than blind approaches.

An extra obstacle in dealing with the spatial distribution of seed predators is the absence of historical accounts. It is often unknown whether the observed distribution of a seed predator reflects the natural niche or is human-induced. Farmland birds form an exception. In several EU countries, population trends have been monitored since the 1980s. Species distribution modelling (ecological niche modelling) can help to distinguish between natural and human-induced niches, and can help determining the potential distribution of a species. However, for this technique information is required on the identity, …

presence/absence or density of a species over large areas. This is where I would like to call upon the international community for assistance.

Simple techniques exist to determine whether seed predation is caused by vertebrates or invertebrates (exclusion cages; presence/absence data). It may even be possible to distinguish between the main types (selective exclusions). More complicated, laborious or expensive techniques are required to determine the identity (e.g., camera trapping) and densities (pitfall traps, nest counts, bird sightings, rodent life traps, footprint traps) of the seed predators involved. Depending on interests, experience and facilities, different protocols can be designed to maximize information output.