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The development of a predictive indicator to assess the effect of agricultural practices on plant diversity in margin strips and their ecosystemic services (Pollination and Conservation flora)

Charles Ricou, Bernard B. Amiaud, Sylvain Plantureux, Christian C. Bockstaller

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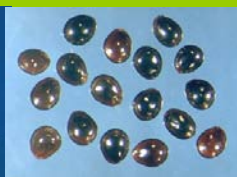
4th Workshop of the EWRS Working Group

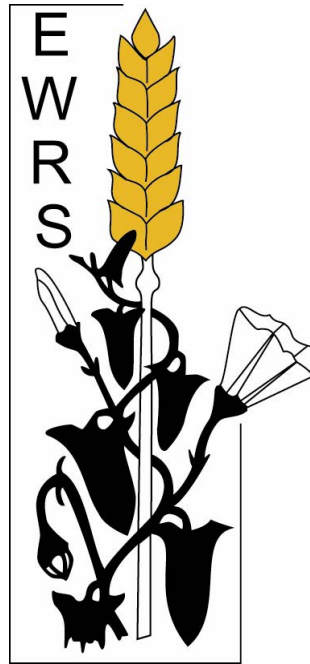


WEEDS AND BIODIVERSITY



Dijon (France)
28 February–3 March 2011





European Weed Research Society

4th Workshop of the EWRS Working Group Weeds and Biodiversity

AGROSUP, Dijon, (France)
28 February - 2 March 2011



4th Workshop of the EWRS Working Group: Weeds and Biodiversity
AGROSUP, Dijon, (France) 28 February – 2 March 2011

Organising Committee:

Bruno CHAUVEL, Henri DARMENCY, Fabrice DESSAINT, Sabrina GABA,
Etienne GAUJOUR, Jean-Philippe GUILLEMIN, Sandrine PETIT

Scientific Committee:

Bruno CHAUVEL, Henri DARMENCY, Fabrice DESSAINT, Sabrina GABA,
Bärbel GEROWITT, Jean-Philippe GUILLEMIN, Sandrine PETIT

Training Session: *Seed predation studies and methodologies*

Adam DAVIS, Bärbel GEROWITT, Sandrine PETIT, Paula WESTERMAN

Sponsored by L'INRA, AGROSUP Dijon, l'EWRS

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EWRS Working Group: Weeds and Biodiversity

Coordinator: Bärbel Gerowitt

This Working Group (WG) focuses on the role and contribution of weeds to conservation aspects and ecosystem services in agro-ecosystems. Without neglecting the damage caused by weeds in various ecosystems, the WG fosters discussion and research on reasons why weeds could be tolerated in agrosystem or even be supported by farming activities. These reasons can be:

- being endangered plant species – conservation aspects and insurance for possible use;
- being the base of trophic chains in the agroecosystem – biotic ecosystem services;
- preventing water or nutrient losses – abiotic ecosystem services;
- being objectives for public transfer payments to agriculture.

Species composition, population size and spatial distribution of weeds are mainly determined by agricultural activities at various space scales – hence, maintaining or even enhancing weed species, communities or populations is also widely an agricultural business. Interest around these topics is growing in Europe and elsewhere. Therefore, the Working Group is an agricultural platform integrating related botanical, ecological and economic expertise within and outside EWRS. Research is demonstrating the importance of weeds for many other taxa in farmed landscapes. With greater appreciation of the complex ecological interactions within agroecosystems and with regulatory organizations examining the impact of non-target effects of pesticides, this WG provides a forum for discussion between members and enhance relevant research. Contributions in the form of questions, discussion points, information about projects or deliverables are always welcome.

The 4th workshop is hosted by AgroSup Dijon on 28 February - 2 March 2011 in Dijon (France). An optional half-day training is held on March 3rd to share know-how and projects about seed predation studies (organized by Adam Davis, Bärbel Gerowitt, Sandrine Petit and Paula Westerman).

The Working Group had its 3rd workshop in Lleida (Spain) in March 2009. The Proceedings of this workshop are available online at <http://www.ewrs.org/biodiversity>. From the same webpage you can also download the Proceedings of the 2nd workshop (Salem, Germany, March 2007).

Activities of the Working Group are now focused (but not restricted to):

- (a) Ecosystemic services: the link between weed seed availability (feed for vertebrates and invertebrates) and ecosystem services (self-regulation processes) is an objective of several experimental activities.
- (b) Farming systems and arable weed diversity: analysing the bilateral relationship between diverse arable systems and diverse weed populations.
- (c) Socio-economic aspects of diverse weed vegetations: who is interested in weed biodiversity? Can diverse weed communities contribute to farmers' income?

We seek to identify key research needs and to develop relevant research, including collaborative programs, via national and international funding opportunities. As for any EWRS Working Group, membership is free and not restricted to EWRS members, therefore anyone is encouraged to take part in the WG activities. Please contact Bärbel Gerowitt (University of Rostock, DE), the WG coordinator, to become a member and/or to get more information on the WG. You can also access more info via the Working Group web site at biodiversity@ewrs.org

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Invited Speakers

Attracting Farmers for producing Weed Diversity – Issues of Socio Economics and Administration

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Abstract

Weed Diversity, as well as biodiversity of farm and landscape, is generally not considered as a farm product. To enhance this diversity farmers participation could be stimulated in three ways: i) convincing farmers for volunteer offering of more diverse crop stands and landscapes, ii) attracting farmers for increased participation in agri-environment schemes, iii) implementing legal constrains for mandatory biodiversity measures. In the EU all these ways are available in different modifications or at least are matter of discussion for agricultural policy of the next decade. Discussing the promotion of biodiversity according to weeds by schemes or administrative rules, it is essential to distinguish between weeds as a biodiversity product itself or weeds as a functional element of diversity amongst others. Indeed, this differentiation is not a biological issue but an administrative one.

When farmers should be paid for weed diversity as a product itself, two approaches are to be mentioned: i) farmers participation in a programme according to a catalogue of mandatory agronomic practices which are proven to preserve weeds, ii) installation of a payment-by-results approach where previously defined outcomes of biodiversity are rewarded.

During the last 4 years our working group was involved in several approaches to develop agronomic and societal instruments for the establishment of higher weed species diversity on farmers fields. Therefore a payment-by-results approach was tested to attract farmers for tolerating higher weed species numbers in their fields. Furthermore, agronomical studies were carried out to identify cropping practices enabling farmers to produce desired weeds. Additionally, socio economic calculations of farmers costs and studies on societal and administrative issues were included.

The social studies indicated that rural inhabitants justify funding for ecological goods preferentially to species-rich grassland, orchards and buffer strips. Fields with elevated weed species numbers are considered less important. So, paying farmers for preservation of weeds must be accompanied by scientific expertise because weedy fields might not receive highest value in the public view.

Sampling strategies to assess biodiversity of weeds: what is carried out today?

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Abstract

The present political shift towards more sustainable agricultural systems has recently modified scientific questioning for weed research. If former questions such as effects of cultural practices or economic thresholds are still studied, new challenges (interactions with other organisms, effects on the functioning of the agro-ecosystem) are now taking into account. If practices affecting weed communities richness or diversity have traditionally been studied at the within-field level, landscapes and effects of environmental heterogeneity requires studies on scales larger than the field and its surrounding margins. The necessity to go beyond simple correlations between landscape parameters and weed communities require to take into account neighbouring habitats and to propose realistic sampling methods. The patchy distribution of weed populations with patches of a varying size and density and areas with no plants remains a problem in the weed density estimation. In the same way, spatial distribution of weed population knowledge needs new methods to make maps as well as to collect data to develop new strategy management. We discuss the key questions to design more efficient sampling strategies to evaluate the weed community. In addressing these questions, we hope to help researchers to develop more optimal sampling. But, it seems that definitive protocol is still far from having been achieved as objective of studies are now very different: does the effect of a cultural practices in terms of efficiency or functional diversity be estimated with the same sampling method.

New approaches to understanding weed seed predation in agroecosystems

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Abstract

Postdispersal predation of weed seeds in arable systems can be a valuable ecosystem service, with the potential to support ecological approaches to weed management by reducing inputs to the soil seed bank. Scientific understanding of factors regulating weed seed predation rates is still insufficient, however, to enable producers to consistently manipulate predator activity with the aim of increasing postdispersal seed losses. Two recent methodological advances highlight key considerations for future studies of weed seed predation. First, whereas most measurements of weed seed predation are made at very short (hours to days) time scales due to rapid weed seed removal by granivores, the ultimate impact of seed predation on weed population dynamics is realised at a longer (monthly to annual) time scale. It is now possible to scale sequential estimates of seed predation rates made at a daily time scale to seasonal or annual rates using a simple function, verified through empirical tests in Europe and the USA. Iterative resampling indicates that for maximum predictive power, experimental units should be allocated primarily towards adequate temporal representation within the desired study period, with a secondary focus on spatial replication and comparisons of management treatments. Second, empirical studies weighing the relative importance of abiotic and biotic influences on postdispersal weed seed predation suggest that both bottom-up (intrinsic to seed predator) and top-down (extrinsic to seed predator) processes must be considered to fully understand the ecological context for seed predation. In particular, evidence of top-down control of both invertebrate and vertebrate granivores by their predators indicates that granivory should be studied within the broader scope of agricultural food webs.

Session 1

Agriculture and Biodiversity

Weed biodiversity is not related with yield loss risk – a calculation for German oilseed rape fields

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Abstract

Manipulating weed species composition into a desired and manageable direction is essential for the protection of arable biodiversity and for integrated weed management. However, there is no consensus between ecologists and agronomists about what is desirable regarding the quality and quantity of weed vegetation and the associated risk of yield loss.

In this study data on the occurrence of weed species in 1461 German oilseed rape fields were used to investigate the relation of weed biodiversity and the risk of yield loss due to weeds. Species abundances were weighted by species specific competition values that had been derived from field experiments and biological traits of the species. The risk of yield loss due to weeds was determined as sum of the weighted abundances for each investigation site. On the basis of medians of species richness ($S \geq 9$), the evenness ($J \geq 0.78$) and the risk of yield loss fields were classified into sites with “desired” and “undesired” weed vegetation. Logistic regression analysis with management and site data (12 resp. 8 parameters) was used to find factors correlated with the “desired” weed vegetation.

16 % of the fields were found to contain highly diverse weed vegetation which caused a relatively low risk of yield loss. Risk of yield loss was negative correlated to the evenness of weed vegetation and fields with highly balanced weed vegetation usually showed low potential yield losses regardless of how many weed species were involved. Consequently, high weed biodiversity does not necessarily imply high yield loss due to weeds.

The percentage of variation (Nagelkerke's R^2) accounted for by management factors was 6 %. The most important single factor was the region the field was situated in (Nagelkerke's $R^2 = 8$ %). “Region” probably represents a range of parameters which are not explicitly handled in this study. One major component could be historical differences in weed management. Hence, agricultural policies and cropping intensities in the different regions of Germany could result in different regional seedbanks.

The impact of agricultural intensification and land use change on the European arable flora

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Abstract

Plants adapted to arable habitats are among the most threatened groups within the European flora. A number of changes in crop management and land use, including increased use of agro-chemicals and the abandonment of marginal land have been implicated in their decline. We conducted a survey of the threat status of this vulnerable group of plants across 29 European countries. An agricultural botanist from each country was invited to fill in a questionnaire. They were first asked to identify any plants on their national Red Data List which were particularly associated with arable habitats. A second list was also requested of plants that were known, from expert knowledge, to be declining or threatened but were not currently on the Red Data List. The European distribution of each species cited in a questionnaire was obtained from the Flora Europaea and the proportion of species present in each country that were identified as rare or threatened was calculated. This variable was modelled against agricultural and land use statistics using Generalised Linear Models.

The countries with the highest numbers of rare or threatened arable plants were concentrated in central and north-western Europe with Germany, Austria and Switzerland at the top of the list. Variability between the countries was significantly explained by a combination of wheat yield and the proportion of arable land. The most threatened plants tended to be those adapted to specific crops such *Camelina sativa* in flax and *Bromus grossus* in spelt. These species have become rare across Europe as areas of these crops have declined. More generally, the increased use of agro-chemicals and abandonment of marginal land has selected against a group of plants with a short stature and / or a large seed. These plants tend to be adapted to habitats with low or intermediate fertility – habitats that have declined with the increasing use of fertiliser. A large seed is correlated with low fecundity and the populations of these species are, therefore, less able to buffer against herbicide mortality. There is an urgent need to implement conservation strategies for this important group of plants on a continental scale.

The application of agri-environment schemes in semiarid landscapes in NE of Spain involves changes on weed flora ?

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Abstract

Within the agri-environment schemes proposed in semiarid arable land in NE of Spain (Catalonia), the implementation of conservation agriculture (CA) techniques (e.g. direct drilling) are included in those protected ZEPA areas, where the preservation of steppe birds is a priority. Recent studies demonstrate that CA provides environmental benefits and also contributes to maintain biodiversity. However, CA techniques can also cause changes on the composition of the weed flora, which make management more dependent on herbicide application and, thus, it has become an important constraint to adopt these CA techniques. In this sense, a study of the effect of conventional tillage and direct drilling on the richness and diversity of weed flora was carried out in 28 pairs of cereal fields during the season 2009 and 2010. Two surveys were made in the center and other two in the margins of each field between April and May.

116 and 112 weed species were found in 2009 and 2010 respectively, and in both years richness was higher in field margins than in field centers and in direct drilling than in conventional fields in 2009, but not in 2010 (Table I). Shannon α values reflect similar pattern as richness. The fact that richness and diversity (Shannon) was higher in conventional fields than in direct drilling in 2010 might have happened because of a better management of the fields in direct drilling that year. Despite this, the variability between fields under direct drilling is greater than in conventional fields, except for the field centers in 2010 (β values in Table I).

Weed composition was also observed in function of the soil management applied. Higher differences were observed between margin and field centers than between direct drilling and conventional fields. If any difference was found in weed flora composition in 2009 between both types of management, this tended to decrease in 2010. Independently of the management, data demonstrate the value of the cereal field margins as a refuge of weed flora in Mediterranean semi-arid landscapes and that conservation strategies should focus on them.

Table 1: Richness (mean number of species per field) and Shannon values for margins in direct drilling (SDM), field center in direct drilling (SDI), margin of conventional field (CNM) and center of conventional fields (CNI) in 2009 and 2010

	SDM	SDI	CNM	CNI
Richness 2009	11.8	8.4	8.2	4.7
Richness 2010	7.8	2.0	9.3	3.4
α Shannon 2009	0.98	0.84	0.90	0.76
α Shannon 2010	1.32	0.86	1.64	0.99
β Shannon 2009	1.27	1.41	0.75	1.09
β Shannon 2010	1.55	0.07	0.71	0.65

Do landscape characters affect the diversity of plants on farms?

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Abstract

Ecosystem diversity is based on the diversity of plants present within a system. In an arable farming context this equates to the vegetation present outside and within fields. The evidence indicates that the greater the plant diversity the greater the diversity of higher trophic groups is likely to be. An issue of some debate is how much of this diversity should be outside fields and how much within the crops. The UK project Farm4Bio (2006-2010) has been endeavouring to identify the impact of field margins (both sown and semi-natural) on overall diversity on 28 farms (100ha/farm) in southern England. As part of this work the heterogeneity of the landscapes has been monitored as well as the diversity of plant species on and off fields. It has been suggested by some researchers that the diversity of plant species within fields is associated with the overall heterogeneity of the landscape – the more heterogeneous the landscape the greater the number of plant species in fields. This paper will explore the links between weed species number and total plant species number, and landscape characteristics of the 28 studied farms.

Autumn crocus (*Colchicum autumnale*) – a conflict species for agriculture and nature conservation?

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Abstract

High densities of the toxic *Colchicum autumnale* may endanger grassland management in Austria. Since the toxic components persist in hay and silage, the continuation of the management of these grasslands, which are often characterised by a high biodiversity, is uncertain. This study examines the perception of the farmers concerning the occurrence, dynamics and related problems with *C. autumnale*. Moreover, we discuss the impact of nature conservation regulations, e.g. within the context of agri-environmental programmes, on *C. autumnale*.

Data were obtained by 144 face-to-face interviews with farmers in four regions of Lower Austria from 2007 until 2010. The semi-structured interviews contained questions on the management of grassland with *C. autumnale*, its occurrence level and dynamics, related problems and control measures.

An increase of *C. autumnale* was reported by 48.6% of all farmers on at least one plot of their farm. This trend was especially strong in the region of the Danube/March floodplain (78.6%). The management of the entire grassland in this region has to fulfill nature conservation regulations. On average 56.9% of all farmers participated in agri-environmental programmes with nature conservation regulations. Many farmers in the Danube/March floodplain region traced the increase of *C. autumnale* back to the fertilization ban of the national park. 16 out of 17 farmers, who reported a decrease, have intensified management by either applying more fertilizers or increasing cutting frequency. Farmers reported an increase significantly more often if their grasslands were subject to nature conservation restrictions ($p=0.001$ Chi-Square test). 25.7% of all interviewees have already tried to reduce *C. autumnale* by various measures. Most problems occurred if farmers had to sell hay with *C. autumnale* to riding stables.

Agricultural management of grasslands with high densities of toxic weeds has to be adapted to fulfil economic and ecological needs. Therefore, it is necessary to optimise management regulations to secure high nature value grassland and long-term agricultural management.

Do Agri-Environmental Schemes (AES) enhance weed diversity?

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Abstract

Voluntary Agri-Environmental Schemes (AES) are the main tools of the European Agricultural Policy aiming at reducing the negative environmental impacts of agriculture. Existing AES-schemes primarily designed for bird and groundwater protection might arguably also have impacts on weed communities such as increases in abundance and diversity due to restrictions on herbicide and fertilizer use, soil tillage intensity and forage harvest dates. This might be beneficial for farmland biodiversity yet negatively impact crop production. This hypothesis was tested in the Chizé region (western France). Weed diversity and species composition were measured in 503 fields either without or with AES-contracts of varying types and application times (1-6 years) in 1) annual cereal crops and 2) perennial forage crops.

1) In cereals, five AES-schemes were investigated: A) reduced soil tillage, B) limited herbicide application (IFT) to 60% of the reference, C) limited nitrogen fertilization to 120 units ha⁻¹ y⁻¹, D) B&C combined, and E) organic farming. While organic farming led to slightly increased weed species richness, schemes A-D had no impacts on weed species richness. These preliminary results suggest that (a) the investigated bird and groundwater-directed AES-schemes do not immediately enhance plant abundance and diversity in cereal crops and that (b) herbicide and fertilizer inputs might be reduced without increasing weed infestation.

2) On the contrary, in perennial crops, six different AES-schemes were studied (including restrictions or interdictions of fertilizers and/or herbicides and/or specifying the crop species), most of which had positive impacts on plant species richness. However, restrictions on hay cutting dates (bird nest protection) had no additional positive effects. In general, the magnitude of the impacts increased with the duration of contract application. Multivariate analysis of similarities (ANOSIM) and indicator species analysis (ISA) showed that species composition varied significantly between some types of AES-contracts, while pairwise differences to control fields were rarely significant.

These preliminary results suggest that the effects on weeds appear only after some delay which may question the current practice of 5-year-contracts. However, several previous studies (Meiss 2010) showed that the introduction of rather short periods (3-5 years) of perennial forage crops into cereal-based crop rotations might be beneficial both for biodiversity conservation AND preventative weed control.

Meiss (2010) Diversifying crop rotations with temporary grasslands: potentials for weed management and farmland biodiversity. PhD-thesis Université de Bourgogne, France & Giessen University, Germany, 233 p, available at: <http://geb.uni-giessen.de/geb/volltexte/2010/7803>

Poster

Landscape complexity does not compensate for the negative effects of land-use intensity on weed flora in Mediterranean cereal fields

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Abstract

Most of the available literature on biodiversity in agroecosystems states that land-use intensity and landscape complexity could potentially affect weed flora of arable fields. However, research on the effect of these facets of agricultural intensification has produced opposing results. In this study, we evaluate the relative importance of both factors on weed species richness and weed community composition in the centre of organic and conventional dryland cereal fields selected along a gradient of landscape complexity in central Catalonia. The percentage of arable land plus human settlements was used as a surrogate for landscape complexity and the amount of nitrogen inputs for land-use intensity. We surveyed the seedbank, which could reflect the long-term effects of the agricultural intensification, and the emerged vegetation with and without weed control, to obtain comparable values of the weed flora overcoming differences caused by weed control effectiveness. Moreover, by suppressing control practices in a given year, the effects of the agricultural intensification process can be evaluated more accurately.

Our results point out that intensive management causes species richness decline and, to a lesser extent, changes in weed assemblages. Intensive land-use had more detrimental effects on weeded plots, which is clearly related to the direct negative effect of weed control practices. Besides, their experimental suppression and the analysis of the seedbank revealed that weed species depletion was not only the result of the current weed control, but that intensive management exerts long-lasting negative effects, leading to a certain level of weed species pool erosion. Contrariwise, our findings, either from the emerged vegetation or the seedbank, do not support any effect of landscape complexity on weed flora of field centres. Thus, complex landscapes do not compensate for the negative effects of farming intensification on weed flora. Accordingly, strategies of weed flora conservation within arable fields in a Mediterranean context should focus on promoting low-intensity agricultural practices, since they benefit arable weeds in field centres irrespectively of the surrounding landscape.

Poster

Segetal plants network enables farmers, natural environment managers, teachers and researchers to meet and share data and practices in order to protect biodiversity

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Abstract

In order that the issue of segetal plants do not remain the only field of experts, it is necessary to raise people awareness and to train the actors of the rural world. Accordingly the segetal plants' network has been set up to build awareness-raising tools and training resources on segetal plants in 2006. It connects actors of agricultural education, researchers, farmers and professionals in nature conservation, to capitalize and share data showing the role segetal plants play in the agroecosystem functioning.

The wiki collaborative website - <http://www.cdrflorac.fr/Messicoles/> - is set up and managed by Supagro Florac, thanks to the implication of the ministry of Agriculture, the ministry of Ecology and with the participation of Europe through the European social fund (ESF). Each year people implied in such actions meet in order to exchange on what they do in the field of segetal plants, to create technical and educational resources they put at the disposal of all actors interested by such a topic. Master degrees' students doing research on segetal plants also take an active part in creating resources.

The segetal plants' network has already issued six data files and ten technical documents. Today other educational files are still in preparation. The whole literature on segetal plants has largely been disseminated to the different following partners : agricultural education, office of the protection of the environment, agricultural development and research network, and been used in many contexts. A film is also being created presenting the issue and stake of segetal plants on biodiversity. Moreover different educational projects have been set up within agricultural vocational high schools and colleges.

The segetal plants network actively contributes to the national action plan for the conservation of segetal plants on biodiversity developed by the Ministry of Ecology.

Poster

Which species are adapted to grow in sown grass strips? not annual !

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Abstract

Since 2005 French farmers have established sown grass strips with perennial grass species at the edge their field along streams and rivers. The spontaneous species could easily grow because spraying herbicides is prohibited on these areas. Previous studies identified that sown grass strips were a richer habitat in comparison with the adjacent field and harboured a large plant diversity. However, do all these species have biological traits adapted to the selection pressures and life conditions in sown grass strips? This study aims to identify the biological traits of spontaneous species that could explain their frequency and abundance in sown grass strips.

Vegetation of grass strips was surveyed in 75 grass strips located in two French departments dominated by arable crops, Côte d'Or (Eastern France) and Deux-Sèvres (Western France). A score combining the frequency and the abundance was calculated for each species. The 125 spontaneous species were described with 8 biological traits: F-, L- and N-Ellenbergs values, the biological Raunkiaer type, the Grime strategy of establishment, the size at the flowering stage, the period of fructification and the botanical classification (grass or forb). Species were pooled in functional group with a multiple component analysis and hierarchical classification analysis. Statistical tests identified the discriminating attributes of biological traits for each functional group.

The results showed 4 functional groups. The first was mainly composed by grasses, geophytes, tall species with CS-strategy. The second was composed by therophyte forbs with CR-strategy fructifying from spring to autumn. The third was composed by hemicryptophyte tall species with C-strategy fructifying from spring to summer. Finally, the fourth was composed by therophyte, ruderal and small species. This last group showed a significant smaller median score (Kruskal-Wallis test, $H = 11.7674$, $df = 3$, $p\text{-value} = 0.008$) indicating that these attributes seemed to be disfavoured to species to maintain their populations in sown grass strips.

These results contribute to explain the decrease of annual species in these perennial habitats without soil tillage where competitive grass species were sown. In consequences, the establishment of sown grass strips seems to reduce the area of the habitat of annual species and notably of segetal species. These results encourage to conclude that environmental measures could have detrimental effects on the diversity of certain plant communities.

Key words : biological trait, functional group, annual species, agri-environmental schemes, biodiversity

Poster

Balancing biodiversity conservation and weed control purposes in Mediterranean arable fields: lessons from seedbank analysis

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Abstract

Understanding the effects of agricultural intensification at local and landscape scales on biodiversity is an issue of widespread concern. Nevertheless, there are few studies addressing their effects on arable seedbanks at a regional scale. Weed seedbanks are good indicators of medium and long-term influences of management on weeds, allowing to overcome the effects of short-term environmental stochasticity and management. As arable seedbanks are a reserve of weed diversity and the primary source of weeds in cultivated soils, their management should consider both biodiversity conservation and weed control purposes.

In this study we focus on the effects of management practices and surrounding landscape on weed seedbanks. To this end, we surveyed seedbanks from 30 paired organic and conventional cereal fields located in central Catalonia (NE Spain), within a gradient of landscape complexity. We evaluated the effects of distance to the margin (edge vs. centre), farming system (organic vs. conventional) and landscape complexity (percentage cover of arable land and associated human settlements) on seedbank size and specific richness. Furthermore, information from agricultural practices for the last 5 years was obtained from personal interviews with farmers and the relationship between concrete management practices and weed seedbank was analysed.

Our results indicate that field edges and organic fields have more species-rich, larger seedbanks than, respectively, field centres and conventional fields. Landscape complexity had a limited effect on arable seedbanks: it only affected species richness at the edges. Consequently, the promotion of low-intensity farming practices, especially at the edges, would be an efficient measure for conservation purposes in Mediterranean agroecosystems. However, organic seedbanks were also very large, especially among some problematic weeds (i.e. *Papaver rhoeas* and *Lolium rigidum*), what points out the need for more accurate seedbank management to avoid weed infestations. In this sense, our results highlight that organic farmers should improve their seed cleaning procedures to reduce seedbank size and that the implementation of complex rotations is a good tool for seedbank management, because they do not affect species richness while they reduce seed abundance.

Poster

Role of novel methods in Organic Weed Management

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Abstract

New learning methods have reached significant importance in education in the last decade. Application of novel technologies is a great challenge and opportunity as well for universities to follow the direction where education develops. The aim of this paper is to introduce two strong initiatives as examples how novel technologies can serve the education of weed sciences.

CerOrganic is a two year Leonardo da Vinci Multilateral Project financed by the European Commission that aims to develop and test a quality assurance procedure for the vocational education/training of agricultural advisors/trainers in Organic Agriculture, based on the European Quality Assurance Reference Framework (EQARF).

In the CerOrganic Training of Trainers Summer School academic lectures (presentations) and practical sessions (hands-on e-learning material, field visits) on principles, methods and practices in Organic Agriculture will be discussed.

As for agro-ecological weed management, which is going to be an integrated component of the 7-day course, the task is to discuss the most important questions: how we can solve weed control by agro-ecological weed management.

Green Plant Protection (GPP) will provide an easy access to all key issues of plant protection in ecological agriculture using web platform designed for standard (www.greenplantprotection.eu) and mobile version (m.greenplantprotection.eu). Internet is the key media of modules designed for eLearning and mLearning environment and the content can easily be upgraded. Training material is prepared in Slovak, Hungarian, Italian and English languages. Users will access the on-line learning resources after the registration on the web site.

The project will provide useful information for developing environmentally safe agricultural technologies heading to sustainable development that is one of the top priorities of European Union. GPP is dealing with animal pests, plant pathogens and weeds in cropland. A concise description in table format with hyperlinks to pictures and photos helps the users to identify the problematic weed first, then familiarize with the damage the weeds cause and the possible control methods.

The project and its deliverables will offer additional career development training for users, and the practical implications of the project could significantly contribute to a reduction in the use of pesticides in agriculture.

Poster

Long term effects of farming on weed seed bank size and diversity in arable fields

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Abstract

Agricultural intensification over last decades has caused a loss of aboveground weed diversity and also has had its effects on the composition of soil seed bank. Organic farming is an alternative to conventional agriculture that could enhance both aboveground and seed bank biodiversity. The effects of farming management would be more reliable on weed seed bank because it is the result of processes that have occurred in the past and consequently it could better reflect the agricultural processes over the years overcoming differences in weed control effectiveness among fields at least in the sampling years. This is why the assessment of the soil seed bank in a long-term study could be very interesting.

The aim of our study is to determine the long term effects of different farming systems on the size of the soil seed bank, shifts in species composition, diversity and evenness, functional traits (e.g. growth and life-form and pollination type) and also on habitat preference of species. To this end, we carried out this study in potato crops under organic and conventional farming practices within a replicated, long-term experiment [DOK (bioDynamic, bioOrganic, Konventionell) trial, Therwil, Switzerland]. Seedlings of soil samples under greenhouse conditions from DOK trial plots were periodically identified and counted.

Our results show that long-term management on arable fields has significant influence on the size and composition of the weed seed bank. Seed abundance and species richness were higher in organic than in conventional farming systems, because of less intensive weed control management. Functional traits did not vary among farming systems, so management intensity is not yet reflected on the functional traits of species of seed bank. However, the relative importance of habitat preference of species was significantly different between farming systems, showing a greater proportion of typically non-weed species in organic and biodynamic systems, which indicates a reduced farming intensity. In this way, higher species richness and abundance under organic management with the entrance of species from other habitats is not a potential problem because of mechanical control but therefore it would enhance and stabilize the upper food web relations in agroecosystems.

Poster

Weed diversity assemblages in cereal fields related to irrigation gradients in important birds areas (IBAs)

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Abstract

In the NE of Iberian peninsula seminatural arable land conservation is a priority that is regulated by the EU with the aim to protect different threatened birds. In this sense, thousands of dryland cereal hectares are excluded from irrigation in spite of the construction of Segarra-Garrigues irrigation channel and their derived infrastructures. Farmer's claim for water is increasing the possibility to use it only as a partial support to improve crop production as well as preserve the avifauna. In order to know how an irrigation gradient increase affects weed diversity, surveys of weed flora were made in 5 different areas with different irrigation intensity. The results showed that only in these intensively irrigated areas, weed composition changed significantly, whereas low water supplies in these semi-arid cereal systems do not involve significant changes compared to these not irrigated areas. The potential use of weed flora as an indicator of abiotic conditions and agronomic management applied in these rainfed areas is discussed.

Session 2
Sampling and Assessing Biodiversity

A hierarchical model for weed mapping from field data combining weed counting and qualitative abundance notes

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Abstract

Weeds are a potential threat for ‘cash’ crops. They are generally not uniformly arranged across a field or a landscape. To evaluate the need for control measures and the response of weed populations to cultural practices and environmental variables in large commercial fields, a realistic description of these populations with a spatial dimension is needed.

One way to get that knowledge is to make weed maps. Most weed maps in literature were generated with kriging which has been criticized for producing weed maps with less variation in the population at short distance than is realistic. Moreover, (co-)kriging may lead to poor interpolations when dealing with weed quantification of two different types i.e. counting and abundance class and is difficult to apply when sampling unit sizes are heterogeneous. Thus, the development of new spatial interpolation methods is required.

We developed a hierarchical spatial model for producing weed maps. The model accounts for different types of information i.e. counting and abundance classes, and for different size of the sampling units. Hierarchical Bayesian modeling was used to predict abundance maps for frequent weed species in a conventional and integrated weed management cropping systems. Weed maps can be used for analyzing crop yield loss due to a complex weed community, or for studying species interaction e.g. competition. Estimations obtained by the model and the effect of the cropping system on the spatial distribution of weed species will be discussed.

Multivariate analysis of a maize field survey in Germany

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Abstract

Multivariate statistics has become usual in the analysis of weed communities in the last decade. Especially different methods of ordination are used to evaluate their structure and composition. Some prospects of these methods applied to large datasets are shown here.

A field survey in 2602 maize fields in Germany was conducted in 2000-2004. The monitoring was organised by Syngenta Agrosience and the University of Hohenheim. Weed densities of $10 \times 1/10 \text{ m}^2$ in each field were recorded during the 2- to 6-leaf stage in unsprayed plots. Possibly influencing factors were collected by interviews of farmers. We received the dataset for secondary analyses.

Data from national databases were added to the original data.

After eliminating empty lines, less important factors and excluding the less frequent species there were 1103 samples, 60 species and 14 influencing factors left for the following analysis.

Nonmetric multidimensional scaling (NMDS) was used as well as (partial) canonical correspondence analysis (CCA/pCCA) to get an overview of the weed community in maize and to see if important factors are still missing. Then influencing factors were grouped in "management", "year" and "location" and examined separately. Mean, median and maximum of species abundances were calculated as well as correlations between weeds and factors and correlations between factors. Both, "total weed density" and "species richness" were analysed.

By comparing the results of NMDS and CCA which included all factors we conclude, that most of the important influencing factors seem to be covert. However, some seem to be still missing. No single factor group could be identified as the most important for the community composition, but there were large influences of crop rotation. With longer duration of continuous maize-growing the weed density increased significantly ($\alpha = 0.05$, 109 plants/ m^2 without maize in the last to years to 179 plants/ m^2 for maize in the two last years). For the same comparison, species richness decreased significantly (10 species/ m^2 and 9 species/ m^2 respectively).

A method for monitoring arable weed populations

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Abstract

Weeds are an important component of the food chain in the agri-environment. Farming practice is a major determinant of weed communities and changes in management of arable land over the past decades have altered the composition of these communities. Further changes in management could result in community shifts with potential impacts on species of higher trophic groups. However, in the UK, there is no weed monitoring programme that could detect such changes.

A generic method for monitoring weed populations within a crop type, was developed through review of the literature. In addition, power analyses of existing weed data were undertaken to estimate the number of samples within field and the number of fields required to be able to detect different degrees of change in weed occurrence at a range of initial densities.

Sampling based on a binomial recording method (presence/absence) is rapid and objective. However, using such a method makes the choice of quadrat size important; if the area assessed is too large a common species could be present in all quadrats, whereas a small quadrat may record few species, hence a nested quadrat approach is recommended. Systematic quadrat placement within the field has practical advantages. Precise timing of survey will vary, however, monitoring post herbicide application will assess the full impact of management. Farms could be selected at random each year, however a panel survey approach, where a proportion of farms are maintained for two or three years with some newly selected farms would reduce the cost of a large survey.

Obviously a smaller number of samples will be required to detect a common species than a rare one and larger changes in abundance will be detected with fewer samples than small changes. In the data analysed, most species were present at low densities or in only a small proportion of fields. Where a species was present in a field, 15-30% would be recorded at least once if 15 quadrats were monitored representing 1.6-4.5 species per site. At the farm scale, 32 fields would be required to detect a change in the presence of a species from 10 to 40% of farms.

A weed survey must be designed to meet the objectives of the study. However, this work has developed a generic structure for a survey, which could be modified and applied in a range of circumstances.

May 'cross functional groups' help explaining landscape effects on weed community composition?

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Abstract

Although there is a growing scientific interest on the effects that landscape and land use modification exert on agro-ecosystems, few papers have taken into account the effect of new types of land use, such as abandonment and urbanization, on the composition of agricultural weed communities. Understanding the role played by abandonment and urbanization in determining weed species presence and abundance can help clarify weed community dynamics and its consequences for agroecosystem management. This might provide farmers and land managers important clues for weed management at farm and landscape scale. We assumed that weed communities respond to landscape dynamics according to the ecological and biological characteristics of their component species. Those characteristics (e.g. climate, Raunkiaer life-form, Ellenberg value, duration of life cycle, Grime strategy, geographical extension) were used to cluster species into functional groups, aimed to explain how species respond to landscape characteristics (composition, matrix, modification) and to generically indicate their ability to damage crop production (e.g. competitive ability, threat to crop management, invasion capacity). In this study, we further elaborated new groups of species called 'cross functional groups', defined as the combination of two or more classical functional groups: e.g. stress tolerant (Grime strategy) & geophyte (Raunkiaer life form) & not cosmopolite (geographical extension). All species within the same cross functional group share the same functional traits. We expected that cross functional groups would better elucidate the effect of landscape and dynamics (abandonment and urbanization) on weed species composition. Weed community dynamics was studied in 21 fields located along the coastal plain bordering Toscana and Liguria (NW part of central Italy). A land use map was compiled in 2008, field management and field margin characteristics were recorded in 2009, and flora and vegetation samples were collected in 2009 and 2010. A Generalized Additive Model (GAM) analysis was performed to elucidate the landscape effect on weed community composition and to compare the ratio of total variance explained when classical vs cross functional groups were used. For the landscape effect, the Grime strategy was the group which explained a higher variation in weed community composition compared to the two other classical functional groups and the cross functional groups, especially for percent abandonment (12.3% of variance explained for stress tolerant Grime species) or urban sprawl (11.9% in competitive-ruderal Grime species). Instead, the use of cross functional groups resulted in higher variance explanation when patch size, patch shape and patch diversity effects on weed community composition were analysed. Cross functional groups may be useful to disentangle landscape attitude of some groups of plants leading to a finer definition of function from both the ecological and the agronomical points of view.

Assessing the trait screening approach for comparative plant ecology

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Abstract

Comparative plant ecology has a long tradition of using functional traits as tools to understand species functioning and distribution in relation to changes in environmental conditions. A central tenet of the comparative approach is the screening for traits on a large number of species. Two questions must be addressed for the screening procedure to deliver meaningful results: (i) which traits should be selected? and (ii) under which environmental conditions should the screening take place?

In the present study we assess intra- vs. interspecific variability for a large number of traits pertaining to various aspects of plant functioning. These include the three traits of the Leaf-Height-Seed (L-H-S) strategy scheme, several traits involved in the leaf economics spectrum, and traits pertaining to reproductive phenology. We use three different data sets combining different sources of variation in environmental conditions: (i) at a local scale traits of 18 species grown in a common garden experiment at two levels of nitrogen supply (ii) at a regional scale, the trait values of these 18 species grown under the lowest nitrogen supply will be compared to those obtained on the same species in nearby old-fields from a Mediterranean secondary succession and (iii) at a continental (European) scale, trait values for 33 species measured in these Mediterranean old-fields will be compared to values extracted from the LEDA traitbase.

Poster

An adaptive sampling method using Hidden Markov Random Fields for weeds mapping at the field scale

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Abstract

The mapping of weeds abundance is usually based on direct observations within fields. Full exploration of the field is often impossible, due to its size. A common approach is to divide the field into a regular grid of quadrats and to select a fixed number of them for sampling, once and for all. Sampling is designed considering only practical constraints and not, in general, with the objective of maximizing the quality of the reconstructed weeds map. Moreover, the weeds map is generally reconstructed using the kriging technique, under the assumption of Gaussian distribution of weeds abundance, even though this assumption is (often) not satisfied. Here we propose (i) an alternative modeling approach to reconstruct weeds maps and (ii) an adaptive sampling method where the visited quadrats are chosen sequentially, so as to maximize a criterion incorporating both exploration costs and the quality of the reconstructed map.

We propose to characterize weeds abundance distributions using the common image analysis tool of Hidden Markov Random Fields. This model is naturally used for mapping discrete variables such as weeds abundance classes. It can represent anisotropic phenomena and takes into account possibly noisy observations. Once observations are available, the complete map of weeds density is reconstructed as the most probable map, given the observations.

We first define the quality of a sampling policy from the quality of the most plausible reconstructed map using this sampling policy and the associated cost of exploration. The problem is then to compute an optimal policy (which has maximum quality). This optimization problem is intractable, so we propose simulation-based algorithms for computing approximately optimal policies.

We evaluate this sampling approach, using data consisting in complete maps of weeds densities abundance, resulting from a six years experiment in Dijon-Époisses (France). The method is tested for five weeds species which exhibit a significant spatial correlation (estimated from the data): *Cirsium arvense*, *Galium aparine*, *Alopecurus myosuroides* Hudson, *Fallopia convolvulus* and oil seed rape volunteer.

This work will contribute to help agronomist researchers designing sampling strategies and/or comparing the quality of current sampling protocols when the objective is to map weeds species densities.

Poster

Weed survey during inter-cropping period: a better weed estimation?

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Abstract

The assessment of weed communities in cultivated fields still raises many questions about the sampling methods to achieve an accurate estimation. The sampling of the established flora is generally the main chosen method but the question of the optimal timing for the survey remains.

In this work carried out on the study site of Fenay (eastern France), 52 field surveys were conducted in 2008 in six crops at two different periods. The flora was first estimated at the beginning of spring before the first period of weed control in order to record winter and spring weed species. The second survey was conducted during the inter-crop period just after crop harvest. The sampling strategy was similar in both surveys and consisted of a comprehensive recording of all species occurring within a 2000 m² area (40 m × 50 m). Species abundance was recorded using six cover abundance classes.

A total of 93 taxa were identified in the 52 fields over the two surveys: 66 taxa were identified during the spring survey (7.0 taxa on average per field), while 76 taxa were identified during the inter-crop period (10.7 taxa on average). 49 taxa (just over 50%) were common to the two survey periods and the taxa present in a single period were generally observed at low frequencies. For 42 fields, the inter-crop survey gave higher estimate of species number than the spring survey with an average increase of 5.0 species. Only six fields were more diverse in spring. Yet, records from both surveys enabled to discriminate between crop types on the basis of the assemblages of taxa with the same accuracy, the main difference being between winter crops and spring crops.

The choice of the best period of sampling is important and its positioning in time will depend on the question and the constraints of implementation. Our study shows that surveying in spring or during the inter-crop will give a comparable insight into the effect of the crop type on the weed flora while surveying during the intercrop will give a better picture of species richness in cultivated fields.

Poster

A national survey of rare arable plants in France

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Abstract

The French Department of Ecology set up national programs to preserve the most threatened fauna and flora species, in application of the French commitments for biodiversity preservation. The arable weeds were identified as a priority, because of the dramatic changes in the wild communities of arable lands due to cropping practices and use of agrochemicals during the 20th century. Some species seem to be already extinct and a few are on the brink of extinction in France.

A species action plan was initiated and a data collection was carried out through the network of the National Botanic Conservatories (CBN), scientific structures in charge of the survey and preservation of the wild flora and habitats.

102 species were listed in 2000 as strictly associated with arable lands in France. In 2009 and 2010 more than 190 000 data were collected from the CBN's databases, most of them providing from field investigations (106 415). Each data is related to a district, a municipality, an observation date and/or a publication date and an author. Two periods were considered to assess the decrease of plants related to arable lands, before 1970 and after 1990. Their frequency was illustrated by (a) the number of species in a district, (b) the number of municipalities where a species occurs in a district.

9 species are probably extinct in France and 25 others are extinct in more than half the districts they were previously known. Even the most common species before 1970 were found to have dramatically decreased in terms of occurrence and abundance.

The main areas for preservation of a high diversity of segetal flora are located in the South-East, where agriculture remains extensive. Elsewhere, segetal communities have been severely affected by farming management but, it is still worth acting for preservation as they contribute to maintain farmland biodiversity and the ecological services associated.

The action plan includes the organisation of a set of actions in various areas : studies (11 actions) preservation (8) and communication (8). The actions will be implemented in 2011 after being approved through a wide consultation of all the concerned actors. The data will be used to locally select areas for conservation of the threatened species. They also might help to apply the French policies to preserve biodiversity corridors in agricultural landscapes.

Poster

A temporal perspective of weed species abundance distribution

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Abstract

We could gain further insight in how different management procedures affect weed community structure attending to the abundance distribution of species from a temporal perspective. Here we show that arable plant communities can be separated in two groups of species, core and occasional, attending to their persistence in the record and that the commonness of each species is related to their permanence. It has been proposed that each group of species follows a different distribution and that the overlay of both leads to the general observed pattern of species distribution in an assemblage. The abundance of core species would be log-normal distributed whereas the abundance of occasional species would follow a log-series distribution.

Here we apply a previously employed methodology (Magurran and Henderson 2003) to separate core and occasional weed species is not an artifact. We used data from a long term experiment in which three different tillage systems were compared. We pooled data from the three systems and calculated for each year the value of Simpson's diversity index (D) in progressively larger subsets of the data: from a subset in which only species present in =8 years were included to a subset in which species present in = 19 years were incorporated. For each subset we related the value of D to the number of years of the data. D remains constant when species are distributed according to the log series distribution, whereas the index increases if data follow a log normal distribution. Also, we calculated the variance to mean ratio for each species and related it to the number of years that each species appeared on the record. The variance to mean ratio is not significantly different from one in those species following a Poisson distribution.

Our results show that only ten of the 45 species recorded in the experiment could be considered core species. Although the distinction between both groups is commonly done by researches when eliminating rare species from analyses, it is useful to formally divide both groups to test the nature of the processes that structure the abundances of species.

Poster

Session 3
Ecological services of weeds

Weeds and aphid-parasitoid communities benefit differently from organic and conventional cropping of winter cereals

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Abstract

The interaction between cereal aphids and parasitoids constitutes a complex system that has frequently been studied because of its implication in biological control. However, not all aphids living in cereal fields are crop pests, because there are also aphids living on weeds which may serve as an alternate resource for aphid parasitoids. In this context, a concomitant survey of plants and insect communities was carried out in an homogenous area of the NE of Spain to understand how farming system and plant community of winter wheat fields affects the abundance and richness of aphids, and the interactions with their primary and secondary parasitoids. The plant community was split into functional groups (grasses, legumes and forbs), and the aphid community was divided into feeding groups according to their host preferences (specialists in grasses, forbs and legumes).

Grass aphids which dominated total aphid catches respond to management, whereas forb and legume aphids which mainly conditioned the total species richness of aphids were closely related to the local abundance of legumes. The abundance and richness of primary and secondary parasitoids were significantly higher in conventional fields than in organic ones and also significantly related to the availability and richness of their local potential hosts. In turn, species richness of primary parasitoids was positively related to the total species richness of aphids and, the richness of secondary parasitoids was closely associated to the richness of primary parasitoids.

The entire system of grass aphid-parasitoids was enhanced in conventional fields, where the abundance of grass aphids was higher, indicating a bottom-up effect through grasses, grass aphids, primary and secondary parasitoids. Additionally, our observational study also enables us to suggest that the presence of legumes is providing alternative hosts to primary aphid parasitoids. In this sense, our findings emphasise the importance of tri-trophic models (plant-aphids-parasitoids) to achieve a greater comprehension of aphid population regulation in dry land agro-ecosystems.

Weeds as sources of pests and natural enemies: consequences for agro-ecosystem management

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Abstract

The spatial and temporal distribution of cultivated and non-cultivated areas may influence the distribution and dynamics of insect populations, including pests and natural enemies, depending on their capacity to disperse and their degree of host specialization. At the landscape level, insects may use various non-crop plant species, including weeds, as overwintering or diapauses refuges, reproduction zones, or alternative sources of food and hosts. However, this implies that insect pests and their natural enemies can colonize and develop on plants with potentially contrasting levels of physical and chemical defences and nutritional contents.

To determine to what extent weeds may serve as refuges for insect pests and their natural enemies, we investigated the suitability of cultivated and non-cultivated Brassicaceae for a generalist aphid, the green peach-potato aphid *Myzus persicae*, and its main parasitoid, *Diaeretiella rapae*. We compared the performance of *M. persicae* (measured as population growth rate) and *D. rapae* (estimated as parasitism rate, larval survival and development time, adult longevity and size) on one cultivar of rapeseed and cabbage, two weed species, *B. nigra* and *Sinapis arvensis*, and one cultivar of tomato as a potential non-Brassicaceae host plant. In contrast with our initial hypothesis, *M. persicae* did not perform better on the cultivated species. Its population growth rate was significantly smaller on rapeseed. Similarly, the host plant on which the aphid was feeding affected the performance of the parasitoid. However, in opposite with its aphid host, the parasitoid developed faster and was larger on *S. arvensis*.

Our results indicate that unexpectedly, cultivated species such as rapeseed could reduce herbivore performance. On the other hand, weeds such as *S. arvensis* could serve as reservoirs of both herbivores and parasitoids. The widespread recent introduction of rapeseed as a crop might have had consequences on the degree of host specialization for both the herbivore and its parasitoid. More work on crops and closely related weed species is needed to gain insights into the strength of bottom-up vs. top-down factors on pest populations in changing agricultural landscapes.

Re-considering associational resistance: how can weeds improve crop yields?

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Abstract

The observation that more-diverse stands of plants may suffer less herbivory than pure stands (associational resistance) has been widely investigated as a means of crop protection, but competitive interference from non-crop plants tends to cause unacceptable crop yield loss. Drawing together literature sources and new ideas, I consider how weeds may contribute to associational resistance in arable crops so as to increase crop quality and/or quantity and hence economic returns.

The plethora of mechanisms proposed to explain associational resistance involving weeds falls into three broad categories: (1) weeds promoting predation by natural enemies, (2) weeds having direct effects on herbivore foraging behaviour and (3) weeds having indirect, bottom-up effects on trophic dynamics via plant–plant interactions. The relative importance of different mechanisms, and their suitability for reducing herbivory while minimizing weed–crop competition, depends on answering some general questions about spatial and temporal scales of ecological processes, as well as local and species-specific knowledge. This leads to a discussion of how spatial, temporal and floristic aspects of weed communities might be used to maximise the quality and quantity of crop yields.

Provisional conclusions include that herbivore diversion from crop plants (especially brassicas) to weeds is one of the most promising mechanisms, but more research is needed drawing upon the ideas and knowledge of diverse stakeholders. A new generation of integrated pest management schemes incorporating associational effects could aid biodiversity conservation as well as giving economic benefits, but progress remains a great challenge for agro-ecologists.

The development of a predictive indicator to assess the effect of agricultural practices on plant diversity in margin strips and their ecosystemic services (Pollination and Conservation flora)

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Abstract

Developing cropping systems and landscape management which maintain or enhance biodiversity is an important challenge for agronomists. Biodiversity has an important role through its effect on the function of the agroecosystem by providing different types of ecosystem services like pollination. Margin strips in farming landscape are known to host a multitude of species. The management of the preexisting strips, the sowing of new ones, as well as practices to reduce drift of fertilizers and pesticides from the neighbouring field may enhance biodiversity. Assessment methods for identifying the effects of agricultural practices on biodiversity and its associated ecosystem services are needed to succeed in this challenge. During the last decade a lot of indicators based on species counting (e.g. number of weeds species) or simple variables like a single practices (e.g. percentage of semi-natural area) were proposed. Nevertheless there is a need of predictive indicators to analyze causal relationships between agricultural practices and biodiversity and to identify relevant management options.

Our objective is to develop a predictive indicator based on an operational model which requires few and easily available input data. The purpose of the model is to assess the effects of agricultural practices on diversity of flora species in margins strip as a first step to evaluate ecosystem services like pollination and plant species conservation.

First, we have selected practices which have the most impact on weeds species diversity of margin strip. The model output is an estimate of the probability for weed species to be present in margin strip. To link practices and species we developed decision tree using fuzzy subsets, quantitative or qualitative relations based on Ellenberg ecological species indicators, and expert knowledges.

Components of the model addressing the effect of drift and mowing regime on plant diversity will be presented. We will discuss further steps our work i) the model validation by comparison of model outputs with a set of field data ii) the transformation of model outputs into an indicator of plant diversity, iii) the integration of ecosystemic service, like pollination or conservation of rare plant species into the indicator.

Poster

Potential Attractiveness of Olive Beneficial Insects to Flowering Weeds

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Abstract

Nowadays, there is a growing concern about keeping olive groves in a good sanitary health with a decreasing input of pesticides. Increasing beneficial insect fauna is a novel, non-intrusive way to achieve this objective. To increase beneficial insect fauna, non-prey food availability must be enhanced, and that purpose can be attained by manipulating olive groves inter-rows natural weed vegetation. Amongst weeds naturally occurring in South Portugal olive grove inter-rows, 20 were chosen provided that they are nectar producers. Flowering period time and duration were additional choice criteria, ensuring that insects can feed on, at least, one flowering species at any time. In order to establish which weeds are more suitable to this purpose, their nectar production and accessibility for two natural olive beneficial insects - the parasitoid *Psytalia concolor* and the pest predator *Anthocoris nemoralis* - were evaluated.

Evaluation of floral morphology included measurements of the length of corolla tube (the distance between corolla insertion and the beginning of corolla lobes), length of whole corolla, major and minor width of corolla tube and diameter of corolla limb; all measurements were repeated on 30 corollas per species.

Nectar production, concentration and sugar composition are also evaluated on 30 flowers per species. To protect flowers from insects visit and, therefore, nectar depletion, they were covered with bridal veil 24 h before collection. Nectar was extracted and quantified with capillary micropipettes (Drummond Microcaps®), and the sugar concentration was determined with a hand held refractometer (Atago®). Nectar was lyophilized for posterior composition determination through gas chromatography.

Descriptive statistics of flower traits were calculated for each of the analyzed species. Classical statistical tests will be applied to correlate morphometric analyses of floral characteristics and nectar volume, concentration and composition will be searched for. After this initial phase, weed species attractiveness for *Psytalia concolor* and *Anthocoris nemoralis* will be further evaluated with using an olfactometer.

Research was financially supported by Fundação para a Ciência e Tecnologia (FCT), with partial funding from the European Fund for Regional Development, through the project PTDC/AGR-AAM/100979/2008.

Poster

How define a pernicious weed?

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Abstract

For a few years now, it has been possible to find in the scientific literature concerning weed flora the term "pernicious". This adjective is used to designate within the weed community, species whose relationships with the global agricultural system are more negative (potentially harmful to the crop or to the adjacent crop = undesirable species) than positive (potentially supporting a wider biodiversity = desirable species).

Since 2000, associated with the noun "weed", the adjective "pernicious" has more and more been used in the sphere of agroecology more particularly in studies on the diversity of arable species communities. In a literature survey that goes from 1971 for today (on title, keywords and abstract) and in a systematic study of the journals *Weed Research*, *Weed Science* and *Agriculture Ecosystems and Environment*, the association "pernicious" + "weed" was found about one hundred twenty times. This association seems indicate two different types of species: on the one hand invasive and poisonous species (about ten different species – e.g. *Parthenium hysterophorus*) and, on the other hand different competitive weeds not easily controlled in habitats related to human activities, such as fields, margin strips, meadows and forests (about fourty different species in about 75% of the articles).

The question that arises then is whether the term "pernicious" can reasonably be used in the research activity on diversity, when concerning annual or perennial native arable species that have as their single ecological niche cultivated fields? Can a segetal species strictly connected to cultivated fields like *Alopecurus myosuroides* or a species characteristic of herbaceous borders as *Bromus sterilis* be designated as "pernicious"? How can we possibly classify *Cirsium arvense*, which is both a very noxious species resented by farmers and an important food source for a very large community of animal species? Is a pernicious weed necessarily always frequent or abundant?

In the sphere of agroecology, the term "pernicious" should perhaps be used more reasonably in scientific papers. More generally, must the presence of a native species in a cultivated area be justified by a potential ecosystem service? Should a species that obviously fails to provide any ecological systemic service compared to species producing, for instance pollen, be managed in relation to its very lack of ecological systemic service?

Poster

Relative importance of arable weeds for phytophagous insects* **Coleoptera* (*Curculionidae* and *Chrysomelidae*) and *Diptera* (*Agromyzidae*)

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Abstract

Weeds are a constraint on crop production, but as part of the primary producers of the agroecosystem, they are also increasingly recognized as important for farmland diversity. However, little research has been undertaken to inventory the faunal biodiversity that depend on these plants. In France, a previous study has listed insects associated to threatened arable weeds with the idea that the extinction of these plants can lead to the decrease or extinction of some specialized insects.

The aim of this work is to provide an update of this pioneering study and to include common weeds that could also support biodiversity. Information on linkages between insects and plants were compiled from the literature. We have focused on families (*Curculionidae*, *Chrysomelidae*, *Agromyzidae*) of phytophagous insects known to be host-specific or at least oligophagous. 461 arable weeds regularly observed on arable fields within the French monitoring survey Biovigilance Flore have been analyzed.

First results for *Curculionidae* shows that 148 weeds (32% of the most frequently observed species) host at least one species, especially weeds belonging to the family *Fabaceae*, *Brassicaceae*, *Asteraceae* and *Polygonaceae*. Common weeds like *Cirsium arvense* and *Sinapis arvensis* exhibit the highest diversity of weevil (14), followed by *Matricaria perforata* (12) and *Sisymbrium officinale* (11). Only 15 of the 103 threatened arable weeds harbour weevils, the most interesting being: *Vicia villosa* (8), *Thlaspi arvense* (5) and *Lithospermum arvense* (3). More than 80% of the 350 weevil species found to be associated to weeds are host-specific or only feed on a few species within a genus. Some other species feed on a wide range of genus within the *Brassicaceae* (*Ceutorrhynchus assimilis*, *Melanobaris laticollis*) or the *Fabaceae* (*Sitona humeralis*) families. Their degree of specialization can help to weight the functional value of arable weeds for biodiversity. For example, *Myagrum perfoliatum* and *Neslia paniculata* both provide food for one species of weevil, but the first (*Ceutorrhynchus minutus*) can feed on several species while the second (*Ceutorrhynchus scapularis*) is much less polyphagous. Conversely, we have also relativized the positive role of weeds on insect biodiversity if they also host some pests (e.g., *Ceutorrhynchus napi*).

Poster

Relative attractiveness of some flowering plants to aphidophagous hoverflies (Diptera: Syrphidae)

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Abstract

Habitat manipulation by increasing floral resources is an important tool to enhance pest biological control by natural enemy populations. Aphidophagous hoverflies (Diptera: Syrphidae) are among the main natural enemies of aphids. The aim of this study was to assess the relative attractiveness of eight species of flowering plants to aphidophagous hoverflies, in order to develop habitat manipulation strategies to improve agricultural pest control.

From a preliminary study carried out in 2008 with 25 flowering plants a selection of the best species was done. Selection criteria were: i) number of syrphid visits, ii) flower production and flowering length time, and iii) weed potential. Hence, 8 plant species were selected for further research: *Calendula arvensis*, *Coriandrum sativum*, *Diploaxis muralis*, *Hirschfeldia incana*, *Moricandia arvensis*, *Matricaria chamomilla*, *Pimpinella anisum* and *Sinapis alba*. In 2009 and 2010 plant species were evaluated in a completely random design. Hoverfly visits, flower density and flowering times were recorded in La Poveda research farm (Madrid).

The results indicate that in both years *Sphaerophoria* spp. was the commonest observed hoverfly with more than 80% of the visits recorded, whereas *Episyrphus balteatus* and *Eupeodes corollae* were much less abundant. With respect to plant species, *Coriandrum sativum* was the preferred species regardless of the year. A good attractiveness was also observed in *Calendula arvensis* in both years. Nevertheless, contrasting results were observed in *Pimpinella anisum* and *Moricandia arvensis* depending on the year. Considering all the selected plants, a direct relationship between flower density and number of syrphid visits was found. In addition, a relatively short period of flowering of about one month was observed for the whole set of plant species analyzed. Indeed, blooming period ranged from the first week of May to the first or third week of June, depending of the year. Taking into account flower attractiveness and phenology, the use of the selected flowering species might be useful in the biological control of aphid pests in early summer crops.

Poster

Session 4

Seed predation

Unravelling the process of weed seed predation: developing options for better weed control

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Abstract

Seed predation can cause significant losses of weed seeds in agricultural systems and can, thus, contribute to weed control. Overall removal rates result from three sequential processes, namely 1) the probability of finding a seed cache (encounter rate), 2) the percentage of seeds utilized once a seed cache has been found (exploitation rate) and 3) seed selection if multiple species are present (preference). Identifying the most important behavioural component and factors that drive it may help to better understand and manage seed predation. Existing data on the removal of *Lolium multiflorum* and *Vicia villosa* seeds by harvester ants (*Messor barbarus*) and rodents (*Mus spretus*) in six cereal fields in NE Spain were divided into the distinctive components.

Seed cache encounter rate correlated well with overall seed removal rate caused by harvester ants ($r^2 = 0.91$), or rodents ($r^2 = 0.82$). Once found, seed exploitation rates were high and fairly constant from spring to autumn for harvester ants, and low throughout the season for rodents. Harvester ants removed almost all *Lolium multiflorum* seeds from caches found, while the exploitation of *V. villosa* seeds varied across the season. In the case of rodents, cache encounter rate, but not exploitation rate, could be explained by canopy cover provided by the crop. *Lolium multiflorum* seemed to be preferred in early 2007, whereas *V. villosa* was in 2008.

The adoption of no-till or minimum tillage systems together with the establishment of field edge vegetation are likely to encourage seed cache encounter and exploitation rates by both harvester ants and rodents, thus leading to increased weed control in semi-arid cereals.

Density dependence of weed seed predation by invertebrates and vertebrates in wheat

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Abstract

Weed seed predation can limit weed population growth within agricultural fields. One important factor for demographic regulation is the ability of predators to respond to increasing weed seed densities: are they able to handle weed patches and limit their growth? We hypothesized a direct density dependence response for highly mobile vertebrates. Invertebrates were expected to react independently.

A short term experiment was conducted in winter-wheat (BBCH 13/15) fields (N=4 in total) during October 2008 and 2009 in north-eastern Germany. Four adjacent 15 m by 15 m plots were established in each field with artificial densities of 0, 1000, 2500 and 5000 seeds m⁻² of *Lolium multiflorum* L. in addition to the very low natural background seed density. Seed predation was determined in randomly located trays made of metallic mesh with either vertebrate exclosures (12 per plot) or open to all predators (8 per plot). The bottom of both was covered with fine cloth mesh preventing seed escape. Trays contained weed seed free soil, seeds and crop plants grown to the same stage as those in the fields. Seeds were exposed for 18 days, recovered from soil using sieves and flotation. Remaining intact seeds were counted. In addition, 20 seed cards were randomly placed in each plot, half of them with vertebrate exclosures. Seeds remaining on cards were counted every other day. Seed predators were identified using Pitfall traps (invertebrates) and Sherman life traps (vertebrates).

In general, seed predation was low (mean: 32.4%). This could be caused by cold temperatures in autumn and poor development of the crop. Predation rates had high variability (standard deviation: 17.9%) and were predominated by different predator groups in different fields. Best model selection resulted in random intercept mixed models. Confirming our hypothesis vertebrates (N=2) responded direct density dependent whereas invertebrates (N=3) reacted independently. Predation of all predators (N=4) showed a mixture of both. Data of the seed cards confirmed these results and demonstrated changes over time.

Our results indicate the ability of vertebrate seed predators to regulate weed patches. Thus, management practices which guarantee optimal population development of vertebrate seed predators will lead to enhanced regulation of seed dispersing weeds in wheat.

Seasonal variability in predation and shed of weed seeds in dryland cereals and effects on the season-long estimate of seed predation

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Abstract

Seed shed and seed predation were investigated in three commercial cereal fields in NE Spain in order to estimate annual weed seed losses due to predation, from April until the end of June (harvest), using seed traps (36 per field) and feeding stations (25-100 per field), respectively. Seed offered were *Lolium rigidum* (fields A and B) and *L. rigidum*, *Gallium spurium*, *Papaver rhoeas* and *Bromus diandrus* (field C). A simple model was used to estimate the annual weed seed losses per weed species and per field under different scenarios of seed burial with regard to the continuous exposure period from seed shed until harvest or exposure for 2-10 days after seed shed.

In two fields (A and B), most seeds caught belonged to *D. eruroides* (32-59%), *C. bursa-pastoris* (7-40%), *L. rigidum* (15-64%) and *A. sterilis* (3-47%). In field C, most seeds caught belonged to *P. rhoeas* (95-99%) and *B. diandrus* (0.03-5%). Percentage of seed predation per two days was 17-60% in April, 36-91% in May and 22-100% in June. The level of seed predation differed between weed species, e.g., *B. diandrus* (17-36%), *G. spurium* (18-73%), *P. rhoeas* (23-86%) and *L. rigidum* (25-100%).

Weeds in fields A and B always suffered higher seed losses than those in field C, because seeds in the former two fields had been shed during the period of highest predation, and because a large proportion of the seeds shed in the latter field became immediately inaccessible at crop harvest, due to debris. The exposure period (2 days – continuous) had little or no influence on the estimates of annual seed predation, because predation rates for most species were very high from seed shed until harvest.

Effect of size, taxonomic affiliation and geographic origin of dandelion (*Taraxacum* agg.) seeds on predation by ground beetles (Carabidae, Coleoptera)

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Abstract

Ground beetles are important predators of herb seeds that are scattered on the ground after dispersal. Beetles prefer particular species of seed, but the causes of this selectivity are not clear because the seeds of different herb species vary in many characteristics.

To reveal which factors determine carabid preference, we offered seeds of the multispecies complex of *Taraxacum* agg. (dandelion) to 19 carabid species. The seeds were similar in shape and morphology, differed in taxonomic affiliation (sections Ruderalia and Erythrospermae) and geographic origin (Czech Republic and Italy, c. 800 km apart) and ranged in size between 0.27-0.74 mg. The seeds were offered in cafeteria experiments where beetles selected between two (dual-choice experiments) or four (multi-choice experiments) types of seed.

As expected, the size of the seed and the size of the carabid species determined the number of seeds consumed and the preference for the seed (the proportion of the total number of seeds consumed). In dual-choice experiments providing Ruderalia seeds, the preference for large seeds increased with carabid size, while in multi-choice experiments, seed size was the factor that explained the most variation in seed preference. In dual-choice experiments using seeds of a similar size, some species of carabid had a marked preference for Ruderalia (nine species) or Erythrospermae (four species) and were also able to distinguish between Ruderalia of Czech origin (preferred by eight species of carabid) and Italia (no preference). Preference for seed size could be enforced by matching the morphology of carabid mouthparts and the size of the seed. Effects of taxonomic affiliation and geographic origin on preference indicate that stimuli on seed coat and surface are also important for carabid choice, but underlying mechanisms of seed selection remain to be tested.

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Spatial and temporal variation in weed seed predation over a winter-wheat crop cycle

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Abstract

The predation of weed seeds by other taxa may potentially contribute to the regulation of weed populations and as such is receiving increasing attention in weed research. In this study, we attempted to quantify the variation in weed seed predation in time - during the winter-wheat crop growing season and after its harvest- and in space at two spatial scales, i.e. the within-field and the inter-field variation.

Trials were conducted from May till October in 10 sessions (5 pre-harvest, 5 post-harvest) in 3 winter-wheat fields that were characterized by similar agricultural practices. Within each field, we set up 12 experimental plots, each plot consisting of 4 seed cards under exclusion cages with 5 weed species: *Alopecurus myosuroides*, *Capsella bursa-pastoris*, *Gallium aparine*, *Veronica hederifolia* and *Viola arvensis*.

Our results indicate that weed seed predation was highly variable over the crop cycle, with three main peaks and that overall more seeds were consumed before harvest than after harvest ($t = 4.78, p > 0.0001$). The three fields exhibited very similar temporal variations in overall seed predation rates (ANOVA for field effect, $F = 1.43, p = 0.24$) although there were differences for individual weed species. Within fields, we found spatial correlation in predation rates for the three fields but only during the second predation peak. Finally, there were clear differences in the predation rates for individual weed species and these were constant over the crop cycle. *V. arvensis* was the most consumed species, *C. bursa-pastoris* and *A. myosuroides* were intermediate and *G. aparine* and *V. hederifolia* were only consumed when the overall predation rate exceeded 20%, indicating that the preferences for particular weed species was weaker during predation peaks.

Poster

Seed consumption by millipedes

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Abstract

Seed predation is a key mortality factor for plants that reproduce by seeds. We investigated seed consumption by *Cylindroiulus caeruleocinctus* (Wood, 1864), an abundant representative of the unrecognised group of seed predators, the millipedes (Diplopoda: Julidae). The consumption of small seed species by millipedes was measured in the absence (41 species) and in the presence (11 species) of alternative food sources (dead leaves). We examined whether millipedes would consume seeds at all and if so whether there were any seed size constraints that determined millipede seed acceptance (i.e., the proportion of millipedes that ate seeds) and seed consumption (i.e., the mass of the seeds eaten).

The millipede readily accepted seeds; 75% of seed species were accepted in a no-choice experiment while 100% of seed species were accepted in a choice experiment. Seed acceptance decreased with increasing seed mass and increased with increasing millipede mass. Seed consumption increased with the size of the offered seed species but was found to be independent of millipede mass. After the millipedes were given dead leaves to consume, the acceptance slightly decreased, and the consumption of the more preferred seed species decreased. Seeds form a small part of the millipede diet but they are consumed regularly. Because of millipedes' foraging preferences and their patchy distribution they may notably contribute to the local mortality of some seed species in their natural environment.

Supported by the grant 526/09/1436 from the CSF.

Poster

Weed seed predation by ground beetles in no-tillage systems

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Abstract

An increasing number of studies indicate that weed seed predation could be of interest for the biological regulation of weed populations. In this study, (i) we assessed regional variation in weed seed predation over the Côte d'Or department and (ii) tested the effect of conversion to systems with no-tillage and permanent cover on seed predation. Weed seed predation rates and activity-density of ground beetles (*Coleoptera, Carabidae*) were evaluated during five consecutive weeks during the spring 2010 in 28 winter wheat and winter barley fields covering a wide range of soil, climatic and landscape conditions. The 28 fields could be split into 14 pairs, i.e. two adjacent fields, one conducted as conventional and the other conducted as no tillage for the first year. The expectation was that no tillage and permanent cover would enhance ground-beetle populations and weed seed predation

Results indicate that (i) ground-beetle communities were highly diverse and variable across fields, (ii) weed seed predation was significant in all fields, with an average rate of predation of 30%, (iii) some weed seed species were preferentially consumed (e.g. *Capsella bursa-pastoris*) and (iv) weed seed predation rates were positively correlated to the total abundance of granivorous and omnivorous ground-beetles observed in each field. We found no differences in carabid abundances and seed predation rates in conventional and no-tillage fields, possibly because "no tillage" fields had just been converted. The lack of effect could also result from the important variability in the agricultural practices used within each of the two farming systems and/or from the strong pesticide pressure applied in both systems that could have counterbalanced a potential positive effect of no-tillage on seed predator abundance. To address these issues, studies are currently in progress in fields converted no-tillage 4 years ago and where pesticide pressure is limited.

Poster

Session 5

Weed Biology

Poster

Establishment of *Heracleum sosnowskyi* in natural habitats of the Lithuania Republic

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Abstract

An endemic Caucasus and Crimea sp. *Heracleum sosnowskyi* is dangerous invader successfully spread along roads and has naturalized in Lithuanian habitats and plant communities acting compressively on native species and changing community composition and structure. This huge plant forms pure stands and changes ecosystems diversity pushing autochthones species from native habitats, thus decreasing biodiversity and transforming landscape. *Heracleum sosnowskyi* establishes in fertile soils and completely changed habitats, therefore makes damage on native flora and landscape. Consequently, this species is enlisted in EPPO A2 and in National List of exterminate plants. Therefore evaluation of *Heracleum sosnowskyi* spread and establishment is the main aim finding effective measures to prevent degradation of biodiversity in natural grassland and forest habitats of Lithuania.

Data were collected on the range of this invader occurring in natural and abandoned anthropogenic habitats, its abundance and spatial allocation to verify the contribution of *H. sosnowskyi* to biodiversity in plant communities. Another objective was to evaluate the spread speed in infected landscape.

Local assessments of the abundances of *H. sosnowskyi* by estimating variables of spatial penetrating and establishment in native plant communities at an individual block scale were carried out. Eight blocks (about 10 m² each) distributed in a 6 km transect along highway Via Baltica near Kaunas, the centre of Lithuania, were inventoried for abundance and invasion of *H. sosnowskyi*. Four population types (solitary individuals, small groups of 1-2 individuals fruited; groups of n×10 m diameter; strips of 1-10 m width and different length along forest, roads, Nemunas river banks; and large pure colonies with density of n×10 individuals 10 m⁻² and coverage of 60-80% (100%)) were found. Species abundance was structured according to distance from highway and significantly correlated (r=0.7) with native plant community type. *H. sosnowskyi* find opportunities for colonization and reproduction resulting in decrease of natural diversity. This species invasion success was the highest in roadside (12.3%), abandoned grassland (6.7%), and wasteland (2.4%) habitats.

Poster

Population biology and mechanical control of the poisonous grassland plant *Senecio aquaticus* L.

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Abstract

Our study aimed at developing management concepts for the control of *Senecio aquaticus*, a poisonous plant in hay meadows. This herbaceous *Asteraceae* grows in wet meadows with mean nutrient supply, usually mown twice a year and poorly fertilized. From a nature conservation point of view, these grasslands are rather valuable and, therefore, chemical control is not desirable.

Between 2005 and 2010 data on population biology of *S. aquaticus* were collected; life history characters were mainly studied on permanent plots in the field. According to our observations, the developmental stage of the seedling is followed by a vegetative rosette, persisting from two to at least six years. At the adult stage the erect stem is elongated and carries several flower heads. Many but not all individuals behave monocarpic.

Aiming at realistic management options two different cutting regimes were applied to meadows at three localities (Thaures, Kleedorf, Harbach) in Lower Austria (Waldviertel) from 2008 to 2010. Cutting regime A (two cuts in June and September) was expected to result in a high number of mature seeds. On the other hand, cutting regime B (cuts in July and August) was expected to prevent the development of mature seeds almost completely.

After two years of different management, cutting regime B resulted in a lower number of seedlings and rosettes in Thaures. In Kleedorf germination was also lower under regime B than in A after the first year, but high enough to increase the number of rosettes in the following year. In Harbach there was not much difference between the two regimes: Only, germination of seedlings was lower under regime B in 2010.

Because of the longevity of seeds and rosettes, the effect of different management regimes can only be verified after several years. Therefore, and in order to obtain unambiguous results suitable for praxis, the duration of the experiment must be extended.

Poster

Mating system adaptation in populations of *Centaurea cyanus* L.

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Abstract

Since the 50s, the agriculture intensification in Western Europe resulted in landscape homogenization and reduction of habitat connectivity, which in turn caused a widespread decline of farmland biological diversity.

Centaurea cyanus is one of the declining “segetal species”. It is an annual and insect-pollinated species with a self-incompatibility system. When the populations are small and fragmented, they may extinct if the incompatibility system cannot evolve towards a compatibility system. A coexistence of mixed mating system is also possible in a population.

In our study, we examined the ability of *C. cyanus* to produce seeds by autogamy. For this purpose, three conditions were tested: 1) two plants in a cage with flies as pollinators to allow outcrossing; 2) one plant by cage with flies as pollinators to force free self fertilization; and 3) one capitulum bagged by cage without flies to force self fertilization. The results confirmed that *C. cyanus* is an insect-pollinated species that cannot produce seeds without pollinators. In most of the plants flower fertilization was less than 1% under free self fertilization while some plants produced more than 6% of seeds. Crossing by flies yielded 26% of fertilized flowers. Therefore, a low frequency of plants seemed to be partially self-compatible. It could be an advantage for the conservation of small populations, but it could change the genetic structure of the populations and modify their biology.

Poster

How does common ragweed (*Ambrosia artemisiifolia*) tolerate herbivory? An artificial defoliation experiment

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Abstract

Insect herbivory generally has a negative impact on the fitness of an individual plant. Most plant species, however, have evolved defence mechanisms to minimize this impact. Plants deter phytophagous insect attacks by producing chemicals or defense structures or tolerate the loss of biomass. With such mechanisms, plant species maintain an equal fitness with or without herbivory.

We assessed the ability of the North American invasive common ragweed, *Ambrosia artemisiifolia* L., to tolerate insect herbivory by removing leaf portions from plants, under controlled conditions. To test if plant defence traits have distinctively evolved since the plant species introduction in Europe, we compared three populations from the native range to three populations from the invasive range. Three levels of mechanical defoliation were tested: (1) no defoliation, (2) 50% and (3) 90% of the total leaf area was removed from each plant leaf. We measured various life history traits to evaluate changes in plant compensatory growth, resource reallocation and reproductive capacity, following plant defoliation. Using Multivariate Analysis of Variance (MANOVA), we will be able to discriminate the effect of populations, provenances and level of defoliation (invasive or native) on life history traits and to reveal interactions between populations, provenances and level of defoliation. According to the Enemy Release Hypothesis (ERH) and the Evolution of Increased Competitive Ability Hypothesis (EICA), we expect that introduced common ragweed populations experience a less fitness cost invested in herbivory resistance and tolerance, meaning that without defoliation, undefended genotypes would outcompete the defended genotypes.

Poster

Genetic structure of two arable weed species, *Adonis aestivalis* L. and *Consolida regalis* S.F. Gray, in relation to landscape structure

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Abstract

Landscape structure is the most obvious and often intuitively used character to judge the quality of our landscape. However, we currently know too little of its impact on the biology, genetic structure and survival chances of plants. We investigated whether landscape structure affected genetic structure and diversity of the arable weeds *Adonis aestivalis* and *Consolida regalis* using dominant amplified fragment length polymorphism markers (AFLP). We chose three monotonous landscapes (> 95% of area being arable land with low extent of field margins) and three diverse landscapes (< 60% of area being arable land with high extent of field margins), thus sampling a total of 6 regions each of 5km². Genetic structure and diversity among populations of *A. aestivalis* and *C. regalis* from the monotonous landscape was compared with those from the diverse landscape.

For both species, most genetic variation resided within subpopulations. Within-population diversity levels of *A. aestivalis* and *C. regalis* were significantly higher for populations located in the diverse landscape (mean $H_j = 0.16$ and 0.16 , respectively) compared with those for populations located in the monotonous landscape (mean $H_j = 0.12$ and 0.13 , respectively). However, populations of *A. aestivalis* and *C. regalis* from the diverse landscape were significantly more differentiated from each other ($\Phi_{st} = 0.12$ and 0.14 , respectively) than populations from the monotonous landscape ($\Phi_{st} = 0.08$ and 0.12 , respectively) and they showed significant isolation-by-distance. In contrast, no significant correlations between pairwise geographical distance and F_{st} -values were found for populations of *A. aestivalis* and *C. regalis* from the monotonous landscape.

These data suggest that genetic structures of *A. aestivalis* and *C. regalis* populations respectively are the result of genetic bottlenecks due to recent or historical habitat fragmentation events and/or founder effects through changes in agricultural land use. Populations in the monotonous landscape are genetically less diverse but better interconnected, whereas diverse landscapes harbour more diversity, which is, however, in higher risk of extinction by stochastic events in smaller, more isolated populations.

Poster

Effect of cold stratification on germination in two *Linaria* species, comparing germination responses between a weedy and a non-weedy relative

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Abstract

Seed germination characteristics, such as parameters describing germination response to temperature and germination character curves, can be used to evaluate the potential of a plant to colonize new habitats on the one hand, and persist in a certain area on the other hand. Also impact of agricultural practice and climate on seed germination characteristics can be studied in particular populations to better understand the biology of weed species. The effect of stratification at 5°C and a range of constant germination temperatures was studied in seeds of *L. loeselii*, a littoral species endemic to the Baltic region, and *L. vulgaris*, widespread in various open habitats throughout Europe and an invasive weed species in parts of North America.

Seeds of both species originated from the same coastal dune habitat in NW Latvia. Seeds were subjected to cold stratification treatment at 5°C that lasted 0, 4, 12 or 20 weeks. After that seeds were germinated at a range of temperatures from 0 to 35°C. To estimate maximum and minimum germination temperatures linear regression was fitted to curves obtained by plotting germination rate against germination temperature and maximum/minimum temperature determined as the intercept of the regression line on the 'x' axis.

Stratification treatment broke dormancy in seeds of both species, which was reflected by the decrease in minimum germination temperature. Final germination increased to 83.3% after 12 weeks at 5°C in *L. loeselii* and to 69.7% in *L. vulgaris* seeds after 20 weeks. *L. vulgaris* seeds were heterogeneous in their response to cold stratification, which may increase the success of establishment of this species in different habitats. Comparing germination character curves showed a considerably wider interval of temperatures suitable for germination in *L. vulgaris*, which is another trait that can enhance the ability to spread.

Seed germination-related parameters can be used to characterize and compare germination between species or different populations within a species. Research on germination and seedling establishment in field conditions, seed bank dynamics and clonal growth would be required to better understand the importance of germination traits for spreading and persistence of weed species.

Factors influencing the abundance of *Ambrosia artemisiifolia* in arable fields of Hungary

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Abstract

The large expansion of ragweed (*Ambrosia artemisiifolia* L.) currently constitutes the greatest conflict to the conservation of arable habitats in Hungary, not only because it is invading more and more habitats of rare weed species, but also because its allergenic effects have resulted in strong eradication campaigns. However, this inevitably means total control of a wide spectrum of species, because of the chemicals and mechanical operations used.

The aim of this study was to identify those environmental and land-use variables which drive ragweed invasion in arable fields. The knowledge of these factors might provide new information about the ecological behaviour of this species, and could be used to optimise selective weed control strategies against it.

A weed survey was carried out in 243 arable fields across Hungary, and 19 environmental and 12 management factors were measured. These were used as explanatory variables to build classification and regression tree models. The most important land-use variables explaining variance in abundance of *A. artemisiifolia* were crop type and crop cover with highest abundance found in sunflower fields and fields with low crop cover. A number of explanatory environmental variables were also identified with significantly higher *A. artemisiifolia* abundance on sites with sandy or acidic soils, higher mean April and annual precipitation, and cooler mean May temperature. Ragweed abundance was significantly lower on soils with high concentrations of Na, K and Mn.

Both farmers and nature conservationists should be increasingly familiar with the conditions and practices favouring ragweed infestations, in order to advance effective, but selective ragweed control, particularly in arable habitats of higher weed biodiversity.

This work was supported by project FVM 12.932/1/2009.

References PINKE G, KARÁCSONY P, CZÚCZ B BOTTA-DUKÁT Z (2011) Determining the importance of environmental and land-use variables for the abundance of *Ambrosia artemisiifolia* in arable fields of Hungary. *Preslia* 83, (in press).

Training session on Weed Seed Predation: From theory to practice

Thursday 3rd March – INRA, Room 31

This optional half-day training has been organized by Adam Davis, Bärbel Gerowitt, Sandrine Petit and Paula Westermann. It aims at sharing theoretical and/or generic aspects related to our understanding of the process as well as sharing know-how and practical issues related weed seed predation studies. About 20 participants have registered.

The half-day is organised as follows:

From theory to experimental design

1. Scaling issues: from point to seasonal estimates of predation (introduction by Adam Davis)
2. Temporal and spatial overlaps in seed predation (introduction by Paula Westerman)
3. Practical exercise: designing a fictitious experimental set up (split into working groups and discussion in plenary)

Practical issues in seed predation studies

- Comparing material used in the different teams*
- Discussion on pros and cons of specific material

*Please bring photos or even material that you use in your surveys (predation cards, dishes, trapping device, cages ...)

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