EUROPEAN WEED RESEARCH SOCIETY

Europäische Gesellschaft für Herbologie • Société Européenne de Malherbologie

ADVANCED WORKSHOP ON WEED MAPPING AS A TOOL IN PLANT ECOLOGY AND WEED MANAGEMENT

Organized by

ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS

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BOOK OF ABSTRACTS

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ELKE AUA

MAICHANIA

HELLENIC MINISTRY OF RURAL DEVELOPMENT & FOOD
HELLENIC AGRICULTURAL ORGANISATION "DEMETER"

16-18 September 2019
Mediterranean Agronomic Institute of Chania Crete, Greece

Local organiser:
Garifalia Ecomomou Agricultural University of Athens, Greece
Dionyssios Kalivas

Organizing Committee:

Garifalia Economou	Professor, Agricultural University of Athens, Greece
Hansjoerg Kraehmer	Former EWRS President
Michaela Kolářová	Assistant Professor, Czech University of Life Sciences Prague
Dimitra Doulfi	MSc Agronomist, Agricultural University of Athens

Session Organizers:

Classical weed survey methods

Moderators: G. Economou- M Kolářová

Advances in precision weed mapping. Automating systems for weed monitoring

Moderators: H. Eizenberg – V. Alchanatis

Site specific weed management

Moderators: R. Lati

Introduction to automated weed mapping and spatial data analysis

Moderators: S. Kalivas

Spatial issues in weed distribution. Dominating weeds, change of composition over time, weed infestation and influence factors

Moderators: J. Salonen

Status of rare and invasive and resistant weed mapping

Moderators: A. Uludag, H. Mennan , J Holec

Administrative Organization:
Conference Center of Mediterranean Agronomic Institute of Chania (MAICH)

Book of Abstracts published by
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PREFACE

Welcome to the "Advanced Workshop on Weed Mapping as a tool in Plant Ecology and Weed Management" in the beautiful city of Chania, in the hospitable region of Crete, the southern part of Europe.
We gathered here in Mediterranean Agronomic Institute of Chania (MAICh), to enjoy the unique experience of sharing scientific knowledge and collegial interactions among experienced scientists, new scientists and professionals with the common interest to increase the rate of progress in the important sector in weed science "Weed Mapping".

The goals of the Advanced workshop are, PhD and Post doc students, experienced "weed/, plant ecology/GIS scientists, agronomists and professionals, i) to create a forum where they will be involved exchanging results, experiences, and information on the technical and scientific progress in weed mapping science and in the innovative mapping tools as part of digital farming and ii) to establish collaboration based on new contacts and networks

The advanced workshop aims to be informal and so stimulate as much discussion as possible among participants. We will combine plenary scientific sessions with oral and poster presentations, practical training on the field using novel tools in weed mapping and training in computer class on weed maps production using software and geodatabase. Topics such as, phytosociology and weed science ,spatial weed distribution and weed shifts ,novel detection tools in weed mapping , mapping of invasive weeds / rare weeds, data processing, spatial interpolation, geostatistics and regional mapping, advances in precision weed mapping, automatic systems for weed monitoring , transfer of field data into available software and databases and State-of-the-art of SDSS, comprise the 7 sessions of the workshop.

Enjoy the Workshop in the MAICh Conference Centre, the special social events and your stay in the hospitable Chania.

The organizers:
Professor Garifalia Economou Agricultural University of Athens
Dr. Hansjoerg Kraehmer, Former EWRS President
Michaela Kolarova, Assistant Professor, Czech University of Life Sciences

Scientific Program

September 15 – September 19, 2019

Sunday Sept 15th

- Arrival
- 19.30 Afternoon and evening: Registration
- 20.00 Welcome drink and dinner

Monday Sept 16th

- 8:30 am to 9.00 am registration
- 9:00 am Welcome address and general announcements

-MAICH Director **Dr. George Baourakis**
-ELGO Director (Institute of olive tree, subtropical plants and viticulture) **Dr. A. Doulis**

- 09:30 – 10:30 am ***Session 1*** - **H. Kraehmer**
  Introductory and overview presentation

- 10:30 am Break
- 11.00 – 12:30 am ***Session 2*** **- G. Economou- M. Kolářová**
  Classical weed survey methods

➢ 11:00 – 11:30 am Choosing weed survey fields – learning from the past- **J. Salonen**
➢ 11:30 – 12:00 am Classical weed survey methods: a case study on the occurrenceof archaeophytes in agrophytocoenoses in the Czech Republic- **M. Kolarova**
➢ 12:00- 12:20 pm Proposal for the establishment of "Weed Observatory" in Cretan citrus orchard - **G. Economou**

- 12:20 – 12:30 pm Giving effective feedback on the presentations. Aspects and comments **by the Session organizers**

- 12:30 pm Lunch

- 02:00 – 03:30 pm ***Session 3*** **- H. Eizenberg – V. Alchanatis**
  Advances in precision weed mapping. Automatic systems for weed monitoring

➢ 02:00– 2:40 pm Introductory speech by the session organizers
➢ 02:40- 03:00 pm Sensor- assisted weed identification as a crop management- **M. Tempel**
➢ 03:00– 03:20 pm The use of UAV for mapping and analyzing weed distribution in onion fields- **G. Rozenberge**

- 03:20 – 03:30 pm Giving effective feedback on the presentations. Aspects and comments by **the Session organizers**

- 03:30 pm Break

- 04:00 – 05:30 pm ***Session 4*** **- R. Lati**
  Site specific weed management

➢ 04:00– 4:20 pm Introductory speech by the Session organizer

- 04:20- 4:40 pm Efficacy and selectivity evaluation of a new mechanical in- row weed control method- **E.Asaf**
- 04:40- 05:00 pm Utilize the potential herbicide savings using weed maps, when the sprayers have limited capabilities- **G. Somerville**
- 05:00- 05:20 pm Development of Integrated weed management for *Moringa oleifera*- **I. Shulner**
  - 05:20- 05:30 Giving effective feedback on the presentations. Aspects and comments **by the Session organizer**

Tuesday Sept 17th

- 8:45 – 10:00 am ***Session 5*** ***-S. Kalivas***
  Introduction to automated weed mapping and spatial data analysis
  (GIS data capture – data sources geodatabases, spatial interpolation, vegetation indices, spectrophotometry)

- 10:00 - 10:30 am Break

- 10:30 – 12:30 pm Unmanned aerial vehicle and mobile applications demonstrations in the field (Citrus orchard)

- UAV and multispectral camera (**S. Kalivas– GIS research team of AUA**)
- Spectral field measurement using Spectoradiometer -(**Charis Kalaitzidis - MAICH**)
- Mobile application for data capture (**S. Kalivas– GIS research team of AUA**)
- Mobile application – Bayer software demonstration (**M. Tempel**)

- 12:30 pm Lunch

- 02:00 – 3:30 pm Data evaluation and weed maps production -**Computer Laboratory**

- 03:30 pm Break

- 04:00 – 5:30 pm cont. Data evaluation and weed maps production- **Computer laboratory**

- 08:30 pm Evening: Party / Social event

Wednesday Sept 18th

- 09:00 – 10: 30 am **-** ***Session 6*** **- J Salonen**
  Spatial issues in weed distribution. Dominating weeds, changes of composition over time, weed infestation and influence factors

- 09:00– 09:20 am Introductory speech by the session organizer
- 09:20– 09:40 am Weed resilience and adaption to climate change in cereal agro-ecosystems- **I.S. Montanya**
- 09:40 - 10:00 am Management of weeds in henna field: a tool to improve production- **K. Benaissa**
- 10:00– 10:20 am - Monitoring of Orobanche and weed distribution in sunflower fields using GIS. The case study of north-east Greece- **A. Karachaliou**

- 10:20 - 10:30 am- Giving effective feedback on the presentations. Aspects and comments **by Session organizers**

- 10:30 am Break

- 11:00 – 12:30 pm ***Session 7*****, A. Uludag, H. Mennan, J. Holec**
  Status of rare, invasive and resistant weed mapping

➢ 11:00– 11:20 am Introductory speech by the session organizer
➢ 11:20 – 11:40 am Mapping of rare arable plants in the Aegean - addressing scientific and dissemination gaps for the new flora of Greece and future agro-environmental schemes (AES)- **S.Meyer**
➢ 11:40– 12:00 am Current Status of invasive weed mapping - **A. Uludag**
➢ 12:00- 12.20 pm The invasion of *Atriplex micrantha* in the Czech Republic- **Josef Holec**

- 12:20- 12:30 pm Giving effective feedback on the presentations. Aspects and comments **by the Session organizers**

- 12:30 Lunch

- 02:00 – 03:30 pm **Poster session**

➢ 02:00 – 02:10 pm Counting Canola flowers and estimating seed yield using UAV images under Egyptian desert conditions. - **I. Frahat**
➢ 02:10 – 02:20 pm Monitoring and evaluation of pre-emergence herbicides performance in malt barley through remote sensing- **I. Katsikis**
➢ 02:20– 02:30 pm Efficacy assessment of pre - emergence herbicides to control Lolium rigidum L. in brewery barley- **D. Doulfi**
➢ 02:30- 02:40 pm Weed community changes during the last three decades in semi- arid cotton crop using spatial temporal analysis- **K. Lontou**
➢ 02:40– 02:50 pm How weeds respond to nitrogen fertilization in a barley field- **I. Thomopoulos**
➢ 02:50- 03:00 pm Cattle grazing as a tool for invasive weed management and endangered species support on former pastures in mountain nature reserve- **M. Kolářová**

- 03:00 – 3:30 pm Poster discussion

- 03:30 – 04:30 pm Short summaries of session organizers on podium (10 minutes each + 5 minutes general discussion). Closing of the workshop

- 5.00 visit to Vinery

Thursday Sept 19th Departure

Introductory and Overview Presentation on Weed Mapping

Hansjörg Krähmer

Kantstraße 20, 65719 Hofheim, Germany

kraehmer-hofheim@t-online.de

The basis for the Weed Mapping Working Group of the EWRS was laid in Prague in the year 2009. The members of this group early defined its tasks and established a website with its mission in the year 2010. Continuous mapping allows us to document weed population changes not only on a field level but also on large scale bases. Ranking of weeds gives us the opportunity to provide long term predictions about weed problems on local and regional levels. Correlating the occurrence of weeds with environmental or agronomic factors helps us to explain and to predict the global distribution of weeds also. Weed biodiversity can be documented with maps. The introductory lecture for the workshop will demonstrate what kind of maps can be used. It will exemplify how members of the working group contributed to our knowledge of the distribution of the most frequent weeds in Europe and beyond. It will stress what the working group has achieved over a period of ten years. At the same time, new trends will be presented such as the automated weed identification with cameras and its potential use in precision farming.

Key words: *Weed population dynamics, prediction of weed problems, automatic weed identification, precision farming, weed biodiversity*

References

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Choosing weed survey fields – learning from the past

Salonen J.[1], Heikkinen J.M.[2]

[1]Natural Resources Institute Finland (Luke), FI-31600 Jokioinen, Finland,
[2]Natural Resources Institute Finland (Luke), PL 2, FI-00791 Helsinki, Finland

jukka.salonen@luke.fi

Sampling procedures in weed surveys require careful planning not only for biological reasons but because of economic limitations in collecting data from arable fields. Knowledge from earlier surveys can be utilized when planning repeated follow-ups. In Finland, comprehensive weed surveys in spring cereal fields have been carried out since the early 1960's and repeated over the decades in the same regions, farms and fields. The basis for the surveys was established in 1961-1964 when a total of 2 710 fields in 32 regions were surveyed. Afterwards, the survey has been repeated three times, latest during 2007-2009. Due to the economic reasons the number of survey regions has been dropped down to 16 and the number of fields has varied between 600-700 in the latest surveys. The primary attempt has been to re-observe the same fields which have been surveyed earlier for precise assessment of changes in weed species composition over the decades. In addition, some new fields have been included for better representation of organic production and changing trends in primary tillage.

he number of sampling units per farm has varied between 1-5 fields. The odds that spring cereals are grown in a previously surveyed field have been a random factor when visiting farms during a fixed survey year. The likelihood of getting same fields has been greater in conventional farms than in organic farms where the crop rotation is more diversified. The number of survey fields per farm needs to be re-considered when aiming at more optimal sampling effort. If new fields should be monitored, it might be more valuable to search them from other farms within the region. This leads, however, to increased number of survey farms to be contacted, visited and interviewed to obtain information on cropping practices. This drawback can be partly overcome with email communication and national databases.

Finnish weed surveys have assessed both the density and biomass of each weed species. Altogether 10 randomly placed quadrats (4 for biomass) per field have been observed resulting in data sets from which we can derive frequencies of occurrence and abundances of weeds by species and in total. Frequency ranking is practical when comparing results with other surveys whereas abundance values are feasible to relate with cropping practices in each field. Still, even the total density of weeds varies a lot between quadrats and merits further thoughts when planning the sampling procedures.

The objective of our workshop presentation is to show and discuss how the sampling procedure could be optimized in the forthcoming weed surveys in a manner which will rationalize the sampling effort, preserve connection to earlier studies and end up with relevant results describing the weed populations and affecting factors in Finnish spring cereal fields.

In particular, we present balanced sampling techniques, which result in a sample of fields that represents the target population as well as possible with the predetermined survey effort. The effect of reduced effort to the precision of the estimates is assessed through simulations studies, where balanced subsets of the fields of the most recent survey are sampled.

Keywords: sampling effort, weed survey, balanced sampling, sampling simulation

Classical weed survey methods: a case study on the occurrence of archaeophytes in agrophytocoenoses in the Czech Republic

Kolarova M[1], Economou G[2], Holec J[1], Tyser L[1], Soukup J[1], Krähmer H[1]

[1]Department of Agroecology and Crop Production, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague 6, Czech Republic,

[2] Department of Crop Science, Agricultural University of Athens, Iera Odos 75, 118 55, Athens, Greece.

mkolarova@af.czu.cz

A variety of methods for weed surveys have been developed by generations of weed researchers and many methods have been adopted to weed science from other branches of vegetation science. Most often, weed mapping methods include data collection, descriptive and analytical statistics and graphical interpretation of results. Individual weed mapping approaches follow various aims, have to be conducted at different scales and may therefore have very different requirements for sampling, statistical and interpretation methods. The choice of data collection methods will depend primarily on research objectives. Different methods will be used for different scales of study and habitats. Other factors influencing this selection are financial, equipment and time availability matters. In environmental studies, data are acquired mostly by sampling and some kind of species abundance or relative importance of different species in defined areas is the subject of interest. It can be expressed by several ways including number of individuals, area covered, weight of plant material, species frequency or by distances among individuals etc. Cover is one of the most common measures of community composition because it equalizes the contribution of species that are very small, but abundant, and species that are very large, but few. A key advantage of cover as a vegetation measure is that it does not require the identification of the individual (as e.g. density does), yet it is an easily visualized and intuitive measure. A disadvantage of cover measures (especially canopy cover) is that they can change dramatically over the course of a growing season, while both frequency and density measures seem to be more stable after species emergence.

Archaeophytes are alien plants introduced to the Czech Republic before the year 1500. Their occurrence is strongly connected with agricultural production. The aim of the study was to assess the occurrence of archaeophytes in arable fields in the Czech Republic in terms of applied management systems (conventional and organic farming), crops (winter cereals, spring cereals, wide-row crops) and environmental site conditions at different altitudes. In 2006–2018, a phytocoenological survey was conducted in selected farms across the Czech Republic using relevés that were 100 m2 in size, placed in the central part of fields. Totally, 180 weed species were found, of which 48.89% were considered as archaeophytes (88 species). In view of the invasive status, 5 archaeophytes were considered as invasive, the other 83 species were regarded as naturalized. The net effects of all variables studied on the occurrence of archaeophytes were statistically significant. The majority of the variation was explained by altitude, followed by crop and type of farming. Incidence of archaeophytes increases with an increasing altitude and is also related to their affinity with environmental factors. The highest occurrence of archaeophytes was found in cereals, some species, however, occur more frequently in wide row crops. The higher occurrence of archaeophytes was observed in organically managed fields.

Keywords: Czech Republic, plant cover estimation, weed sampling methods, archaeophytes

Proposal for a weed observatory in Cretan citrus orchard

G. Economou

&

Weed Mapping WG members (EWRS), Hellenic Agricultural Organization (H.A.O)
"DEMETER" - IOSV, AUA, MAICH

economou@aua.gr

The proposal focuses to increase awareness towards an early warning and information system about the weeds dispersal in the Mediterranean agroecosystems and particularly the invasive alien species (IAS) which threaten the crops and biodiversity as well. Taking into account that the capacity to assess the spatial/temporal weed dispersal and mitigation of the weeds infestation depends on the availability of accurate and easily updated accessible information, members of the Weed Mapping Working Group in cooperation with AUA, scientists from H.A.O.- IOSV and MAICH propose the establishment of a weed observatory within a citrus orchard.

Before addressing the core issues of this proposal, it should be essential to define the reason of the observatory establishment. We got the trigger to set up the observatory from the existence of the "National Collection of Citrus Varieties" which is maintained by H.A.O. – IOSV and the stressed need to take measures to reduce the impact of weeds and particularly the IAS species Araujia sericifera which threaten the citrus orchards in Crete.

For this reason, it should be crucial to improve the ability to detect and report the weed abundance, its spatial distribution, the new incursions of IAS and resistant weeds, so as to develop a surveillance and monitoring network at a local scale initially, in combination with an integrated weed management protocols. This system could potentially evolve into a regional one where reliable risk assessments can be produced and optimized weed management can be implemented promptly wherever needed. Actually, it underlines the need to combine geographical information and precision agricultural systems helping to locate, document, analyze the data and provide a stronger scientific basis for decision-making as concerns the sustainable weed management.

The observatory dedicated structure would have the task: i) to provide support for reliable taxonomic identification of weeds and possible new incursions using classical and GIS methods, ii) to compare confirmed data with existing databases and inventories in order to define the status of recorded species (annual, perennial, resistant to herbicides, 'alien in Greece/Europe, 'native', or 'uncertain'), iii) to establish an integrated weed control procedure and response actions via the use of innovative technology at farm scale, iv) to analyse the data and disperse information demonstrating optimum agricultural practices for weed management, v) to be a pilot action for weed surveillance / monitoring in other crops.

It would be an omission to ignore the effect of changing climate variables (atmospheric temperature, elevated CO_2, uneven rainfalls distribution and floods) which may either increase the distribution range of weed species or allow some non-potent weeds to dominate or display tolerance to herbicides with serious consequence to overall functioning and productivity of agro ecosystems. Actually, after catastrophic climatic events such as drought or flood, weeds will have a greater chance to colonize and invade disturbed habitats.

Chemical control measures may become less effective due to a change in the external environment or changes in growth physiology, and phenology of the target weeds. Additionally, extremes of moisture availability, viz., flood as well as drought, may hinder cultural and physical management methods. Importantly, research efforts and infrastructures are also needed to record the occurred climatic parameters and explore the adaptive mechanisms of weeds under the changing climatic conditions, a key point in developing future management protocols.

The technical structure of the observatory should be established with the primary task of enhancing the coordination of actions at a national level (H.A.O.-IOSV, MAICH, AUA), European Level (EWRS WGs) and professional expertizes on weed science, agronomy, ecology, climatology, geo informative science, precision agriculture. The costs of the network would be covered by each national and local authority and European synergy. The observatory should be considered a scientific body to be hosted by H.A.O. with institutional support (H.A.O.-IOSV, MAICH, AUA, EWRS WGs) responsible for finding funds by submitting proposals to ensure the implementation of the activities.

Sensor-assisted weed identification as a crop management tool

Matthias Tempel, Hansjörg Krähmer

Bayer AG, Digital Farm Solutions, Building 6100, 40789 Monheim, Germany

Efficient and long-term weed management highly depends on the knowledge of weed species and local weed infestation levels. Today, weeds can be identified with sensor-driven automated identification tools and earth-bound or unmanned aerial vehicles (UAVs). Machine learning has improved the automated identification of weeds within the last ten years considerably (Alexandridis et al., 2017; Castro et al., 2018). Multispectral cameras and special evaluation tools even make it possible to distinguish between grass weeds in grass crops (Barrero and Perdomo 2018, Lambert et al. 2017). One advantage of many automated weed mapping devices is their speed and the relatively short time needed for the assessment of weed infestation within arable fields (e.g. Laursen et al., 2017). Unfortunately, the present results are still far from those achieved by experienced botanists and the costs of dedicated systems are high. Continuous advances in camera technology and processing speed will help to close this gap sooner or later. Also. modern smartphones can be involved as supportive tools in a weed identification program. A central request of a data-driven decision support system are high quality measures in weed identification and the involvement of many experts. Large quantities of data have to be handled. Weed species distribution has to be analysed in a structured way in order to increase and validate the efficacy of weed control. We will present a concept demonstrating how Bayer will support farmers when collecting information in an automated and cost-efficient approach to advanced weed control decisions.

Key words: *Weed management, digital farming*, *risk assessments, artificial intelligence, computer vision, deep learning, Climate Corp, Bayer AG*.

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The use of UAV for mapping and analyzing weed distribution in onion fields

Rozenberg G. [1,2,*], Kent R.[3], Blank L.[1]

[1] Department of Plant Pathology and Weed Research, Agricultural Research Organization - the Volcani Center, Rishon LeZion, Israel 7528809
galrozenberg@gmail.com
[2]Department of Geography and Environment, Bar-Ilan University, Ramat Gan 52900, Israel
[3]Hamaarag - Israel's National Nature Assessment Program, The Steinhardt Museum of Natural History, Tel Aviv University, Klausner St. 12 Tel Aviv, 6901126

Weeds cause significant yield loss in dry onion (*Allium cepa*) fields. Due to the crop's growth characteristics and despite intense herbicide treatments, many weed species successfully compete with the crop throughout the entire season resulting in decreased yield production. While most research focuses on the initial growth stage, late season weed management in this crop is of great importance as weed species that thrive at this stage enrich the seed bank and force the operation of heavy machinery or spraying herbicides to enable harvesting, and thus inflicting damage to the crop. In addition, while many studies describe the spatial distribution of weeds throughout fields as patchy, the application of herbicides is usually uniform and results in unnecessary use of chemicals. Site-specific weed management with a map-based approach consists of developing robust methods for mapping weed distribution. The spatial distribution of weeds within a crop can be detected and mapped using remote sensing or by field monitoring. While the latter can be expensive and time consuming, using remote sensing platforms such as unmanned aerial vehicle (UAV) provide a quick alternative for creating accurate weed maps. At the last phenological stage before harvest, the dry onion foliage plummets, dehydrates and changes its color to yellowish-brown while the growing weeds remain essential and green. Therefore, it can be assumed that it is possible to use the spectral differences resulting from the different phenological stages in the crops and the weeds to distinguish the weeds. The goal of this study is to examine late season weed mapping using UAV. For this purpose, an "off the shelf" DJI Mavic pro was utilized to obtain high resolution orthomosiacs (0.5 cm/pixel) from 15 commercial onion fields in Israel, during June-July 2018. Image analysis techniques including segmentation, vegetation indices and classification methods were used to accurately classify, and map weed patches in the field. Additionally, crop rows were mapped for detecting within-field weeds' preference. Classification was validated using overall accuracy and Kappa coefficient derived from confusion matrix with results ranging between 94.3%-99.3% and 0.75-0.94, respectively. These results indicate successful classification process, allowing weed coverage quantification. Weed cover varied extensively between the plots ranging between 0.83% and 79.6%, showing no clear tendency to establish between or within rows. This work shows the potential of using drones for weed mapping and constitute an important step in the development of precise weed control.

Key words: Classification, Drones, Precision agriculture, Weed mapping

Potential Utilization of Accessible Sensors and Data Analysis Tools in Weed Research

Ran.N. Lati
Department of Weed Research and Plant Pathology, Agricultural Research Organization, Newe Ya'ar Research Center, Israel

ranl@volcani.agri.gov.il

The vast technological development offers a wide range of tools for decision making in different aspects of agriculture, and particular, in weed control and research. However, in many cases a significant gap is maintained between the cutting edge technological achievements and the everyday usage of growers and agronomy-oriented–researchers that can benefit from these findings. This gap may resulted from economic (high sensors costs) or technic (operational and data analysis difficulties) reasons, nonetheless, both hinder the adoption of these technologies and their potential contribution. One of our research objectives is to turn highly accessible and inexpensive sensors and data analysis means into end user friendly and viable tools for weed research. This objective will be demonstrated using two case studies: evaluating crop tolerance to flaming application and early identification of failure in herbicides application. Crop tolerance for flaming is usually performed by visual ranking, a biased parameter. Biomass evaluations, another key parameter, are labor intensive and must be held long time after the application. Thus, adoption of accurate, fast and automatic method to achieve these evaluations is of great interest. For herbicide application, early detection of control-failure may allow growers the opportunity to improve their application result and suggest on flawed equipment or the development of tolerance population. In summary, the sensors and platforms demonstrated here can save growers and researcher time, money and efforts in varied tasks on the field scale and improve their accuracy compared to current methods of data collection and decision making.

Efficacy and selectivity evaluation of a new mechanical in-row weed control method

E. Asaf[1,2], H. Eizenberg[1] and R. Lati[1]

[1]Department of Plant Pathology and Weed Research, Newe Ya'ar Research Center, Agricultural Research Organization, Ramat Yishay 30095, Israel; [2]Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture, Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot 7610001, Israel.

evya.jd@gmail.com

Effective weed control is an essential stage to ensure farmers profitability, while herbicides are the basis for most conventional weed control managements. In recent years with regulators banning the use of large number of herbicides, the potential use of new non-chemical means has gained much attention. One of this option is the Finger-Weeder (KULT, Germanny), a cultivator that handles weeds growing on the crop row and can be used in different soils and on different vegetable and field crops. However, there is no scientific data about the impact of the different sizes and hardness levels of the fingers parts on the control efficacy and on potential selectivity for specific weed species. The objectives of this study are to: 1. characterize the impact of different Finger-Weeder sizes, hardness levels and setting (distance between the two units) on the weed control level, and 2. evaluate the potential selectivity of this control mean for specific weed species. To compare the selectivity for broadleaf vs. cereal weeds mustard (*Sinapis sp.*) and wheat (*Triticum sp.*), respectively, were used as model weeds and seeded at different densities (30, 60 seeds/meter) and treated at different growth stages (cotyledons, two leaves and four leaves). To evaluate the impact different setting, sizes and hardness levels on control efficacy mustard was used as a model weed and seeded and treated at the same stage using all combinations of the two hardness levels (hard and soft), three finger sizes (370, 290 and 250 mm) and three finger setups (recommended, extreme and low overlap). Weed control was evaluated by cover area and biomass evaluations. A significant selectivity for the cereal plant (wheat) was found and at the first evaluation (germination), no effective control was achieved in the wheat (15% control) compared to complete control level (100%) achieved with mustard. Similar results were observed at the two leaf stage with 80% and 20% control for the mustard and wheat, respectively. A significant decrease in the control efficacy for both species, 20% and 25% control, respectively, was observed at the four true leaves stage. Our observations suggest that the root system that anchored the plants to the ground may be the selectivity mechanism. The fingers hardness levels had a significant impact on the control level ($p = 0.0002$) and the soft one was less effective than the hard one. The setting was also highly significant factor ($p < 0.0001$) where the low overlapping was less effective compared to the recommended and extreme overlapping setups. Finally, the finger size had a significant impact ($p = 0.0236$) and the medium finger (290 mm) was more efficient compared to the large and small sizes (370 and 250 mm). Our experiments show the potential use of the Finger-Weeder as an alternative weed control mean or as complementary mean within IWM programs.

Key words: finger- weeder, mechanical in-row weed control, Integrated Weed Management

Utilise the potential herbicide savings using weed maps, when the sprayers have limited capabilities

G.J. Somerville[1], R. N. Jørgensen[2], O. M. Bojer[3], P. Rydahl[3], M. Dyrmann[2],

P. Andersen[4], N.-P. Jensen[5], O. Green[6]

[1]Department of Agroecology, Aarhus University, Forsøgsvej 1, 4200 Slagelse, Denmark
[2]Department of Engineering, Aarhus University, Finlandsgade 22, 8200 Aarhus N, Denmark
[3]IPM Consult ApS, Stenlille, Denmark
[4]Datalogisk A/S, Noerre Alslev, Denmark
[5]I-GIS A/S, Risskov, Denmark
[6]Agro Intellingence ApS, Aarhus, Denmark

gs@agro.au.dk

The capability to analyse high-resolution images using machine learning is consistently improving. Detailed weed maps of within-field weed populations are becoming a reality for precision agriculture, which will help reduce herbicide use.

For the last 25 years in Europe 'pesticide action plans' have been constructed, with the aim of reducing the use of pesticides. Field validation trials show that application of herbicides can be reduced by 20-40%, using uniform rates and typically available herbicide application machinery (sprayers). However, further herbicide reductions are expected to require spatial on/off nozzle control and variable herbicides and dosages. Further herbicide reductions may be possible by adapting spray maps to the limited adaptability of currently used sprayers.

Images collected in a ~9 hectare winter wheat field, (~100 images ha-1) were used to build herbicide spray maps. The advantage of this new analysis system is that it is designed to be used with currently available sprayers, using only GPS and boom-wide spray changes. This study predicted a further 40% reduction in herbicide use (below the already reduced recommendations discussed in paragraph 2 above), whilst still maintaining a high level of weed control.

Key words: Integrated weed management, application maps, herbicide mixtures, automated weed recognition, 'IPMwise'.

Development of Integrated weed management for *Moringa oleifera*

I. Shulner[1, 2] Z. Peleg[1], R. Lati[2]

[1]The R.H. Smith Institute of Plant Science & Genetics in Agriculture, Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot 76100, Israel.
[2]Department of Phytopathology and Weed Research, Agricultural Research Organization, Newe Ya'ar Research Center, Ramat-Yishay 30095, Israel.

itayshulner@gmail.com

Moringa oleifera Lam. (moringa) is a deciduous tree member of the Moringaceae family. The tree originates from South-Asia and is typically cultivated as a perennial crop. Moringa is a fast-growing tree with a wide variety of uses: medicine, biodiesel, water purifying and for human and livestock feed. In Israel, the crop is harvested several times per year, thus, weed managements must take into consideration several control scenarios: between seeding and early growth (PRE), between early growth and canopy closure (POST), between harvests when the soil is exposed to light and during the winter when the tree is dormant. To the best of our knowledge, no previous studies have addressed weed control issues for this crop and there is no data about potential herbicides or alternative non-chemical methods that can be safely used in moringa. The main objective of this study is to evaluate the safety and efficacy of herbicides and non-chemical means for moringa and to develop integrated weed management (IWM) for this crop. For that purpose, herbicides from various modes of actions were tested: seven PRE treatments and seven PRE and six POST herbicides during the dormancy phase. Additionally, propane-flaming and cultivation were evaluated during dormancy. Safety was determined by evaluating moringa biomass and weed control efficacy was determined by evaluating weed cover area using RGB camera mounted on a drone. At the PRE treatment, saflufencil (70 g ha -1) diuron (1600 g ha -1) and flurochloridone (500 g ha -1) were safe and the crop biomass values at harvest (42 DAT) were 107%, 91% of 83% compared to non-treated control, respectively. Weed control level following these treatments was adequate with 10%, 2% and 1% weed cover area compared to non-treated control, respectively. During the winter, PRE-treatments with indaziflam (75 g ha -1) and diuron (1600 g ha -1) were effective, with 14% and 26% weed cover area compared to hand-weeded control, respectively. However, the POST treatments with glufosinate+oxyfluorfen (800 g ha-1 + 240 g ha -1) and glufosinate + saflufencil (800 g ha-1 + 70 g ha -1) were less effective and resulted with 26% and 39% weed cover area compared to hand-weeded control respectively. The non-chemical methods, propane-flaming and cultivation were less effective than the herbicides treatments with 29% and 42% weed cover area compared to hand-weeded control, respectively. For the dormancy phase treatments, no crop safety data were collected yet, and crop yields will be evaluated during the spring. More research is needed to develop effective IWM for this crop, however, our results show potential herbicides and non-chemical methods that can be used in this crop.

Key words: moringa, cimical weed control, non cimical weed control, herbicide.

Spatial and temporal issues in weed distribution

Salonen J

Natural Resources Institute Finland (Luke), FI-31600 Jokioinen, Finland

jukka.salonen@luke.fi

Information about the composition of weed populations in arable fields is one of the key principles in Integrated Weed Management (IWM), an effort required to follow in the EU since 2014. Weed species composition has both temporal and spatial aspects related to abiotic and biotic factors. For instance, climate in general and seasonal changes in temperature and precipitation explain differences in weed populations. Moreover, arable crops and cropping practices create a basis for crop-weed interactions that finally lead to weed shift, that is to say changes in weed occurrence, both in terms of species composition and their relative abundance.

Weed populations are not stable. Weed surveys aim to record shifts in the weed flora composition. The most worthwhile way to demonstrate weed shift in arable fields over time is to re-observe the same fields of the previous survey(s). Now that the composition of weed populations is strongly associated with changes in crop rotations and cropping practices, data on the occurrence of weeds should always be linked with the information from the survey fields and farms. Thus, a fruitful co-operation with farmers is a prerequisite for successful collection and interpretation of survey results.

Contributions in the Session 6 address sampling process, data handling and linking of weed data to factors, including climate, which are assumed to influence on weed species composition in long run.

Key words: weed flora, weed shift, weed surveys

Weed resilience and adaptation to climate change in cereal agroecosystems

M. L. Gandía, C. Casanova, J. L. Tenorio, M. I. Santín-Montanyá
Environment and Agronomy Department
National Institute for Agricultural and Food Research and Technology (INIA), Madrid, Spain

isantin@inia.es

As a response to climate change (CC) ecosystems need to rebalance and undergo process of adaptation and reorganization in order to ensure long term sustainability. In agro- ecocystems biodiversity, the space and temporal distribution of flora strongly influences the success of the crop. The capacity know as r*esilience* applied to plant species reflects the ability to absorb changes in the environment. If there are resilient weed species in the agro- economic system, they can act as a buffer and lesser the effect of CC on the crops. This is referred to resilience of the agro- ecosystem. If systems can adapt to changing climate conditions sustainability is facilitated. Unfortunately, there is a lack of information about how agro- ecosystems adapt to environmental changes.
The general objective of this work is to associate the weed distribution patterns, within a determined area, with environmental variables due to differences in altitude. For this study, we selected one variable (temperature) in order to compare the weed flora at different altitudes. We aim to gain insight into cereal agro-ecosystems and potential adaptation to a rise in temperature due to CC.
In the sampling track carried out in June 2019, established in latitude 38°N, we identified weed species in cereal agro- ecosystems found within altitude range from 275 to 1735 m. We represented the weed distribution ranges graphically based on the presence of weed species in altitude intervals of 100 m. Information in each sampled point, was also collected about average temperature (maximum and minimum) by means of Worlclime. The graphs were made to visualize the weed species distribution variation in different altitudes and at maximum ans minimum average temperature. Then, weed species were defined according to altitude and temperature distribution ranges.
The results of this process of categorising of weed species have provided interesting information about distribution of weeds according to altitude and temperature. We obtained a classification of thirty- three weed species, identified in our monitoring area. We found six weed species, in agro- ecosystems along our established route, which we can classify as generalist: *Anacyclus clavatus*, *Cirsium arvense*, *Cnicus benedictus*, *Convolvulus arvensis*, *Euphorbia helioscopia* and *Sinapis alba*, all of them with high thermal amplitude dispersion and the highest altitude range.
The understanding of weed species distribution could allow us obtained weeds as potential allies for the sustainability of cereal agro- ecosystems because of their resilience to CC. In the face of CC, it is important to understand the concept of weed resilience in order to conserve biodiversity and protect ecosystem services in our dryland cereal agroecosystems.

Key words: altitude, climate condition, diversity, temperature, weed flora

Management of weeds in henna field: a tool to improve production

Benaissa K.

Department ofAgronomics sciences
University of Mohamed Khider of Biskra, Algeria

Miskelil07@gmail.com

The henna (*Lawsonia inermis* L.) is a cosmetic and aromatic medicinal plant highly adapted to the arid climate. Its culture is renowned in the Saharan oases, driven by ancestral techniques. In order to collect information about traditional know-how in the management of henna and to improve the production of this crop, a field survey was conducted in the area of Biskra (South East of Africa) among 115 farmers during 4 years (2010-2012-2014-2016).

A questionnaire sheet containing questions about henna crop management was prepared and distributed to farmers. The statistical processing of the results was carried out by the software SPSS (*Statistical Package for the Social Sciences*)which allowed us to analyze the information collected, among others the question about the most redoubtable plant protection problems of henna in the field that cause significant damage to the production.

All farmers replied that weeds are the main problem in the management, 56 % of farmers used manual weeding, 15 % used integrated weed management and only 7 % used herbicides.The inventory brought out 12 weed species and the most common species were: Cynodon dactylon L., Convolvulus arvensis L. and Setaria veticillata L. They also reported the presence of a parasitic plant of the genus Cuscuta. The distribution of these weeds is variable in the fields since we could find from one weed species in one field till 8 species in another one.

The overall conclusion of the answers confirms that the success of henna production depends on the control of these weeds; in case of heavy weed infestation evaluated to 30 % of yield losses, the field of henna won't be harvested because the production of henna's leaves after processing will be of bad quality.

Key words: henna, *Lawsonia inermis*, weeds, crop management, weed survey.

Monitoring the distribution of Orobanche and other weeds in sunflower fields using GIS. A case study from north-east Greece.

Karachaliou A.[1], Lontou K.[1], Gavriil E.[1], Vahamidis P.[1],Lyra D.[2], Kalivas D.[3], Economou G.[1]

[1]Agricultural University of Athens (AUA), Department of Crop Science, Iera Odos 75, 11855 Athens, Greece
[2]International Center for Biosaline Agriculture, P.O. Box 14660, Dubai, United Arab Emirates
[3]Agricultural University of Athens, Department of Natural Resources and Agricultural Engineering, Iera Odos 75, 11855 Athens, Greece

andriana_kar@hotmail.com

Weeds consist in a major problem in sunflower (*Helianthus annuus*) production. Especially *Orobanche cumana* was the most significant problem in the past. Post-emergence weed management became feasible after the development of Herbicide–Resistant Crops (HRCs), a dominating production system in sunflower in Greece since 2008. Recently, the main applied technologies in sunflower were ExpressSun® and especially Clearfield®.
The aims of the study were the identification of the changes in weed species composition in sunflower under the repeated use of the aforementioned technologies during 2012 and 2015, as well as the effect of the abiotic and farming factors on weed flora.
Extensive surveys were conducted in 27 and 50 different sunflower fields in the same cultivation zone across Evros region of NE Greece during two periods, July 2012 and July 2015, respectively. In each field a sample of 10 quadrats of 1 m^2 following a Z-pattern was collected. In each quadrat weed species, their frequency, uniformity and mean plants density were recorded in order to determine their Abundance Index (AI). Canonical Correspondence Analysis (CCA) was used to quantify the relative contribution of several variables of climate, site and crop management to weed species composition. Weed spatial distribution maps were created in order to observe changes for each weed species as well as the weed flora composition. Based on AI the most important weed species during 2012 surveys were *Xanthium strumarium*, *Abutilon theophrasti*, *Solanum nigrum* and *Chenopodium album*, and during 2015, were *C. album*, *Echinochloa crus – galli*, *Sorghum halepense* and *X. strumarium,* in decreasing order. Observed change in weed species composition may be due to either the emergence of resistant biotypes or the absence of competition with the weeds *X. strumarium, A. theophrasti* and *S. nigrum* which were controlled by the applied weed control means (research in progress). *O. cumana* has been observed in very low infestation level confined to the margins of the fields during both periods, showing the efficient control under the application of both systems (ExpressSun® and Clearfield®). The current survey shows the great importance of herbicide and particularly of the Clearfield® as long as the weed population remains at low abundance. However, it is worth to monitor the emergence of higher populated weeds. According to CCA considerable differences in weed species composition were recorded. These differences were mainly associated with N fertilization, irrigation, production system, total rainfall and average temperature, altitude of fields, soil organic and clay content and time of sowing. O. cumana was favored by high soil organic content and dry conditions, which were typical in many survey sites.

Key words: sunflower, weeds, spatial distribution, temporal distribution, weeds survey

Mapping of rare arable plants in the Aegean - addressing scientific and dissemination gaps for the new flora of Greece and future agro-environmental schemes (AES)

Meyer S[1], Bergmeier E[1]

[1]Department of Vegetation and Phytodiversity Analysis, Albrecht-von-Haller Institute for Plant Sciences, Georg-August University Göttingen, Untere Karspüle 1, 37073 Göttingen, Germany

smeyer1@gwdg.de

The agricultural landscapes of Europe have changed enormously in recent decades due to intensified cultivation bringing many of its characteristic species to the brink of extinction. By European standards, the species richness of native arable plants and archaeophytes in Greece is unrivalled, and many species which are rare or nearly extinct elsewhere can still be found in the Eastern Mediterranean with many subpopulations. Yet, on closer inspection, there is a dramatic and ongoing decline of traditional arable farming and its ecosystems in this area, caused by (1) increasing intensification in areas favourable for cultivation, (2) the abandonment of marginal or remote arable lands, and (3) the transformation of cereal fields to other, often perennial crop fields and plantations. A recent survey concludes that the arable plants in the existing Red Data Book of Greece have been neglected and that a considerable proportion of the plants of traditional agriculture occurring in Greece are threatened by IUCN Red List standards. While in Central and Western Europe the protection of the arable flora and fauna has received some attention in nature conservation policy making in recent years, there appears to be little such effort in the Aegean, Greece and the Mediterranean, although Southern Europe harbours most of the continent's arable plant diversity.
The primary aim of the study is to use the results of botanical surveys on the Aegean Islands to fill in knowledge gaps about the occurrence and distribution of rare arable plants in the Aegean. The data will be incorporated into the new Flora Graeca currently in preparation. Since 2015 we volunteered in visiting more than 20 Aegean islands and recorded their segetal species pools. As a result of these mappings, we recorded several species for the first time on individual islands and floral regions. Some species have been reconfirmed, such as Nigella orientalis, which was found for the first time in more than 100 years on the island of Lesvos.
Our second aim is to establish a novel approach to identify important arable plant areas (IAPA) at various scales – regional, nationwide or Europe-wide – for the four floristic regions of the Aegean. To raise awareness and to spark policy-making for the values of diverse cultural landscapes we intend to provide solutions for an adequate compensation and long-term perspective for local farmers, i.e. designing of agro-environmental schemes (AES) in terms of agrobiodiversity conservation. The Mediterranean Institute for Nature and Anthropos (MedINA), acting as a link to the Greek Ministry of Agriculture, will transfer the scientific recommendations into agropolicy. The aim of this cooperation is to support the designing and establishing of an AES for traditional arable land use to be implemented in the next European Common Agricultural Policy (CAP).

Keywords: agrophytodiversity, conservation, important arable plant areas, Mediterranean, weeds

Current Status of invasive weed mapping

Uludag A.
Faculty of Agriculture, Canakkale Onsekiz Mart University, Canakkale, Turkey

ahuludag@yahoo.com

Invasive alien plants (IAP) as invasive alien species are one of the main reasons of biodiversity loss. Furthermore they have impact on ecosystem services, which are the source of our livelihood. First of all, the difference and resemblance between weed and IAP should be clarified although it is not easy to draw a straight line. Weed can be defined as a plant that causes economic losses or ecological damage, creates health problems for humans or animals, or undesirable where it is growing (WSSA, 2016). IAP are alien plants (any live specimen of a species, subspecies or lower taxon of plants introduced outside its natural range including any part, gametes, seeds, eggs or propagules of such species, as well as any hybrids, varieties or breeds that might survive and subsequently reproduce) whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services (socioeconomic impacts) (EU, 2014). Very broadly, IAP are harmful plants outside their biogeographical range, weeds are plants with economic hazard mainly. Even we can say more, IAP are potentially harmful while weeds are already creating problems.

Mapping IAP provides information not only for today but also for future. We can even assess which plant could be a weed in our cropping systems. Mapping IAP also includes different levels from a small community to worldwide. Using climate and global change scenarios, potential distribution, introduction and spread of IAP can be assessed, which can help to develop policies and take early measures to prevent IAP introductions and spread. Mapping is a useful tool for an early detection of IAP, which is the second step of hierarchical strategy of IAP management. Mapping in the stage of containment and control, the third step, more resembles weed mapping. Data for IAP mapping can be gathered via systematic or special surveys, or through new systems such as remote sensing etc. But, citizens, who are aware of problems and care about environmental issues and taught on what they will look for, can help us for IAP mapping efficiently if we establish a system.

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The invasion of *Atriplex micrantha* in the Czech Republic

Michaela Kolářová, Klára Novotná, Josef Holec

Atriplex micrantha C.A. Mey. in Ledeb. (syn. A. heterosperma Bunge) is native in Central Asia. Steppes and semi-deserts are its natural habitats, the species is tolerant to drought and salinity. Adventive range of occurrence covers central and western Europe, North and South America. During 80th of 20th century *A. micrantha* started to spread along highways in Germany. Traffic helped *A. micrantha* to spread to neighbouring countries. In the territory of the Czech Rep. the species was recorded for the first time in 1967. Similar records from late 60th and 70th represent casual occurrence of A. micrantha as a wool adventive on waste places and disposal sites. In 2014, first study was published on *A. micrantha* occurrence in north-eastern part of CZ. At this time, *A. micrantha* was already widespread along the highways, especially in central reservation (median strip). We observed the main highways and motorways in central Bohemia – Prague region and we found *A. micrantha* occurring there in high numbers. Frequent occurrence in large area of the country indicates that the spread was fast and took place probably during the last decade. Since the very beginning of its spread, *A. micrantha* has been neglected and omitted by scientists. We have no data about the early phases of its invasion. There are several reasons for this: Central reservation of highway is hard to reach, for safety reasons it is normally not possible to collect specimens there. Without closer look, *A. micrantha* can be misidentified as *A. sagittata* or when ripen as *A. oblongifolia*. We can predict future spread of *A. micrantha* along the roads and consequently its occurrence along the arable land. It can become common ruderal species in peri-urban zones. We do not expect it to become arable weed in the near future.

POSTERS

Counting Canola Flowers and Estimating Seed Yield Using UAV Images under Egyptian desert conditions.

Islam Frahat Zaky Hassan
National Research Centre, Cairo, Egypt

Islam_frahat@yahoo.com

The objective of this study was to optimize the yield estimation models in canola in order to enhance the selection process in plant breeding programs by the use of unmanned aerial vehicles (UAVs). The UAVs, via sensors equipment provide large quantities of field data and images giving the ability to select key phenotypic traits of canol . This approach can be a useful tool to estimate accurately canola final yields taking images and analyzing reproductive and growth parameters, such as flower quantity, pod quantity, pod structure, canopy size, plant height, and pod moisture content. The development of digital phenotypes may be help the improvement of monitoring canola growth and forecasting of potent canola yield. The importance of this work is to develop a proper pipeline, to be used by breeders, agronomists, and farmers. The high-throughput phenotyping method using UAVs provides new phenotyping assessment methods increasing the data accuracy compared with conventional phenotyping methods. Furthermore, the application of UAVs technology in canola crop can be useful to the determination of agricultural input factors. Fertilization, herbicides and fungicides application, irrigation, harvest and pos harvest practices can be planned or adjusted using UAV-based field scouting. The farmers after training will be able to use this system through the application of "good farming practices" with environmental and financial benefits for the agroecosystem and the farmers, respectively.

Monitoring and Evaluation of pre-emergence Herbicides performance in Malt Barley through Remote Sensing

Katsikis Ioannis[1], Kalivas Dionysios[1], Vahamidis Petros[2], Economou Garyfalia[2]
[1] Agricultural University of Athens, Department of Natural Recources Management and Agricultural Engineering, Laboratory of Soil Science, G.I.S. Research Unit
[2] Agricultural University of Athens, Department of Crop Science, Laboratory of Agronomy, Iera Odos 75, 118 55, Athens, Greece

johnkatsikis91@gmail.com

Lolium rigidum L. is one of the most important weeds in malt barley causing yield losses as the usual weed management practices prove ineffective to control this weed especially under monocropping farming systems. The aim of this study was to evaluate the efficacy of pre-emergence (PRE) herbicides labeled for use in malt barley under two different barley densities (low & normal) using Geographic Information Systems (GIS) and Remote Sensing and also to find a solution in yield monitoring through vegetation indices.
The field experiment was arranged in a two-factorial randomized complete block design with four blocks. Treatments were completely randomized within each block and included three competitor pre emergence herbicides (prosulfocarb, pendimethalin, chlortoluron + diflufenican) with two controls (no weed control; the common practice of the Greek producers namely post emergence mixture of pinoxaden with 2,4-D + florasulam) and two barley sowing densities (290 & 415 seeds/m^2). After malt barley (variety RGT Planet) seeding *Lolium rigidum* L. was also added (9 g seeds/m^2) in each plot. Plot size was 9 m^2, including 15 rows spaced 20 cm apart.
An Unmanned Aerial Vehicle (UAV) with a multispectral sensor was used for monitoring crop and weeds development. Altogether 7 flights were made at 20m altitude and the images taken were processed with Pix4D Mapper and ArcGIS softwares. In particular, a combination of the images taken were combined into orthomosaics and then vegetation indices were extracted. Finally, spatial statistical analysis was made in ArcGIS and the yield data were correlated with vegetation indices in IBM SPSS and Statgraphics Centurion softwares.
The results showed significant differences between vegetation indices of the experimental plots of chlortoluron + diflufenican compared to the other tested herbicides. Significant correlations were also found between vegetation indices and crop features at stem elongation phase. Both barley grain yield and grain number per unit of land area were closely associated with NDVI ($R^2 = 0.71$, $P<0.01$) and RESAVI ($R^2 = 0.75$, $P<0.01$), respectively, highlighting the importance of UAVs as useful tools for monitoring malt barley.

Key words: Barley Growth, Vegetation Indices, Supervised Classification, Spatial Analysis, UAV, Weeds

* The experiment was funded by Athenian Brewery SA.

Efficacy assessment of pre - emergence herbicides to control *Lolium rigidum* L. in malt barley.

D. Doulfi[1], A. Efthymiou[1], P. Vahamidis[1], G. Economou[1]

[1] Agricultural University of Athens, Department of Crop Science, Laboratory of Agronomy, Iera Odos 75, 118 55, Athens, Greece

dimdoulfi@yahoo.gr

In recent years malt barley has gained an increased importance for the brewing industry in Greece. Weeds, and especially *Lolium rigidum* L. (rigid ryegrass), pose a great challenge for the malt barley production. Thus, the main objective of this study was to evaluate the efficacy of new pre-emergence (PRE) herbicides labeled for use in barley for the control of *L. rigidum*. Three PRE treatments were tested under field conditions during the 2018-2019 growing season: chlortoluron + diflufenican, psofulocarb and pendimethalin. Additionally, the impact on *L. rigidum* phenology stage and population density as a mean of control efficacy and the impact of these PRE treatments on barley yields and qualitative characteristics were evaluated. The control treatment was the commonly used management in Greek: POST application at barley tillering phase of pinoxaden + 2,4-D + florasulam. The other control treatment was untreated plots. Herbicides were applied with a pressurized CO_2 backpack sprayer (AZO sprayers) equipped with flat-fan nozzles spaced 50 cm apart on a 3m boom calibrated to deliver 350 L ha^{-1}. The experiment followed a complete randomized block design with four replications. The data were subjected to ANOVA and all means were tested for LSD test at $P = 0.05$. The PRE herbicides showed similar efficacy between them in controlling *L. rigidum* population density. The higher inhibition of *L. rigidum* phenology development compared to the untreated plots was recorded in the chlortoluron + diflufenican treatment (100%), followed by the prosulfocarb (72%) and pendimethalin (11%) treatments. However, the phenology development of barley was not affected by none of the the applied herbicides. Although crop emergence did not show any phytotoxicity affect following the chlortoluron + diflufenican treatment, a significant phytotoxicity occurred at the onset of tillering phase of barley and expressed finally with 40% decrease in the yield. However, plants recovered at later developmental stages and no phytotoxicity symptoms were observed.
Our results showed that PRE application of the herbicides, psofulocarb and pendimethalin allowed effective weed control directly after germination and prevented early competition, with safety for the barley crop.

Key words: malt barley, *Lolium rigidum* L., control efficacy, herbicides.

* The experiment was funded by Athenian Brewery SA.

Weed community changes during the last three decades in semi-arid cotton crop using spatial temporal analysis

Lontou K.[1], Dimoulas D.[1], Karachaliou A.[1], Kalivas D.[2], Economou G.[1]

[1]Agricultural University of Athens, Department of Crop Science, Iera Odos 75, 11855 Athens, Greece
[2]Agricultural University of Athens, Department of Natural Resources and Agricultural Engineering, Iera Odos 75, 11855 Athens, Greece

kwn.lontou@gmail.com

A number of initiatives have been implemented to meet cotton growing concerns due to negative side effects of the intensive land-use practices over the past 30 years. In this study, the spatial and temporal variability regarding the frequency, uniformity and density of the main weeds were compared among three sampling periods in Karditsa's prefecture (the main cotton zone in Greece). Taking into consideration that the spatial distribution of weeds depends on a great part on spatially variable safe sites necessary for initiating germination and ensuring growth to maturity we studied the role of abiotic factors. The surveys were conducted during 1995-1997, 2007-2009 and 2018 in 150, 80–101 and 160 cotton fields, respectively. The exact position of each sampling site was recorded using a GPS device and collected data were entered in a geodatabase in order to proceed to extended analyses using GIS. According to our approach, climate conditions, soil properties, irrigation method and herbicides' application were included in the geodatabase and were spatially correlated with the weed flora records to determine spatial and temporal differences.

During the first survey (1995-97) 15 weed species were recorded belonging to 11 botanical families, while in the second survey (2007-09) 17 weed species were recorded belonging to 9 botanical families. In general, the rank of the main weeds, estimated by Abundance Index (AI), varied widely within the two surveyed periods. Particularly, the most important weeds (depending on their AI) during the 1st sampling period were, *Solanum nigrum* (61.44), *Chrozophora tinctoria* (42.38), *Convolvulus arvensis* (39.81), *Cyperus rotundus* (33.94), *Xanthium strumarium* (26.07) and *Cynodon dactylon* (23.97) whereas, in the 2nd sampling period the rank was as follows: *C. rotundus* (151.03), *C. arvensis* (68.25), *C. dactylon* (46.86) and *Sorghum halepense* (24.57). In the current survey, conducted during 2018, 11 weed species were recorded belonging to 7 botanical families. According to the AI, the most important weeds were *Physalis angulata* (84.66), *C. rotundus* (55.56), *S. nigrum* (45.32), *Xanthium strumarium* (16.42), *C. dactylon* (13.55), *C. arvensis* (5.39) and *S. halepense* (3.77). It is noticeable that the new species Physalis angulata appeared in high population.

The survey obviously indicated that the perennial weeds create the major problem in cotton fields as they were not effectively controlled by the commonly applied cultural practices. Weed spatial distribution maps were produced using interpolation methods to monitor the appearance of weeds through the last three decades. The research is still in progress and more data are under evaluation.

Key words: cotton, GIS, weeds, weed survey

How weeds respond to nitrogen fertilization in a barley field

Thomopoulos, I.[1], Petraki El..[2]; Vahamidis, P [2]., Kalivas, D.[3], Economou, G.[2]

[1] Department of Pesticides Control & Phytopharmacy
Benaki Phytopathological Institute
Stefanou Delta Street 8, 14561, Athens, Greece
[2] Department of Crop Science,
[3] Department of Natural Resources and Agricultural Engineering
Agricultural University of Athens (AUA)
Iera Odos 75, 118 55, Athens, Greece.

j.thomopoulos@bpi.gr

Barley is one of the most important crops worldwide and given that is crucial to maintain high and stable yields, weeds can cause in several cases strong competition, and result in reduced yield and malting quality. The objective of this study was to observe the dynamics in weed populations as well as their spatial development within the cultivated field under different fertilization schemes.
In order to investigate the spatial spreading and variability of weeds, an experiment was carried out in a field (1000 m2) cultivated with malt barley, in the AUA's experimental station (Spata), for the winter growing season in 2014. The barley field was totally under rainfed conditions. Utilizing the Randomized Complete Block (RCB) design, the field was divided in 45 sampling units of 1 m2 following a regular grid sampling of 5 rows and 9 columns. Two different nitrogen fertilizers were applied, Ammonium nitrate (34-0-0) as a controlled release fertilizer was used for 15 plots, and urea with agrotain (20-7-12+2MgO+B) (Nutrimore) as a slow release fertilizer for another 15 plots. The remaining 15 plots were left without any fertilisation to be the control treatment. These fertilizers were applied during the tillering stage of the barley at a rate of 60 kg ha-1. Regarding the monitoring of weeds, their density was registered once towards the end of growing season during the early ripening stages of barley. At the same date a digital camera of 13MP resolution was utilised for taking pictures of each plot. Moreover, on the harvesting date the weeds were gathered, and their dry weight was measured. Spatial interpolation methods were applied and weed maps were created.
The accumulated data showed that 14 different weed species appeared and among them the five major, based on their density were the following Lolium rigidum, Phalaris paradoxa, Papaver rhoeas, Chamomilla recutita, and Convulvulus arvensis in measures of 11.02, 7.42, 0.8, 0.73 and 0.64 weeds per m2 respectively. Concerning the dry biomass of the weeds, P. paradoxa, developed the most with 398.53 g m-2 of dry weight, followed by L. rigidum with 361.59 g m-2 and after that there are C. arvensis with 69.9 g m-2, C. recutita with 48.15 g m-2 and P. rhoeas with 42.69 g m-2 . Regarding the fertilisation effect on the weeds, there were no significant differences, however there was a tendency especially for L. rigidum and P. paradoxa to develop more biomass within the fertilised plots by Ammonium nitrate than the control plots. Additionally, the dry weight of the weeds in the urea plots was in most cases less than the one of the control plots. Lastly, the average barley grain yield of the control plots was 3.45 t ha-1, while the plots with amonium nitrate yielded 3.8 t ha-1 and the ones with Nutrimore 3.74 t ha-1.
In conclusion, given the highly competitive ability of barley, few of the weed species seemed to be affected by the applied fertiliser and thus develop more biomass. Moreover, the weed mapping achieved by spatial interpolation methods revealed weed patchiness, thus providing valuable data for a successful site-specific weed management in precision agriculture.

Key words: barley, grass weeds, fertilization, weed mapping

Cattle grazing as a tool for invasive weed management and endangered species support on former pastures in mountain nature reserve

Michaela Kolářová, Josef Holec, Marie Mrázková, Radek Štencl, Luděk Tyšer

Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Resources, Department of Agroecology and Crop Production, Kamýcká 129, 165 21 Prague 6, Czech Republic.

holec@af.czu.cz

Grazing is considered as a suitable tool to maintain biodiversity of grassland. Once the pasture is abandoned, natural succession take place with highly competitive species expanding their dominance. As a result, many herbs including rare and endangered species may disappear. In 2012, grazing was restored in the Hrubý Jeseník Mts. (the Praděd National Natural Reserve) in northeastern part of the Czech Republic. The aim of the study was to estimate changes in plant species occurrence in the locality of Švýcárna (1304 m a.s.l.), where the cattle grazing after the long-term management cessation was introduced on the pasture area of 3.6 ha in 2012. The pasture was divided into two grazing plots: P1 (Nar) with dominance of Nardus stricta and Avenella flexuosa and P2 (Des) with dominance of Deschampsia cespitosa. For grazing, Highland cattle was used with stocking rate up to 1 livestock unit per ha and year. Floristic composition vas evaluated and statistically analyzed. After six years of restored grazing the overall species richness enhanced and a higher occurrence of rare and endangered species was found. The occurrence of some common and often dominant species like Avenella flexuosa, Vaccinium myrtilus, and Calamagrostis villosa tended to decrease within a grazing period in favor of new species colonisation. On most of the plots, an increase in the number of rare and endangered species was noticed. For some species like Allium schoenoprassum subsp. schoenoprassum L., however, grazing seems to be probably unsuitable as it disappeared on the grazing plot within a study period.

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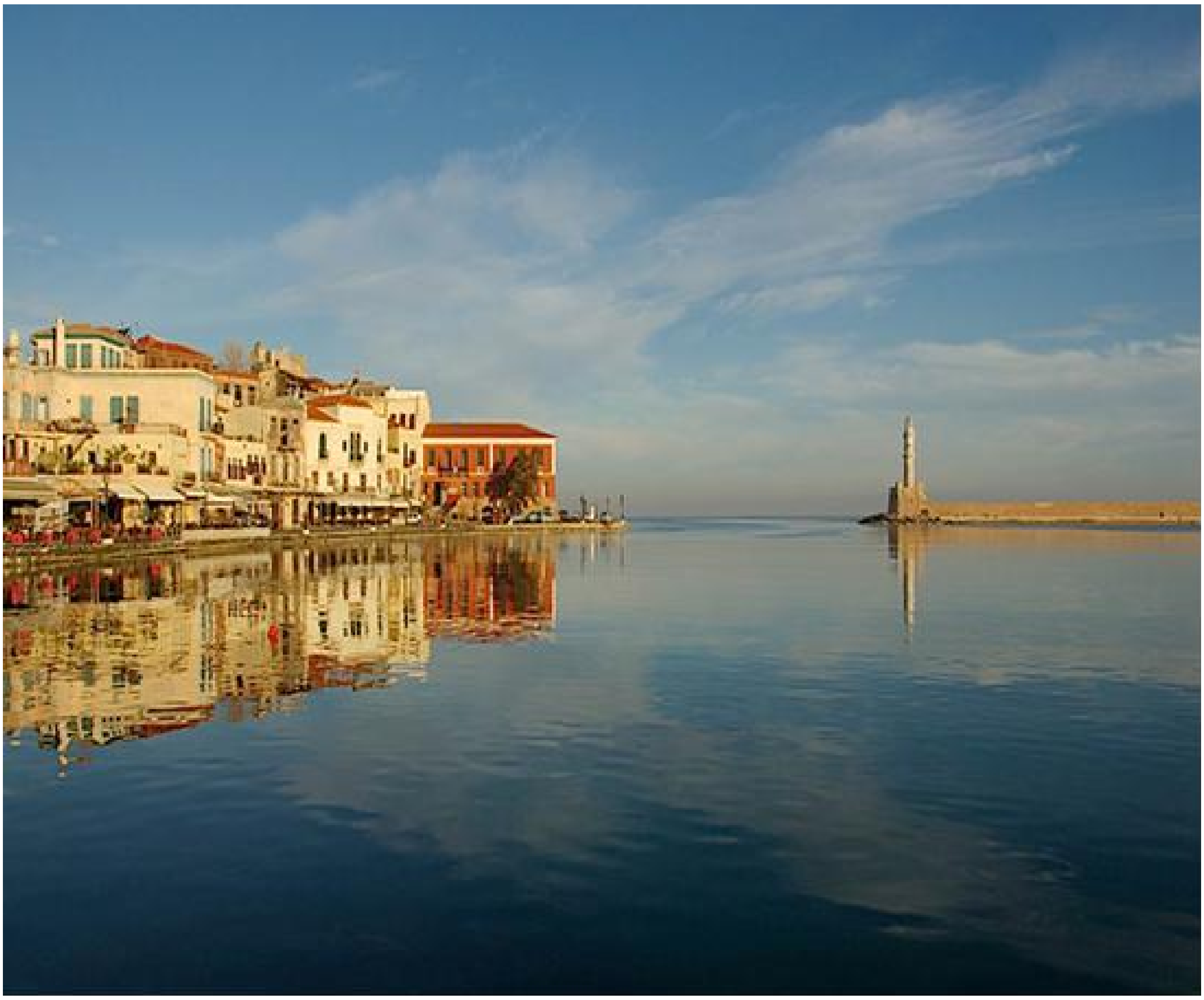
LIST OF PARTICIPANTS

	Last name	First name	Institution	e-mail
1	ALCHANATIS	Victor	Agricultural Research Organization- Newe Ya'ar Research Cente	victor@volcani.agri.gov.il
2	ASAF	Evyatar	Agricultural Research Organization- Newe Ya'ar Research Cente	evya.jd@gmail.com
3	BENAISSA	Keltoum	University of Biskra	Miskelil07@gmail.com
4	DOULFI	Dimitra	Agricultural University of Athens	dimdoulfi@yahoo.gr
5	ECONOMOU	Garyfalia	Agricultural Univeristy of Athens	economou@aua.gr
6	EIZENBERG	Hannan	Agricultural Research Organization- Newe Ya'ar Research Cente	eizenber@volcani.agri.gov.il
7	HASSAN	Islam	National Reserach Centre	islam_frahat@yahoo.com
8	HOLEC	Josef	Prague University	holec@af.czu.cz
9	HUSREV	Mennan	Ondokuz Mayis University	hmennan@omu.edu.tr
10	INES	Santín-Montanyá	INIA	isantin@inia.es
11	KALAITZIDIS	Chariton	Hellenic Agricultural Organization "Demeter" IOSV	chariton@maich.gr
12	KALIVAS	Dionyssios	Agricultural University of Athens	kalivas@aua.gr
13	KARACHALIOU	Andriana	Agricultural University of Athens	andriana_kar@hotmail.com
14	KATSIKIS	Ioannis	Agricultural University of Athens	johnkatsikis91@gmail.com
15	KOLAROVA	Michaela	Prague University	mkolarova@af.czu.cz
16	KOUMBOURIS	Giorgos	Hellenic Agricultural Organization "Demeter" IOSV	koubouris@nagref-cha.gr
17	KOURGIALAS	Nektarios	Hellenic Agricultural Organization "Demeter" IOSV	kourgialas@nagref-cha.gr
18	KRAEHMER	Hansjoerg	Bayer AG	Kraehmer-Hofheim@t-online.de
19	LATI	Ran	Agricultural Research Organization- Newe Ya'ar Research Cente	ranl@volcani.agri.gov.il

20	LONTOU	Konstantina	Agricultural University of Athens	kwn.lontou@gmail.com
21	MEYER	Stefan	University of Göttingen	smeyer1@gwdg.de
22	ORFANIDIS	Georgios	3d s.a. General Aviation Applications	administrator@3dsa.gr
23	PAISIOS	Dimitrios	ALFA Company (ADAMA Representative in Greece)	
24	PRIOVOLOU	Anastasia	Agricultural University of Athens	gisaua@aua.gr
25	ROZENBERG	Gal	Agricultural Research Organization- Newe Ya'ar Research Cente	galrozenberg@gmail.com
26	SALONEN	Jukka	Natural Resources Institute Finland (Luke)	jukka.salonen@luke.fi
27	SHULNER	Itai	Agricultural Research Organization- Newe Ya'ar Research Center	itayshulner@gmail.com
28	SOMERVILLE	Gayle	Aarhus University	gs@agro.au.dk
29	TEMPEL	Matthias	Bayer AG	
30	THOMOPOULOS	Ioannis	Benaki Phytopathological Institute	yiannis.thomopoulos@gmail.com
31	ULUDAG	Ahmet	Canakkale Onsekiz Mart University	ahuludag@yahoo.com
32	ZIOGAS	Basilis	Hellenic Agricultural Organization "Demeter" IOSV	



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