The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Sustainable Weed Management in Mediterranean Cropping Systems

Workshop of the EWRS working groups:

“Weed Management in Mediterranean Cropping Systems” and “Herbicide Resistance”

BOOK OF ABSTRACTS

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The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Amaranthus retroflexus

Amaranthus palmeri

Oryza sativa

Pot trials

Lolium rigidum

Organic mulches

SCIENTIFIC PROGRAMME

The aim of this meeting is to review the different strategies of weed control in order to mitigate the evolution of weed resistance evolution to herbicides and improve the cropping systems sustainability. The Workshop is aimed at students, Ph.D. candidates, as well as established scientists. Despite the workshop focuses especially on herbicide resistance in the Mediterranean Area, researchers working with resistance and its management in other parts of Europe are also warmly welcome.

The workshop will be divided in 5 parts:

1. An introduction and an Invited Speakers Session
2. A session dedicated to Herbicide Resistance
3. A session dedicated to short oral presentation of posters
4. A sessions dedicated resistance status in different countries and the International Herbicide-Resistant Weed Database
5. A sessions dedicated to Weed Control and Herbicide Use
6. A session dedicated to Integrated Weed Management
7. A wrap up discussion aiming to draw conclusions and select the frame to write a review article which will be submitted to Weed Research.

ORGANIZERS

Prof. Dr. Hüsrev Mennan (Ondokuz Mayis University, Turkey)

Dr. Maor Matzrafi (Agricultural Research Organization - Volcani Institute, Israel)

Dr. Roland Beffa (Senior Scientist Consultant, Germany)

Dr. Katerina Hamouzova (Czech University of Life Sciences Prague, Czech Republic)

Dr. Alicia Cirujeda (CITA, Saragossa, Spain)

PROGRAMME

TUESDAY, 3rd DECEMBER 7:00 PM Dinner for Participant already present in the venue.

WEDNESDAY, 4th DECEMBER

9:00 – 9:30, Welcome – Aims of the Workshop and Get together (Lead by **Kateřina Hamouzová, Alicia Cirujeda, Hüsrev Mennan, Roland Beffa**).

9:30 – 12:00, Session 1. Invited Speakers / Zoom Session (Lead by **Hüsrev Mennan**).

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17:20-17:50	**International Herbicide-Resistant Weed Database** – Roland Beffa

17:50 – 18:40, Day 1 General Discussion. Take home messages.

19:00 – 20:30, Dinner

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12:00 – 13:30, Lunch

13:30 – 18:00, Excursion

The excursion the Bati Akdeniz Agricultural Research Institute (BATEM) located in Antalya. BATEM focuses on the development of sustainable agricultural practices, the conservation of plant diversity, and the progress in specialized crop research, especially within the Mediterranean region. The institute conducts extensive research in fields such as horticulture, field crops, medicinal and aromatic plants, and plant protection, with a commitment to support both national and international agricultural needs. In addition to the citrus orchards, the field visit will include the observation of various aromatic plant areas, including ginger, turmeric, stevia, thyme, and myrtle, sage and passiflora. Weed management in these cultures is done without the use of chemicals and offers the opportunity to observe alternative models of weed control.

19:00 – 20:00, Dinner

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11:05-11:25	**Roland Beffa**. How genomics can contribute to improve modelling to predict resistance evolution in the fields.	35

11:25 – 12:30, Session 7. Meeting wrap up. Main take home messages. Meeting follow-up (Lead by **Maor Matzrafi**, and **Roland Beffa**)

12:30 – 13:30, Lunch

Effect of herbicides on the management of the invasive weed *Solanum rostratum* Dunal (Solanaceae)

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ABSTRACT

Solanum rostratum Dunal is an aggressive invasive weed spreading across many regions globally. This species germinates in multiple flushes, from early spring to late summer. In Israel, its distribution has recently expanded, with new populations identified in the northern areas of the country. This study aimed to evaluate the efficacy of herbicide applications at different growth stages of *S. rostratum* and to examine the functional leaf surface anatomy to understand variations in herbicide effectiveness. Results revealed that while herbicide efficacy showed minor variability between populations, plant growth stage significantly influenced herbicide response. Carfentrazone-ethyl demonstrated high effectiveness against plants at both early and late growth stages. However, the efficacy of metribuzin, oxadiazon, oxyfluorfen, and tembotrione was significantly reduced when applied to plants at later growth stages (8–9 cm height) compared to earlier stages (4–5 cm height). Anatomical analysis revealed that young leaves were densely covered with stellate trichomes on both surfaces, whereas mature leaves exhibited lower trichome density and increased prickle rigidity. Additionally, mature leaves had higher wax content, while young leaves exhibited a greater number of stomata and higher permeability. Fluorescent dye studies showed greater penetration in young leaves, with the dye staining the vascular bundles. This study highlights effective chemical management options for S. rostratum while emphasizing the critical role of leaf surface anatomy in herbicide performance. Differences in herbicide permeability between young and mature leaves likely explain the reduced efficacy observed in mature plants.

Herbicide resistance in Europe. Focus on the Mediterranean area

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Herbicide resistance is an increasingly significant challenge in European agriculture, particularly in the Mediterranean region. This area faces unique pressures that exacerbate the spread of herbicide-resistant weeds, characterized by its extensive agricultural production and diverse climate. In this review, the Mediterranean area will be comprised by Portugal, Spain, Italy, Balkan countries, Turkey and Greece, without considering France. In these countries, major crops such as winter cereals, rice, and perennial crops are heavily reliant on herbicides for weed control. However, over-reliance on chemical herbicides, coupled with limited crop rotation and monoculture practices, has led to the evolution of herbicide-resistant weed species. According to a recent study, Spain is the European country with most reported cases of herbicide resistance, showing how sensitive is the Mediterranean in this respect. The rapid spread of herbicide resistance in this region can be attributed to several factors. First, its agriculture often involves high-intensity cropping systems, with high herbicide selection pressures. Second, limited adoption of integrated weed management strategies, such as crop rotations, mechanical weeding, and cover crops, further drives the resistance spread. Third, weather variability in the Mediterranean area, together with climate change, can alter both herbicide efficacies and weed life cycles, facilitating the evolution of resistant traits. The most troublesome resistant weeds across this region are Lolium spp., Echinochloa spp., Conyza spp., Avena spp., and Papaver rhoeas, all of which have developed resistance to widely used herbicides like glyphosate, ALS and ACCase inhibitors, or synthetic auxins. Unlucky, the latest and greatest threat is the arrival and spread herbicide resistant Amaranthus palmeri in some of those countries. Finally, besides target-site resistance mechanisms, the rise of metabolism-based non-target-site resistance mechanisms is of great concern to sustain the use of chemical control under the European scenario.

The eternal debate on the use of optimized herbicide doses and its implications for precision agriculture: the case of IPMWise

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For many years, it has been demonstrated that the use of sublethal doses of herbicides can increase the risk of developing metabolic resistance. This fact has been greatly simplified from a technical standpoint, leading to the assertion that the use of doses below the maximum authorized dose generates resistance. This simplification fails to consider that the maximum authorized dose is established to achieve a sufficient level of control in the worst-case scenario indicated on the label and does not take into account, for example, treatment conditions or even the difference in sensitivity between weed species per se, or due to their growth stage.

In the 1980s, product labels indicated in many cases the dose to be applied according to the species and even differences in efficacy according to the amount of clay and organic matter in the soil. This information was no longer provided in the 1990s and 2000s. However, today, we see that some companies are returning to providing dose information related to soil types, species, or even growth stages. This is important for the sustainability of weed control as it allows technicians and farmers to have the appropriate information to make the best decisions.

In the near future, new technologies such as AI, Deep Learning, and soil sensors will allow us to know which weed species we have at each point in the field. However, to generate a suitable spraying map, we need tools like IPMWise, which allows us to generate the best possible recommendation taking into account the specific characteristics of each point: weed species present, density, soil characteristics, etc. This allows us to optimize the herbicide dose applied without increasing the risk of resistance, which is the key to sustainability.

Crop Life International. Stewardship approach to manage pesticides including resistance

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CropLife International is a trade association committed to sustainable agriculture, including resistance management. It works through regional and national associations across the globe. Closer to home, CropLife Europe has full or associate associations in more than 30 countries. Promoting resistance management is a key element of stewardship activities conducted by member companies and CropLife associations.

Effective weed resistance management requires farmers, retailers and regulators to understand weed resistance and ensure that farmers have an effective toolbox which they then use for the management of resistance. Industry supports this through stewardship. Effective stewardship activities work with different stakeholder groups so as to establish an effective ecosystem for the implementation of weed resistance management. This requires engagement with regulators, retailers, farmer associations, certification organizations, amongst others. These days stewardship is a lot more than communication.

However, stewardship communication itself has progressed a lot. This progression has been in terms of the tools that are used, in particular the use of mobile phone based digital technologies. In addition, the emergence of behaviour science provides a clearer foundation for developing communication activities which have a better chance of bringing about change at a farm level.

Across all of these activities it is important that CropLife works in partnerships with other organisations in the system whilst ensuring that new knowledge on resistance management continues to be incorporated into stewardship activities.

Herbicide resistance in Italian rice cropping systems

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ABSTRACT

The Italian rice area represents more than 50% of the European rice surface and it is mainly concentrated in the northwest region of the country. The area has been managed in the years as a continuous rice monocropping, with weed control strategies relying primarily on the use of herbicides, similarly to what occurred in other European rice producing regions. In recent years, the number of available herbicide modes of action has significantly decreased due to the introduction of more restrictive EU regulations. This has made it challenging to rotate herbicides with different modes of action, leading to the selection of weed populations resistant to certain herbicides, mainly ALS- and ACCase-inhibitors, across a considerable portion of the rice-growing region. The introduction of rice varieties resistant to imazamox (Clearfield® and Fullpage®) and to the ACCase-inhibitors cycloxydim (Provisia®) and quizalofop p-ethyl (Max Ace®) has facilitated weed control but may result in the further development of weed resistant populations. The rice weed species that have evolved resistance to herbicides mainly pertain to Poacee family, such as *Echinochloa* spp. and *Oryza sativa* (weedy rice), Cyperacee, mainly *Schoenoplectiella mucronata*, *Cyperus difformis* and *Cyperus esculentus*, and Alismatacee, with *Alisma plantago-aquatica*. In dry seeded rice, resistant populations can also be found in *Digitaria sanguinalis* and *Panicum dichotomiflorum*. In order to counter or limit the development of herbicide-resistant weeds, farmers are increasingly adopting integrated weed management practices, including false seeding, precision weed management, mechanical weed control strategies and rotations between crops, seeding techniques, resistant rice varieties, and herbicides. This approach allows for the reduction of resistant populations in the seed bank and represents the key strategy for a sustainable weed management in rice.

Keywords: resistant rice varieties, ALS inhibitors, ACCase inhibitors, *Echinochloa*, integrated weed management .

Multiple resistance to glyphosate and ALS inhibitors in palmer amaranth (*Amaranthus palmeri*) identified in Turkey

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ABSTRACT

Amaranthus palmeri was first reported in Turkey in 2016, and an immediate heavy infestation of the weed was found in fruit orchards and summer crops such as maize, cotton, and sunflower. There have been farmers' complaints about the ineffective control of Palmer amaranth through use of glyphosate and some sulfonylurease herbicides. Hence, this study aimed to determine the possible herbicide resistance evolution in Palmer amaranth against glyphosate and acetolactate synthase (ALS) herbicides. Seeds of 21 Palmer amaranth populations were collected from five provinces of Turkey where control problems with glyphosate and ALS inhibitors were reported in maize fields. Seeds of certain biotypes that had been categorized as resistant or susceptible were grown to obtain the F_2 generation. A single-dose assay experiment was conducted to determine possible resistance to ALS inhibitors and glyphosate among the 21 populations. Out of this, 18 populations were included in the subsequent dose-response experiments due to evident survival. Based on ED_{50} values from the dose-response experiment, SNU-04 and ADN-21 had the highest resistance index for glyphosate which was more than 7. The biotypes ADN-21, OSM-15, and DIR-09 recorded the highest ED_{50} value with a resistance index of 9.21-10.35 after nicosulfuron application. Whereas, the biotypes SNU-04, OSM-15, and ADN-21 were with the highest ED_{50} value and resistance index of 6.41-7.44, after the application of foramsulfuron + iodosulfuron methyl-sodium. The increase in genomic 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) copy number has been observed in suspected cases that have been accepted as the molecular basis for the development of resistance against glyphosate. The results of sequence alignment for the ALS gene contained Ala122Val and Pro197Arg mutations related to target site resistance against ALS herbicides.

Keywords: palmer amaranth, Turkey, EPSPS inhibitor, ALS inhibitor.

Herbicide-resistant crop technology drives *Amaranthus retroflexus* Resistance to foramsulfuron + thiencarbazone-methyl

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ABSTRACT

Amaranthus retroflexus L. has recently emerged as a troublesome weed in CONVISO® SMART sugar beet fields in the Czech Republic, primarily due to the rapid adoption of this system and the extensive use of ALS-inhibiting herbicides across nearly all crops, including those with ALS herbicide-tolerant varieties. In this study, we report two *A. retroflexus* biotypes that have developed resistance to the herbicide combination foramsulfuron + thiencarbazone-methyl and have also shown cross-resistance to imazamox and tribenuron-methyl. Dose-response experiments revealed that the resistant (R) biotypes, AMARE1 and AMARE2, are 351 and 12 times less sensitive, respectively, to foramsulfuron + thiencarbazone-methyl than the susceptible (S) biotype. Pretreatment with malathion reduced the resistance index by half in AMARE1, suggesting that cytochrome P450 enzymes may play a role in the resistance mechanism. However, there was no evidence of GST involvement. Additionally, both R biotypes exhibited higher ALS enzyme activity compared to the S biotype. Genetic analysis identified a target-site mutation, specifically the substitution of tryptophan (*Trp*) with leucine (*Leu*) at position 574 of the ALS enzyme, as a likely mechanism of target-site resistance in both R biotypes. In conclusion, our study suggests that resistance in the AMARE1 biotype is due to both enhanced metabolism via cytochrome P450 enzymes and a point mutation, whereas in AMARE2, the point mutation alone is responsible. This is the first documented case of *A. retroflexus* developing resistance to foramsulfuron + thiencarbazone-methyl, emphasizing the adaptive response of weed populations to herbicide pressure and the need for alternative weed management strategies in sugar beet cultivation.

Keywords: redroot pigweed, sugar beet, sunflower.

Acknowledgement: This work has been supported by the National Agency for Agricultural Research No. QL24010167.

Resistance to ACCase and ALS-inhibiting herbicides detected in targeted sampling of *Lolium rigidum* (rigid ryegrass) populations from cereal crops in Morocco, Algeria, and Tunisia

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ABSTRACT

Lolium rigidum Gaud. (rigid ryegrass) is one of the most widespread weeds in cereal crops in Morocco, Algeria and Tunisia. This weed has evolved resistance to various herbicide modes of action in this region. ACCase and ALS inhibiting herbicides are mainly used in the major-cereal growing regions to control rigid ryegrass. Through a questionnaire, regions where farmers reported less control of herbicide treatments were registered in the three Maghreb countries. Registered fields were visited for collection and 75 field populations were screened with two ACCase and two ALS herbicides. Target site resistance (TSR) was diagnosed using Illumina Next Generation Sequencing (NGS) technology. The sensitivity bioassay results revealed over 60% of sampled populations to be resistant to pinoxaden and/or clodinafop and about 40% to be resistant to iodosulfuron + mesosulfuron and/or pyroxsulam. In addition, 53% of populations displayed resistance (R) to the two herbicide modes of action tested among the regions. In total, 16 ACCase and 11 ALS mutant alleles were identified, carrying out an amino-acid substitution and conferring herbicide resistance in 3700 of the analyzed plants. Most ACCase and ALS mutations were detected at codons Ile1781 and Pro197, respectively. Not only does this study demonstrate the presence of both cross and multiple resistance, it also highlights the non-ACCase and non-ALS based resistance mechanisms that could confer resistance to herbicides with different modes of action which complicates the resistance management strategies. In the three Maghreb countries, this challenge is even more prominent due to few modes of action being available for rigid ryegrass control due to low-cost market and the prevalence of generic herbicides.

Keywords: rigid ryegrass (Lolium rigidum gaud.), acetyl-CoA carboxylase (ACCase), acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS), target site resistance (TSR), next generation sequencing (NGS).

Monitoring herbicide resistance in the Czech Republic: ALS and ACCase resistance is on the rise

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ABSTRACT

Until the end of the last millennium, herbicide resistance (HR) was quite a rare phenomenon in the Czech Republic. However, due to dramatic changes in farming practices and herbicide use, HR has recently become one of the most important issues in weed management systems. Status of herbicide resistance has been monitored in our lab for a long time mainly in projects sponsored by companies, but most recently also by the Ministry of Agriculture in the framework of then National Action Plan for sustainable use of pesticides. The results of the monitoring are regularly reported to national and EFSA databases. Each year since 2020, we have tested about 50-80 populations of troublesome species which are suspicious of resistance from fields across the country. Populations are tested for resistance in standardized growth assays and selected cases from this monitoring are further analyzed for mechanism of herbicide resistance.

All tested populations of weedy grasses showed different levels of herbicide resistance, but in all cases to ALS inhibitors. The following species were found resistant to herbicides in parenthesis (ALS herbicides in italics): *Apera spica venti* (L.) P. Beauv. (*iodosulfuron, pyroxsulam*, chlorotoluron), *Bromus sterilis* L. (*pyroxsulam, propoxycarbazone*), *Alopecurus myosuroides* Huds. *(iodo + mesosulfuron,* pinoxaden, fenoxaprop, chlorotoluron), *Lolium multiflorum* Lam. (pinoxaden, *pyroxsulam, iodosulfuron*). ALS resistance is also starting to appear in broadleaved winter annual species *Tripleurospermum maritimum* (L.) W.D.J. Koch (*tribenuron*). In the last two years, the HR was not detected in any tested population of *Papaver rhoeas* L., although it was previously found in our targeted monitoring, and is also spreading in neighboring countries. We have also found HR in summer annual broadleaved species collected from survivors in fields with CONVISO® SMART sugar beets, such as *Amaranthus retroflexus* L. (*thiencarbazone + foramsulfuron*) and *Chenopodium album* L. (*thiencarbazone + foramsulfuron*).

The results document the quick spread of ALS resistance from the point of view of affected species and frequency of HR among populations. Presence of resistance in both grassy and broadleaved as well as winter and annual species will make proper herbicide use in crop rotation more difficult.

K**eywords:** herbicide resistance monitoring, weeds, herbicides, weed control .

Acknowledgement: This work has been supported by the National Agency for Agricultural Research No. QL24010167.

Herbicide resistance to nicosulfuron and glyphosate of some *Amaranthus palmeri* S. Wats. populations of Aragon (Spain)

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ABSTRACT

Palmer amaranth (*Amaranthus palmeri* S. Wats.) was first detected in the Aragon region (northeastern Spain) in ruderal areas in 2009. Later, this species started infesting crop fields reaching around 318 plots in 2022 in the region, affecting mainly maize fields. Several field trials have been conducted to give the best management recommendations concerning seeding date, the convenience of ploughing or performing direct drill and the efficacy of herbicides. In most of these field trials the populations showed an irregular response when treated with sulfonylureas. To explore this topic in further depth, greenhouse trials were conducted in 2023 and 2024, focusing especially on those populations that still showed some susceptibility. A total amount of 16 populations was tested against nicosulfuron and glyphosate. Individual plants were used as experimental unit. Herbicides were applied at 0, x, 2x, 4x and 8x, being "x" the standard commercial herbicide rate (60 g a.i. for nicosulfuron and 360 ml a.i. for glyphosate). All treatments were arranged randomly in ten replicates. Survival was assessed 35 days after application. Concerning nicosulfuron, 8 populations out of 16 were resistant with a resistance factor (RF) of 9 to 20 based on survival; opposite, only 2 out of 16 populations exhibited resistance to glyphosate with RF 9 and 19, being in both cases populations growing on the roadsides. The results confirm that the in many cases the populations found in Aragon were resistant to sulfonylureas so that farmers should avoid using active ingredients belonging to this family. Based on the field trials, the recommendations include several non-chemical control methods and, in case of using herbicides, glyphosate should thus be used carefully to prevent resistance. When sowing annual crops, pre-emergence treatments should be applied and followed by another post-emergence treatment using active ingredients belonging to modes of action other than sulfonylureas.

Keywords: invasive weed, target-site resistance, maize, alfalfa, integrated weed management.

Acknowledgements: This work has been supported by the European Agricultural Fund for Rural Development through the autonomic group of cooperation COOPALMERI (GCP2021000200).

The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Effect of nutrient and weed management practices on growth and yield of transplanted hybrid rice (*Oryza sativa)*

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ABSTRACT

A field experiment was conducted during the kharif season of 2022 and 2023 at the crop research farm of Sam Higginbottom University of Agriculture, Technology and Sciences with the objectives to study the effect of nutrient management practices on growth and yield of hybrid rice sown under different weed management practices and efficacy of herbicides for weed control in transplanted rice. None of the pre-emergence and post-emergence herbicides alone provided desired control of weeds. However, inclusion of two hand weedings on 20 and 45 DAT with 50% RDF and 50% vermicompost markedly improved weed control efficiency (WCE), yield attributes, grain and stover yield. Treatment with 50% RDF + 50% vermicompost + Bensulfuron methyl + pretilachlor (N1+W1) also controlled the weeds at initial crop growth stages. Among the weeds that appeared in transplanted rice, the broadleaved weeds were mainly *Eclipta alba*. Among sedges, *Cyperus rotundus* were aggressive and continuously emerged throughout the crop growth period and *Cyperus iria* and among grasses *Panicum repens, Echinochloa colona* and *Echinochloa crus-galli* were dominant and aggressive because of their long emergence profile. The treatment hand weeding twice on 20 and 45 DAT with 50% RDF and 50% vermicompost has shown best results compared to other treatments. Critical period of crop–weed competition in transplanted rice was from 20 to 40 DAT and 15 to 60 DAS, respectively. The weedy situation throughout the crop growth caused yield reduction to 57 to 61% in case of transplanted rice compared to season long weed free situation.

Keywords: crop-weed competition, weed control efficiency, weed management practices and weed free situation, weedy situation.

Emerging threat: glyphosate resistance detected in an *Amaranthus viridis* population from Spain.

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ABSTRACT

Amaranthus viridis (A. viridis) is an annual, monoecious weed species native to the American continent. In Spain, it is typically distributed in both agricultural and urban environments and is commonly controlled with herbicides. Glyphosate is a broad-spectrum, non-selective herbicide that inhibits the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), preventing the synthesis of aromatic amino acid and resulting in plant death. While resistant populations of different Amaranthus species have been documented globally, no cases of glyphosate resistance in *A. viridis* have been reported. Dose-response and shikimic acid accumulation tests were conducted with the aim to characterized glyphosate resistance in three *A. viridis* populations proceeding from citrus orchard (GAN), maize field edge (MAR) and roadside (VAL). To reach our objective, we implemented a bioassay to assess survival rates and fresh weight reduction after glyphosate treatment with rates of: 0, 25, 50, 100, 200, 400, and 800 g ea. ha−1 for MAR and VAL populations (probable sensitive populations) and 0,100, 200, 400, 800, and 1600 g ea. ha−1 for population GAN. Preliminary results suggest that individuals from population GAN survived to 400 g ea. ha-1 of glyphosate thanks to a resistance mechanism related to variations in EPSPS gene copy number. Shikimic acid content has been measured in untreated plants in 4 mm diameter leaf discs using spectrophotometry. The results showed that resistant individuals have a lower shikimic acid concentration, compared to the susceptible biotypes. This research reports the first case of glyphosate resistance in Europe in an *A. viridis* population. The implementation of early detection methods and integrated weed management strategies will be essential for mitigating the impact of glyphosate resistance in agriculture across Europe.

Keywords: EPSPS, shikimic acid, weed, slender amaranth.

Adjuvant and nozzle impact on nicosulfuron efficacy in weed control in corn

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ABSTRACT

The field experiment was conducted during 2021 and 2022 at the Maize Research Institute Zemun Polje in Serbia. The goal of this study was to evaluate the influence of two adjuvants and two nozzle types on efficacy of two herbicides based on the same active ingredient - nicosulfuron. The study was arranged as a split-block design in four replication with 12 treatments plus weed-free as well as weedy season long treatments. All treatments were applied with a CO2 backpack sprayer with a four-nozzle boom with 50 cm nozzle spacing (Bellspray, Inc. Opelousas, LA, United States) when corn plants had developed 5 to 6 leaves (BBCH15-16). 21 day after treatment (DAT) weeds were sampled and both fresh as well as dry biomas were measured. Visual efficacy was assessed 7, 14 and 21 DAT. Among all treatments Motivell extra 6 OD® provided better weed control and reduced weed biomass in higher percent compared to Talisman OD®. In addition, treatments with AMS caused a rapid decrease of efficacy compared to treatments with non-ionic surfactant (NIS) adjuvant where the efficacy was increased and where it lead to faster weed decay. Surprisingly, no differences in efficacy among nozzles were noticed.

By applying nicosulfuron, the nozzle selection did not play a crucial role on weed control, but the use of adjuvants can increase or decrease its efficacy depending on the type as well as weed species.

Keywords: efficacy, weed control, AMS, NIS, weeds.

Weed management in Chilean forestry plantations does not represent a risk for honeybees

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ABSTRACT

In forestry, glyphosate is a widely used herbicide with lower toxicity than others like 2,4-D. Studies show glyphosate affects bees’ gut bacteria and can increase mortality when exposed to sprayed flowers. However, these findings are based on lab conditions using pure glyphosate, not commercial formulations. The project began in 2021, selecting 10 beekeepers and analyzing 11 samples collected by the UCCChile team covering the Bío-Bío and Araucanía regions. Beekepers were selected based on their proximity to forest properties and the vegetational composition within a 3 km radius. Glyphosate was applied for weed control near all beekeepers’ plantations between November 2020 and April 2021. In 2022 and 2023, the same selection criteria were used, analyzing 30 samples (honey and wax) in 2022 and 35 in 2023, expanding the sampling area from Maule to Araucanía. Over three years, 76 hives from 41 beekeepers were sampled. The wax analysis results varied across seasons. In the first season (2021), 10 out of 11 samples showed glyphosate concentrations ranging from 0.321 to 2.5 mg/kg. In the second season (2022), only 6 out of 25 samples had glyphosate, with concentrations between 0.45 and 0.90 mg/kg. In the third season (2023), none of the wax samples contained glyphosate. Based on the results obtained from various sites and analyses (pollen, honey, and wax), it can be concluded that the risk of contamination wi.th glyphosate residues from operational applications is very low. The detected contamination levels do not exceed the maximum residue limits (MRLs) allowed for honey intended for export or domestic sale. Continuous monitoring of herbicide residues is necessary and should be expanded to determine the temporal and spatial distances that protect operational herbicide applications, minimizing the risk of potential contamination.

Keywords: honey, contamination, glyphosate, beekeepers, residues.

Rethinking weed management: harnessing the dual role of weeds for sustainability

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ABSTRACT

Weeds can contribute significantly to agricultural biodiversity, yet they can also lead to substantial crop yield losses. The alarming decline in European biodiversity poses a serious threat to the sustainability of agricultural systems, underlining the need to develop agricultural management approaches that promote biodiversity conservation.
Particularly, in agricultural regions such as Denmark, where farming is the predominant land use and natural habitats have become increasingly fragmented, agricultural habitats must contribute to supporting biodiversity. Therefore, there is a pressing need to integrate biodiversity-promoting practices into agricultural management. The primary step in achieving this transition is to identify which weed species have a substantial negative impact on crop yields and should be removed from the field to protect agricultural production, and which have a minimal effect and could therefore be retained in the field, increasing plant biodiversity and attendant ecological benefits that this less harmful species may provide.
This study investigates the dual roles of different weed species within agroecosystems, examining both their impacts on crop productivity and their provided ecosystem services. To understand this, we review existing methodologies for quantifying the competitive and ecological value of weed communities and discuss their implications for weed management.
Based on these considerations, we propose a possible approach to reduce the trade-off between agricultural production and in-field biodiversity. By employing precision farming techniques, we could selectively target weed species based on their competitive value against the crop and their biodiversity value, while drastically reducing the amount of herbicide sprayed.
This approach would involve identifying and mapping the distribution of beneficial weed species within the field, and then using targeted spraying or to remove only the most competitive and harmful weed species.

Keywords: agroecology, biodiversity, weed management, review.

The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Weed control efficacy of pelargonic and acetic acid as alternative herbicides for stale seedbed termination

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ABSTRACT

Stale seedbed can limit weed infestations in the crop, thereby reducing herbicide use and preventing and managing herbicide-resistant weeds. Stale seedbed termination relies heavily on the use of glyphosate, which has led to the selection of resistant weed populations. The objective of the study was to test herbicidal activity of pelargonic acid and acetic acid as alternatives to glyphosate. Commercial formulations of pelargonic acid (680 g l^{-1}), acetic acid (two formulations at 100 g l^{-1} and 20 g l^{-1}) and glyphosate (360 g l^{-1}) were tested in greenhouse at different rates in post-emergence on the rice weeds *Echinochloa* spp. and *Oryza sativa* (weedy rice). Effect of acetic acid on germination was also tested for a potential use in weed pre-emergence on different rice and maize weeds (*O. sativa*, *Echinochloa* spp., *Amaranthus retroflexus*, *Solanum nigrum*, *Digitaria sanguinalis* and *Portulaca oleracea*). Post-emergence application of acetic acid on rice weeds was not effective even at the highest tested rate (60 $kg_{a.s.}$ ha^{-1}), with visual efficacy < 10% and biomass reduction <20% compared to the control. Pelargonic acid at the label rate (10.88 $kg_{a.s.}$ ha^{-1}) resulted in 70% and 50% biomass reduction in *Echinochloa* spp. and *O. sativa*, respectively. Glyphosate showed the highest efficacy, exceeding 90% even at low rate (0.288 kg ha^{-1}). The concentration of acetic acid required to reduce germination by 50% (ED_{50}) was 4.1 g l^{-1} and 3.2 g l^{-1} for *Echinochloa* spp. and *O. sativa*, respectively. Among the maize weeds, *S. nigrum* showed the highest tolerance to acetic acid (ED_{50} 2 g l^{-1}). The results showed that for stale seedbed termination pelargonic acid at highest rates can be partly effective. Efficacy of acetic acid in foliar application was negligible, but its effects on seed germination deserve to be furtherly investigated.

Keywords: rice, maize, glyphosate, seed germination, herbicide resistance.

Chemical control options for Palmer Amaranth (*Amaranthus palmeri*) in Turkey

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ABSTRACT

Amaranthus palmeri is a newly introduced weed species in Türkiye and became troublesome in various crop species. Previous studies showed that the weed invades some field crops such as cotton, maize, sunflower and tomato. Therefore, studies were conducted to screen the efficacies of 14 different pre-emergence and 19 post-emergence herbicides in pots and evaluate the efficacies of some screened pre- and post-emergence herbicides under field conditions. Results of field experiments carried out three times showed that 280 g/l Dimethenamid-p + 250 g/l Terbuthylazine, 312,5 g/l S-Metolachlor + 187,5 g/l Terbuthylazine vs 225 g/l Isoxaflutole + 90 g/l Thiencarbazone-Methyl + 150 g/l Cyprosulfamide controlled *A. palmeri* effectively in maize. In Sunflower, 450 g/l pendimethalin, 312,5 g/l S-Metolachlor + 187,5 g/l Terbuthylazine and 200 g/l Flurochloridone were effective only in one experiment where rain occurred after treatment. In tomato 70% Metribuzin reduced the number of *A. palmeri* significantly at two experiments, while. 915 g/l S-Metolachlor + 45 g/l Benoxacor showe acceptable effect only in one experiment having subsequent rainfall. In Cotton 400 g/l Flufenacet + 100 g/l Diflufenican, %85 Pyroxasulfone and 450 g/l Pendimethalin provided acceptable effects on two locations. Efficacies of post-emergence herbicides were evaluated only in maize fields. Three herbicides (280 g/l Dimethenamid-p + 250 g/l Terbuthylazine, 330 g/l Terbuthylazine + 70 g/l Mesotrione and 326 g/l Terbuthylazine + 50 g/l Mesotrione) provided acceptable control at all experiments. Other herbicides such as 44 g/l Tembotrione + 22 g/l Isoxadifen-ethyl, 75 g/l Mesotrione + 30 g/l Nicosulfuron, 500 g/l 2,4-D acid dimethyl-amin salt, 340 g/l MCPA + 80 g/l Dicamba and 65,9% Dicamba + 4,1% Triasulfuron gave variable results depending on the experiment. These results showed that sole chemical control of *A. palmeri* can be successful in maize, but may not possible in other crops. Integrated approaches are needed to control of this weed.

Acknowledgement: The studies here was supported by Turkish Council for Scientific Report, Project code: TUBITAK 119 O 525.

Keywords: *Amaranthus palmeri*, Chemical contro, maize, cotton, sunflower, tomato.

Optimization of herbicides use: the role of adjuvants

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ABSTRACT

Herbicides are still the most frequently used practice for weed control in many countries worldwide. While herbicide resistance is an increasing problem, a lack of new herbicides on the market, together with possible negative impact on the environment and human health makes weed management very difficult. Therefore, optimizing of herbicide application is required in order to obtain high efficacy. Adjuvants are agrochemicals, commonly used to enhance pesticide efficacy and minimize spray drift by changing the spray solution's physicochemical properties. In our study, findings emphasized adjuvants as an essential factor for improving weed control over the active ingredient, up to 18.7% and 38.3% for mesotrione and rimsulfuron plus thifensulfuron-methyl (RIMTHIF) tank mixture, respectively. Barnyardgrass biomass reduction was greater than 98% with RIMTHIF in tank mixtures with COC and MSO compared to 65% when applied alone. Common lambsquarters had 52.1% biomass reduction when RIMTHIF was sprayed alone, while adding adjuvants to the tank-mixture resulted in lambsquarters biomass reduction ranging from 60.1% (COC) to 94.1% (AMS). A field study on the influence on nicosulfuron efficacy for johnsongrass and common lambsquarters suggests that addition of the non-ionic adjuvant is essential for successful control of both species in maize and enables use of drift-reducing nozzles. Eight herbicides, with or without adding a NIS adjuvant was tested on weedy sunflower. In general, the addition of non-ionic surfactants significantly increased the efficacy of glyphosate, mesotrione, rimsulfuron, and foramsulfuron. As adjuvants increase efficacy over active ingredient, they should be added every time when possible.

Keywords: agrochemicals, efficacy, pesticides, weeds.

Investigation of herbicide usage in drip irrigated rice fields.

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ABSTRACT

Rice holds a significant place in global human nutrition. However, due to the increasing global climate changes, it is anticipated that rice production will be significantly affected in the coming years. Therefore, in regions with water constraints, rice cultivation using a drip irrigation system, which prioritizes environmental and human health with less water and energy consumption, is gaining importance and attracting the attention of the agricultural world. In this study, the biological efficacy of pre-emergence and post-emergence herbicides in rice fields where drip irrigation system is used is determined. The aim is to create a herbicide spraying program for farmers in weed control. As a result of the measurements and evaluations in the studies carried out in the field where the Osmancık-97 rice variety was cultivated with drip irrigation in 2021 and 2022, 14 different herbicide application programs against the weeds (*Amaranthus retroflexus, Chenopodium album, Portulaca oleracea, Setaria viridis, Sorghum halepense, Cyperus rotundus, Xanthium strumarium* and *Convolvulus arvensis*) in the trial area showed a very successful (>90%) effect.The application of the 500 g/l Pretilachlor (16-20 DAE: day after emergence), 250 g/l Quinclorac (16-20 DAE), 160 g/l Cyhalofop-butyl + 12 g/l Florpyrauxifen-benzyl (16-20 DAE), 200 g/l Cyhalofop-butyl (16-20 DAE), and 250 g/l Quinclorac (35-40 DAE) herbicide program has yielded the most successful results against 8 different weed species in the experimental field, considering yield values. As a result of the studies, it has been revealed that pre-sowing herbicide application is essential in rice fields irrigated with drip irrigation in Bilecik province. Additionally, at least two post-emergence applications (first: 16-20 days after emergence, second: 15-20 days after the first application) have been shown to be necessary for the control of weeds. In cases where weed control is not performed, it is observed that yield values significantly decrease in control plots (280 kg/ha).

Keywords: herbicide, herbigation, Integrated Management, direct seeded rice.

Drone herbicide spraying requires limited safety buffer

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ABSTRACT

The use of drones for pesticide application is highly effective. Drift, the movement of pesticides from the treated area to undesired locations due to wind, is a critical parameter. Determining drift magnitude is essential for establishing safety zones around sensitive areas. In 2018, the first drift study using drones in Chile’s forestry sector was conducted with the Agras MG-1P model. Currently, new models like the Agras T-30 need to be studied for specific drift characteristics. This research aims to determine the drift associated with the Agras T-30 drone under various environmental conditions and flight heights in forested topographies. Six herbicide application flights were conducted on each site using the Agras T30 drone, perpendicular to the wind direction. Flights were at 3- and 5-meters height with wind speeds of ~0, 8, and 12 km/h. The drone, calibrated to spray 30 L/ha, used 16 AXI 110° ceramic nozzles with a 7-9 m application width. Herbicides included glyphosate, simazine, triclopyr and Silwet surfactant. Drift measurement lines with hydrosensitive papers (HSP) were set up perpendicular to the drone’s path. Wind speed was measured during flights and HSP were analyzed post-application using Spray Guru® software at the Pontificia Universidad Católica de Chile. In Coihueco (15-20% slope), drone flights at 3 and 5 meters height with low wind (0-1.8 km/h) showed a maximum drift of 3.8 meters. With wind speeds around 8 km/h, drift reached 13.4 meters, and at 12 km/h, it was 11.4 meters. In Nacimiento (slope >30%), flights at 3- and 5-meters height with low wind (0-2.8 km/h) had a maximum drift of 3.1 meters. Medium wind (6.7-7.9 km/h) increased drift to 7.3 meters and at 12 km/h, drift was 11 meters. The study suggests a 13.5-meter safety buffer for Agras T30 drone applications and recommends wind speeds not exceed 8 km/h.

Keywords: drift, weeds, forestry, UAV, application.

The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

New herbicides for controlling ALS inhibitors palmer amaranth (*Amaranthus palmeri*) in maize

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ABSTRACT

Palmer amaranth (Amaranthus palmeri S. Wats.) belongs to the Amaranthaceae family. It is mainly wind-pollinated and demonstrates high fecundity with up to 600,000 seeds per plant being recorded. Amaranthus palmeri was first reported in Turkey in 2016, and an immediate heavy infestation of the weed was found in fruit orchards and summer crops such as maize, cotton, and sunflower. There have been farmers’ complaints about the ineffective control of Palmer amaranth through the use of some post-emergence sulfonylureas herbicides. There are currently 79 confirmed herbicide-resistance cases globally of Palmer amaranth with single or multiple mechanisms of action. The majority has been recorded in soybean, cotton and maize, and less in sorghum, squash and orchards. This study aimed to determine the possible control of Palmer amaranth herbicide resistance evolution against acetolactate synthase (ALS) herbicides. The experiments were conducted in Eastern Mediterraneant and Southeast Anatolia Region in 2022 and 2023. Florpyrauxifen-benzyl + Nicosulfuron + Thifensulfuron-methyl (trade name Lortama®) is a new herbicide that has been used with 0.5, 0.75, 1 and 2 L/ha. Beside this herbicide, mesotrione + nicosulfuron at 2 L/ha and dicamba + nicosulfuron at 0.8 L/ha were also tested. Weed control was assessed visually by using a 0–100% scale where 0% means no control and 100% means complete control. Analysis of variance was performed and the means that significantly differed from each other compared to by posthoc Tukey’s test. Based on this test, differences between two means greater than the expected standard error were identified. Lortama® (florpyrauxifen-benzyl + nicosulfuron + thifensulfuron-methyl + (isoxadifen-ethyl) applied at 1 L /ha provides good control of Amarathus palmeri. As a result of the studies carried out in both regions, it was seen that Lortama® effectively controlled ALS-resistant A. palmeri populations. Including this herbicide in the integrated weed management program in maize fields is the most important element in suppressing A. palmeri.

Keywords: Palmer amaranth, Turkey, ALS inhibitor, florpyrauxifen-benzyl, weed control.

The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Herbicidal control of weeds in hybrids corn in northwest region of Pakistan

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ABSTRACT

Recently the farming community of northwest area of Pakistan starts growing hybrid corn instead of traditional corn varieties due to its high production. But, meanwhile they are facing some serious issues regarding the pest control in these hybrids particularly the weeds issue. Still there are no proper recommendations for herbicides in the area and the research is still under process looking for recommendations. For this purpose, a field study was conducted to test different weedicides alone and in combinations against weeds in different corn hybrids. The tested weedicides included (Pendimethalin, S-Metolachlor, S-Metolachlor+Mesotrine+Atrazine, Nicosulfuron, Halosulfuron+Mesotrine+Atrazine and Mesotrine+Atrazine. The corn hybrids Poineer-3025, Petal-CS200 and 70-Plus were evaluated against the stated herbicides in the field. The results showed both weedicides and corn hybrids gave significant responses for the recorded parameters. Among the weedicides, Nicosulfuron gave minimum weed density of 26.7 weeds m-2 followed by Halosulfuron+Mesotrine+Atrazine gave 55.1 weeds m-2 as compared to control that gave a weed density of 302.9 m-2. Due to better control of weeds the same herbicide i.e., Nicosulfuron gave the tallest corn plants (186.1 cm) and maximum number of grains/ cob (398.3). Among different maize hybrids Petal-CS200 performed better and gave maximum plant height (156.7 cm), Number of ears plant (1.4) and 1000 grains weight. Hence, from the instant study is has been concluded that the weedicide Nicosulfuron performed better among the herbicides combinations as a results it also improved the production of hybrids corn. Further trials are recommended at different locations to confirm the present findings before recommending to the farming community of the area.

Keyword: Corn, plant height, weed density, weedicides.

The effects of different weed management methods on the yield of sage (*Salvia fruticosa* Mill.)

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ABSTRACT

Sage (*Salvia* spp.) is cultivated in some Mediterranean countries due to its high medicinal and aromatic values. Two *Salvia* species, *S. officinalis* L. and *S. fruticosa* Mill., are cultivated in Türkiye for their essential oil and for herbal tea. The production of sage faces limitations due to weeds, resulting in damage to crops, reducing both quality and quantity. Additionally, the contamination of sage with weeds containing toxic alkaloids during harvest poses health risks for humans. This study aimed to determine the effectiveness of physical and chemical weed management methods on both weeds and the dry herb and essential oil yield of sage. The field trial was established in 2022 with a randomized complete block design, consisting of four replications and twelve plots. Physical control methods, including textile mulch, polyethylene mulch, flaming, and chemical control with three pre-emergence herbicides (metribuzin, pendimethalin, and oxyfluorfen), were employed. Both weedy and weed-free plots were designated as controls in the experiment. The efficacy was evaluated in terms of the density of weeds per square meter at 7th, 14th, 28th and 56th days following the applications. The dry herb and essential oil yield of sage was measured as well. The analysis of the collected data has shown significant differences in sage dry herb and essential oil yield, as well as weed biomass, between weedy and control methods. The weed-free control exhibited a dry herb yield of 50 g/plant, while the weedy control had a significantly lower yield at 3 g/plant. Among the physical control methods, textile mulch emerged as the most effective, providing the highest yield at 44 g/plant and concurrently reducing weed biomass at 90% compared to the weedy control. In the herbicide applications, oxyfluorfen demonstrated effectiveness with a yield of 47 g/plant and reduced weed biomass 92% compared to the control. These findings emphasize the importance of proper weed management strategies to enhance the productivity and quality of sage cultivation. This is the first study on weed management in cultivated sage in Türkiye.

Keywords: sage, physical method, herbicides, flaming.

Acknowledgements: This study was supported by Republic of Türkiye Ministry of Agriculture and Forestry-General Directorate of Agricultural Research and Policies with the project No: TAGEM/BSAD/Ü/21/A2/P4/3967.

New control options for management of ALS and ACCase resistant *Echinochloa* spp. in rice

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ABSTRACT

Rice is one of the most widely grown cereal crops in the world. It's grown in over a hundred countries, and 90% of the world's production is from Asia. Europe has several important rice-producer countries and Turkey is one of the leading countries regarding production and yield. This review aims to provide an overview of herbicide resistance in rice-growing areas in Europe. *Echinochloa oryzoides (Ard) Fritsch* and *Echinochloa crus-galli* L. resistance to herbicides with different modes of action (MoAs) has been reported previously.
Baloric 310 EC (Pretilachlor + Florpyrauxifen-benzyl) is a new tool for controlling ALS and ACCase-resistant *E. oryzoides* and *E. crus-galli* in IWM and resistance management strategies.
Florpyrauxifen-benzyl active is classified as an auxin herbicide (WSSA Group 4; HRAC Group O) and Pretilachlor inhibits Inhibition of Very Long-Chain Fatty Acid Synthesis (WSSA Group 15; HRAC Group 15). The field experiments were conducted in the 2022-2023 growing season in the Thrace and Black Sea Region of Türkiye, where rice production dominated. The experiments were conducted with 8 different characters with four replications. In Echinochloa species that developed resistance to different herbicides, Baloric 310 EC did not develop any resistance and suppressed *Echinochloa* species at the recommended dose. Although crop rotation is the most important agronomic practice to prevent herbicide resistance, it is not preferred by farmers because of the high profitability of rice and the difficulty of growing other crops in rice fields (high groundwater level, salinity, and pH). Therefore, the introduction of new herbicides with modes of action is the key element for weed control in the rice crop under integrated weed management.

Keywords: *Echinochloa* spp., herbicide resistance, rice, weed management.

The workshop “Sustainable Weed Management in Mediterranean Cropping Systems”
European Weed Research Society
4 - 6 December 2024
Antalya, Turkey

Integration of cultural and chemical measures for successful weed control in maize

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ABSTRACT

Maize (*Zea mays* L.) is often cultivated in continuous cropping because of profitability reasons. This means application of the same management practices over time and results in increased weed infestation, particularly with troublesome perennials such as Johnsongrass is (*Sorghum halepense* [L.] Pers.).

The aim of the study was to explore the impact of a continuous maize cropping (Maize-CC) and maize–winter wheat–soybean (Maize-WW-S) crop rotation, combined with three weed management treatments: application of a pre-emergence herbicide mixture (acetochlore/S-metolachlor + isoxaflutole) at the full and ½ of the label rate; and an untreated control. The trial was initiated in 2009, and maize was grown in both cropping systems in 2012, 2015, 2018, and 2021. The total weed biomass (TB) and Johnsongrass (JhB) were evaluated 4-5 weeks after herbicide application. Maize harvest index (HI) and grain yield were measured at the end of the growing cycle.

The average TB and JhB were significantly lower in Maize-WW-S (692.9 g m^{-2} and 130.0 g m^{-2}) than in Maize-CC (1078.6 g m^{-2} and 389.5 g m^{-2}). Maize parameters, HI and GY were higher (6.55 t ha^{-1} and 0.49) in the rotation than in maize continuous cropping (4.51 t ha^{-1} and 0.47). Herbicide application at the full labelled rate decreased TB of weeds and JhB efficiently, especially in three crop rotation (258.8 g m^{-2} and 76.1 g m^{-2}) compared to maize continuous cropping (434.3 g m^{-2} and 202.3 g m^{-2}), whereas efficiency between the full and ½ label rate was not significantly different. The most important results is that TB and JhB decreased over time in Maize-WW-S and herbicide application. The lowest TB and JhB were detected in 2021, in Maize-WW-S and at full herbicide labelled rate (59.1 g m^{-2} and 0.0 g m^{-2}).

Thus, the importance of the integrated employment of rotation and chemical measures in maize production was confirmed and could be adopted for long-term weed management without compromising yields.

Keywords: crop rotation, herbicides, maize, weeds, *Sorghum halepense.*

Organic mulches suppress annual weeds but bermuda grass thrives under them in Mediterranean vineyards.

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ABSTRACT

Vineyard growth and grape yield can be significantly hindered by weeds, particularly those located in the under-vine zone. Traditional weed management in this area typically involves tillage or herbicide application. Plant-based materials used as organic mulches can offer an alternative to manage weed populations. The objective of this study is to test the effectiveness of several agricultural by-products for weed management when used as much in Mediterranean vineyards (*Vitis vinifera* L.).

To achieve the proposed objective, two field experiments were conducted in organic vineyards located in Raimat (Spain). The study includes five treatments, four mulching materials (almond hulls, almond skins, walnut hulls and grape pomace) and a control (cultivated tillage inter-row), distributed following a completely randomized block design with three repetitions. The mulching materials were applied to the under-vine zone in early October 2022. Results indicate that grape pomace and the inter-row cultivator had the highest annual weed coverage, with up to 65% of the soil covered by weeds. In contrast, the other mulches did not exceed 15% of annual weed coverage. However, Bermuda grass (*Cynodon dactylon* L.), a perennial weed, thrived under the mulch treatments and the absence of soil disturbance. Bermuda grass covered up to 90% of the mulched plots and 30% of the cultivated inter-row treatment.

Keywords: Weed management, organic vineyards, almond hulls, grape pomace, walnut hulls.

Ambrosia trifida against *Ambrosia artemisiifolia*: will crops be invaded by a stronger competitor?

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ABSTRACT

One of the most important characteristics of weeds is their ability to grow at high density and maintain reproductive output. To become established, a successful weed species should be able to monopolize resources in favour of its growth and increase its suppressive effect. This experiment investigated *Ambrosia trifida* and *Ambrosia artemisiifolia*, two noxious weed species that cause significant damage to crop production. The newly reported presence of *A. trifida* in *A. artemisiifolia* infested areas warns against the impending establishment of a more damaging crop weed. Herbicide application is the dominant management strategy for both ragweeds on agricultural land. Still, improper and excessive use has led to the evolution of resistance to ALS inhibitors and glyphosate. Knowledge of this species' behaviour in different environments and more precise answers to its competition in different conditions are valuable tools for more accurate management. Using a replacement design model, this study aimed to determine the interaction effect between *A. artemisiifolia* and *A. trifida* in density ratios (%)of 100:0, 80:20, 40:60, 60:40, 20:80, and 0:100. The field experiments were carried out at a farm near Dobrić, Republic of Serbia (44°41’N, 19°34’E) during 2016 and 2017. When grown in monocultures, *Ambrosia trifida* biomass was lowest, while highest for *A. artemisiifolia. A. artemisiifolia* produces its highest biomass in monoculture, while *A. trifida* produces less biomass at high densities. The lowest biomass per plot was produced at a 50/50% ratio, indicating that crop losses would be lowest at this joint occurrence. At the same time, in an even mixture of both ragweed, the highest biomass of other weed species was determined. Despite its larger canopy, *A. trifida* is not predicted to become a more serious threat to crops than *A. artemisiifolia*, as it suffers from intraspecific competition at high density in monoculture and interspecific competition with *A. artemisiifolia.*

Optimizing weed management and herbicide efficacy in wheat: influence of rice residue mulch and herbicide application methods in zero-tillage systems.

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ABSTRACT

The present investigation was conducted at research farm of Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Karnal during winter 2019-20 and 2020-21. In Experiment, level of chopped residue mulch (6 t ha-1) and Fourteen weed control treatments including pre-emergence herbicide (pendimethalin 1500 g/ha), sequential application of pre-emergence fb post-emergence (POE) herbicide (pendimethalin 1500 g/ha fb pinoxaden 50 g/ha), weedy check and weed-free were applied in a randomised block design (RBD) with 3 replications. Pre-emergence (PRE) herbicides were applied on the top of rice (Oryza sativa L.) residues using two water volumes (500 and 1000 litre/ha) with 3 types of nozzles (flat-fan, flood-jet and air-injection). Rice residue mulch (chopped) of 6 t ha-1suppressed most of the weed flora under study; however, magnitude of suppression was higher for some weeds (*Coronopus didymus, Chenopodium album, Anagallis arvensis, Rumex dentatus* and *Phalaris minor*) than others (*Melilotus alba, Medicago denticulata* and *Lathyrus aphaca*). In wheat sown with turbo happy seeder (ZT + rice residue), application of pendimethalin *fb* pinoxaden onto mulch either as PRE with high carrier volume (1000 L ha-1) improved herbicide penetration through mulch and provided satisfactory weed control (85-90%); and grain yield similar to weed-free. The information obtained from this study will facilitate proactive management of herbicide resistant weeds through synergistic integration of PRE herbicides and other non-chemical tools; and to reduce herbicide use in wheat.

Keywords: weed management, weeds, herbicides, residue mulch.

Cover crops shifted weed communities in Chilean cherry and vineyards soils

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ABSTRACT

Cover crops are currently used in several agricultural systems throughout the world with positive effects on soil properties, weed communities, insect biodiversity, among others features. Trials were established during four seasons (2020 through 2024) in the central valley of Chile, in two cherry orchards (Tinguiririca and Las Cabras) as well as and two vineyards (Pirque and Requinoa). Each season the “LivinGro mix” was sown over three inter-rows, approximately of 1 m wide. At the end of each season, the winter annual species seeded and died naturally completing their life cycle. These experiments compared the effect of the LivinGro cover crop against a bare control, replicated in three rows 90 m apart. Each season, evaluations of vegetation cover began in spring (October) with monthly frequency. Four random samples were taken in each location using a 25 x 25 cm quadrant to estimate soil cover percentage. The biomass within the quadrant was harvested, weighed, and analyzed, classifying species as “weeds” or LivinGro mix. For cherries at Las Cabras and Tinguiririca, significant differences were observed with a reduction in weed biomass of 30% and 61%, respectively, in the row with LivinGro vegetative cover. For the locality of Tinguiririca, this reduction was statistically significant ($p=0.0006$), despite the low biomass of the LivinGro mix in the 2023 season. On the other hand, when analyzing weed biomass over the four seasons in the vineyard at Pirque, no decrease associated with the presence of the LivinGro mixture was observed ($p= 0.617$), but there was an effect of the seasons ($p=0.0002$). In contrast, in the locality of Requínoa, a positive effect of the LivinGro mixture treatment (vegetative cover) on the reduction of weed biomass throughout the project was shown ($p=0.04$), as well as an effect of the seasons on the results ($p\leq 0.0001$).

Keywords: weed biomass, LivinGro, orchards.

How genomics can contribute to improve modelling to predict resistance evolution in the fields.

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ABSTRACT

Weed control contributes to guarantee crop yield and quality in modern agriculture. Integrated Weed Management (IWM) based on the right combinations of agronomic measures and herbicide uses is the major approach to insure crop production sustainability. The rare new herbicide modes of action found during the last decades and the intensive use tolerant crops to few herbicides have contributed to resistance evolution with new unique resistant cases observed every year (Weedscience.org database). Herbicide resistance involved several resistance mechanisms which evolve independently and can be observed alone or in combinations in the weed resistant populations. Either the target can be modified by mutations (Target Site Resistance, monogenic trait) or the herbicide cannot any more reach its target either because it is detoxified (enhanced metabolism), or its transport or its uptake can be inhibited, or it can be transported directly into the vacuole (sequestration). These non-target site resistance mechanisms are still poorly understood and in many cases are under the control of multiple genes (polygenic traits). Models to predict resistance evolution in the fields can be of two kinds. They can rely on mathematical equations mimicking the weed development cycle (mechanistic models) or on AI, like a random forest approach, based on field history. The number of genes involved in the resistance is one key parameter to improve the existing models, especially the mechanistic ones. Genomic can be of great help to find these genes and understand their activity and regulation. Examples will be presented using black-grass (*Alopecurus myosuroides*) resistant to post emergence ALS-inhibitor herbicides (HRAC Group 2) and pre-emergence herbicides inhibitors of the synthesis of Very Long Chain Fatty Acids (HRAC Group 15). Genomic analyses related to the characterization of cytochrome P450 and glutathione transferase gene families will be discussed. Finally, it will be shown how to use this new knowledge to improve the modelling approaches aiming to choose the best strategies to mitigate the resistance evolution in the field in a cost-effective way for the farmers.

Keywords: resistance management, modelling, farmer recommendations, cost evaluation, Integrated Weed Management.

Can various cultural practices be combined in a realistic and efficient way in field crops for an agroecological crop and weed management?

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ABSTRACT:

Agroecological crop and weed management is a challenging topic of increasing interest. The evaluation of several cultural practices and their interactions with chemical and non-chemical weed management methods was attempted by means of numerous field trials conducted under different pedoclimatic conditions as part of the Horizon Europe "Agroecology is GOOD" project. In particular, in order to evaluate the combination of different cover crop species with several weed management practices in wheat, a field trial was conducted in a Randomized Complete Block Design (RCBD) with a split-plot arrangement in central Greece. *Trifolium alexandrinum*, *Lolium perenne* and their mixture were the main plots (cover crops), with false seedbed, stale seedbed and mechanical weeding belonging to the subplots. *Avena sterilis*, *Sinapis arvensis*, *Veronica hederifolia*, and *Gallium aparine* were the dominant weeds with frequency higher than 60%. Our results revealed that the mixture of the two CC was the most productive and efficient one against the weeds. Furthermore, the integration of CC establishment with other alternative non-chemical cultural weed management practices as false seedbed or mechanical weed control resulted to higher crop yield. The first results from the on-station participatory trial in wheat and the observed differences build the basis for a feasible and efficient combination of Alternative Weed Management (AWM) practices and boost their wider adoption in European agriculture.

This research was supported by the European Union's Horizon Research and Innovation Action (RIA) project under the grant agreement no. 101083589 (Agroecology is GOOD project – https://www.goodhorizon.eu/).

Keywords: wheat, agronomic practices, cover crops, false seedbed.

Cover crops as a sustainable weed management practice in the framework of the ONE GREEN project

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ABSTRACT:

Weeds are considered the most serious pests for crops, leading farmers to prioritize their management, often relying on herbicide applications. However, the overuse of herbicides in agriculture raises concerns about environmental degradation, risks to human health, and the development of herbicide-resistant weeds. To address these challenges, the ONE GREEN project established an ecosystem of six Living Labs (LLs) to evaluate sustainable crop and weed management practices, including cover cropping, mechanical control and intercropping in various Mediterranean cropping systems. In order to evaluate cover crops in vineyards, a field trial was conducted in a Randomized Complete Block Design (RCBD) in the LL of Korinthos, Greece. At the end of autumn three cover crops were established between the rows of vines: vetch (*Vicia sativa* L.; VICSA), oat (*Avena sativa* L.; AVESA) and their mixture (VICSA + AVESA). Also, experimental plots without cover crop or other weed management treatments were maintained as an untreated control. Marigold (*Calendula arvensis* (Vaill.) L.), bindweed (*Convolvulus arvensis* L.) and fumitory (*Fumaria officinalis* L.) were among the most dominant weed species in the experimental area. The first results of the field trials show that the establishment of cover crops is an effective agroecological weed management practice in perennial crops in Greece. In particular, the mixture of vetch and oat reduced weed biomass by 61, 78 and 84% compared to oat monoculture, vetch monoculture and control, respectively. These findings highlight the potential of cover crops as a sustainable alternative to herbicide use. However, further research is required in order to optimize the practice and overcome the challenges of Mediterranean cropping systems.

The research work was supported by the Hellenic Foundation of Research and Innovation (HFRI) under the action of "Funding for Basic Research (Horizontal support for all Sciences)" of the National Recovery and Resilience Plan "Greece 2.0" with funding from the European Union - NextGenerationEU.

Keywords: agroecology, perennial crops, cultural practices.

Weed management in irrigated summer blackgram (*Vigna mungo* L.) with imazethapyr herbicide

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ABSTRACT:

A field experiment was conducted at the Agronomy farm at the School of Agricultural Science, Nagaland University, during the summer season of 2022. Imazethapyr @ 100 g a.i. ha^{-1} at 25 days after spraying (DAS) were minimum weed population, weed biomass, weed index and highest weed control efficiency and followed by its lower dose and early time Imazethapyr dose @ 75 g a.i. ha-^{1} at 15 DAS. The predominant weed species in the experimental field were *Eleusine indica* (49.97%), *Amaranthus viridis* (20.31%), *Commaelina bangalensis* (5.90%), *Alternanthera sessilis* (4.68% etc. Similarly, the maximum grain yield (1992.37 kg ha^{-1}) was achieved with Imazethapyr @ 100 g a.i. ha^{-1} at 25 DAS and Imazethapyr @ 100 g a.i. ha^{-1} at 25 DAS were maximum crop yield and benefit cost ratio.

Keywords: Imazethapyr, weed, dominant, weed index, blackgram.