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European Weed Research Society
Working Group Meeting:
"Weed Management Systems in Vegetables"
and
"Weed management in arid and semi-arid climate"

13 -15 May 2019, Oeiras, Portugal

Book of Abstracts

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Proceedings

European Weed Research Society Working Group Meeting: "Weed Management Systems in Vegetables" and "Weed management in arid and semi-arid climate"

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Disclaimer

COMMITTEES

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Annotations page

European Weed Research Society Working Group Meeting:
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PROGRAMME

MONDAY, MAY 13th

10:00 - 10:20 OPENNING
Prof. Husrev Mennan - Scientific Committee of the EWRS
Prof. Euro Pannacci - Chairman WG Weed Management Systems in Vegetables
Prof. Hanan Eizenberg - Chairman WG Weed Management in Arid and Semi-Arid Climate

10:20 - 13:00 WORKSHOP ON WEED EMERGENCE MODELLING AND R PRACTICE
(Dr. M. Mesgaran, UC Davis, USA)
This workshop will present both the theoretical underpinnings of germination/emergence and provide hands-on experience in developing predictive emergence models. The first section of the workshop (1.0 to 1.5 hours) will provide an overview of the biology of germination/emergence and various mathematical models that have been developed to characterize it. Example topics to be covered are:
- Emergence as multi-step process
- Type of emergence models
- Inputs and outputs of emergence models
- Species-specific parameters
As a computer lab practice, the second section of workshop (about 2 hours) will use actual germination and field emergence data to calibrate and validate an emergence model. We will use Excel and R for this exercise: while prior experience in working with R is desirable no programing skill is required for the purpose of this modeling practice. Attendees will learn about various methods of estimating cardinal temperature, fitting thermal-, hydro-, and hydrothermal-time models using Excel and R.

13:00 - 14:00 Lunch

SESSION 1 (Part I) - NON CHEMICAL WEED CONTROL AND INTEGRATED WEED MANAGEMENT IN VEGETABLES
Moderator - Prof. Husrev Mennan, Ondokuz Mayıs University, Turkey

14:00 - 14:40 *Advanced Non-Chemical Weed Control Tactics- Meeting the Challenges of Future Agriculture* - Ran Lati

14: 40 - 15:00 *Cover crops use in IWM (Integrated Weed Management) approach in vegetables'* - Husrev Mennan

15:20 - 15:40 *Evaluation of allelopathic effects of Coriandrum sativum L.* - Euro Pannacci, Giulia Contini, Alessio Morelli, Daniele Ottavini

15:40 - 16:00 Discussion

16:00- 16:20 - Coffee Break

SESSION 1 (Part II) - NON CHEMICAL WEED CONTROL AND INTEGRATED WEED MANAGEMENT IN VEGETABLES
Moderator - Prof. Euro Pannacci, Univ. Perugia, Italy

16:20 - 16:40 *Tubers characterization of Cyperus rotundus (L.) Palla., evaluation and extraction of their essential oil properties'* - Ana Neves, Bernardo Campino, Aida Duarte, A. Cristina Figueiredo, Artur Guerra Amaral

16:40 - 16:50 *Weed control with compost: immediate and residual effect'* - Luísa Coelho

16:50 - 17:10 *The application an integrated weed management (IWM) in oregano crop. Evaluation of the system on the quantitative and qualitative characteristics of the final products'* - Eliza Gavrhiil , Anagnostopoulos C, Eleftherohorinos I. Tarantilis P, Knezevic S, Economou G

17:10 - 17:20 *Propane Based flaming- Alternative Mean to Control Weed in Direct Seeded Onion (Allium cepa L.)'* - Karam Igbariya, Zvi Peleg, Ran Nisim Lati

17:20 - 18:00 Discussion

18:00 - 18:30 Working Groups meeting (Room 1 and Room 2)

PROGRAMME — TUESDAY, MAY 14th

09:00 - 12:30 ***WORKSHOP ON PARASITIC PLANT MANAGEMENT UNDER MEDITERRANEAN CLIMATE***
(Prof. H. Eizenberg, Israel).

09:00 - 10:00 *Parasitic weed Orobanchaceae- taxonomy, biology and world populations* - Y. Goldwasser

10:00 - 11:00 *Parasitic weed Orobanchaceae- Chemical management and decision support systems* - Hanan Eizenberg

11:00 - 11:20 Coffee break

11:20 - 11:40 *Biology and management of Egyptian broomrape (Phelipanche aegyptiaca) in cabbage (Brassica oleracea var. capitate)* - Amit Wallach, Hanan Eizenberg

11:40 - 12:00 *New Image-Driven Methodologies for Early Broomrape Detection Parasitism* - Ran Nisin Lati, 1 Filin S, Hanan Eizenberg

12:00 - 12:30 *Cuscuta campestris (field dodder) biology and management under semi arid conditions* - Y. Goldwasser

12:30 - 13:30 Lunch

13:30 - 18:00 FIELD DAY

20:00 - 23:00 WORKSHOP DINNER

PROGRAMME — WEDNESDAY, MAY 15th

SESSION 1 (Part III) - NON CHEMICAL WEED CONTROL IN CEREALS AND INVASIVE WEEDS
Moderator - Prof. Artur Amaral, Polytechnic Institute Santarém, Portugal

08:30 - 09:00 *A demographic role for hybridization in biological invasions* - 'Mohsen B Mesgaran (Invited speaker)

09:00 - 09:20 *Temperature-based prediction model for Ambrosia confertiflora development'* - Omer Kapiluto, Hanan Eizenberg

09:20 - 09:40 *Integrated Weed Management through Genetic Wheat Architecture Manipulations* - Shlomi Aharon, Zvi Peleg, R. Ben David, Ran Nisim Lati

09:40 - 10:00 *Influence of seasonal rainfall and different tillage systems on the total density of weeds and wheat yields in monoculture vs. rotation'* - Maria Luisa Gandía, J.P. Monte, J.L. Tenorio, M. Ines Santín-Montayá

10:00 - 10:20 *Modeling emergence of five California weedy rice accessions under various flooding and burial depths'* - Liberty Galvin, Deniz Inci, Whitney Brim-DeForest, Mohsen Mesgaran, Kassim Al-Khatib

10:20 - 10:40 *Resistance Risk Assessment for ALS Inhibiting Herbicides in Rice Weeds*' - Isabel M Calha, Gonçalo Canha, Filipa Setas, Jorge Zambujo, Teresa Pereira, Capela R, Manuela Leitão, Manuel Luis Fernandes, Pedro Reis

10:40 - 10:50 Discussion

10:50 - 11:10 Coffee Break

EVALUATION OF GLYPHOSATE (SA) IN THE VIABILITY OF TUBERS SEDGE (CYPERUS ROTUNDUS L. (PALLA) IN GREENHOUSE AND OPEN AIR

Artur Guerra Amaral[1]; Renato Ferreira Costa[1]; Isabel Miranda Calha[2]

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Cyperus rotundus L. (Palla) is one of the most important weeds in the production systems of the Tagus Valley, especially in the processing tomato. In 2017, tubers were harvested in two plots of cultivation in the Cartaxo region, with and without glyphosate application at the end of November. After being separated from the soil, the tubers of each treatment were counted, washed and weighed. Sixty-four tubers from each plot were randomly selected, placing 8 tubers in 8 plastic containers filled with soil collected in the field. Four of the containers were put in a greenhouse and four remaining in the open air. The number of tubers harvested per unit area, the percentage of viable tubers and the rate of inflorescence plants in each treatment were evaluated.
The average of tubers per m^2 harvested in the field was 76 in plot without application of glyphosate and 16 with application, respectively. The mean emergence rate of the tubers was 82 and 8%, without and with application of glyphosate. In greenhouse environment, the number of days to reach the forcing was of 29 and 36 days for the treatments without glyphosate and with glyphosate, while in the open air it was 39 and 49 days.

KeyWords: *Cyperus rotundus L*. (Palla); Glyphosate; Viability; Greenhouse; Thermal regime.

MODELLING OF MICROBIAL COMMUNITIES FOR DEGRADATION OF PHENYL UREA HERBICIDES IN CROP SOILS

[1]Kusum Dhakar, [1]Raphy Zarecki, [1]Hammam Ziadne, [1]Shlomit Medina, [1]Jackline Abu-Nassar, [1]Radi Aly, [2]Zeev Ronen, [1]Hanan Eizenberg, [1]Shiri Freilich

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Phenyl urea herbicides are known for their widespread use to control weeds in agricultural system. The accumulation of these herbicides has resulted in soil and water pollution and recorded to have negative effects on the ecosystem. Soils treated with phenyl urea herbicides for more than 10 years showed higher biodegradation activity than untreated soils.

In this study we analyse the shifts in microbial communities by exposing the soils to phenyl urea herbicides to identify the principal degraders in crop soils.

The effect of herbicide in plants was assessed using a wheat bioassay and the microbial soil system was analysed by biomolecular techniques. To retrieve the taxonomic and functional signatures of the principal microbial degraders in soils, enrichments (addition of herbicides in the soils) are being carried out and will be investigated through amplicon sequencing. Apart from the laboratory experiments, the designing of metabolic model was also included in the study.

The effect of herbicides on wheat plants and the soil microbial system is planned to be investigated.

Bioassay results in the pot experiments revealed the reduced fresh and dry weight of plants in treated (herbicides at rate of 500 active ingredients per hectare, a.i. ha^{-1}) soil samples, whereas germination was not significantly affected ($p<0.05$). The phenotype of an herbicide degrader model SRS16 was predicted through computational approach using Model SEED and KBase in the presence of a range of supplements. The predicted results are being validated in-vitro.

The present study will provide an insight towards the utilization of soil microbial factory to degrade the pollutants by following an eco-friendly approach.

Key words – biodegradation, phenyl urea herbicides, amplicon sequencing, modelling of microbial communities remediation

PROGRAMME

WEDNESDAY, MAY 15th

SESSION 2 (Part I) - WEED CONTROL IN ARID AND SEMIARID CONDITIONS
Moderator - Prof. Hanan Eizenberg, Agricultural Research Organization (ARO), Israel

11:10 - 11:30 *The Role of Climate Change in Chemical Weed Management'* - Dr. Maor Matzrafi

11:30 - 11:50 *Factors affecting the infestation level of tomato by Phelipanche ramose* - Ana Paula Nunes, Elsa Valério, Maria do Céu Godinho, Artur Amaral, José Cachado, Lourdes Almeida, Susete Matos, Manuela Leitão, Manuel Luís Fernandes, Isabel M. Calha, Pedro Reis

11:50 - 12:10 *The interference of Lolium rigidum L. with malt barley under mediterranean conditions'* - Dimitris Doulfi, P. Vahamidis, G. Economou

12:10 - 12:25 Discussion

12:25 - 13:30 Lunch

SESSION 2 (PART II) - WEED CONTROL IN ARID AND SEMIARID CONDITIONS
Moderator - Prof. Ana Monteiro,University of Lisbon, Portugal

13:30 - 14:10 *Illustrating the temporal and spatial distribution patterns of weeds: three case studies'* - Lior Blank

14:10 - 14:30 *Herbicide effect of different organic compounds to control Conyza bonariensis in vineyards'* - Carlos Cabrera, Francisco Valencia-Gredilla, Aritz Royo-Esnal, Jordi Recasens

14:30 - 14:50 *Biodiversity of cover crops in vineyards: the influence of soil and climate in the Dão Region, Portugal'* - Gonçalo Coelho, Pina A, Campos A, Santos S, Santos T, Lopes S, Rodrigues, Cristina Amaro da Costa

14:50 - 15:00 Discussion

15:00 - 15:30 Coffee Break

SESSION 3 - HERBICIDE FATE IN ENVIRONMENT
Moderator - Prof. Jordi Recassens , University of Lerida, Spain

15:30 - 15:50 *Predicting sulfosulfuron fate in soil using computer simulations'* - Amit Paporish, Y. Laor, Baruch Rubin, Hanan Eizenberg

15:50 - 16:10 *Modelling of microbial communities for degradation of phenyl urea herbicides in crop soils'* - Kusum Dhakar, Raphy Zarecki, Hammam Ziadne,Shlomit Medina, Jackline Abu-Nassar, Radi Aly, Zeev Ronen, Hanan Eizenberg, Shiri Freilich

16:10 - 16:30 *Evaluation of glyphosate (sa) in the viability of tubers sedge (Cyperus rotundus L. (Palla) in greenhouse and open air* - Artur G Amaral, Renato Ferreira Costa; Isabel M Calha

16:30 - 16:50 Discussion

CLOSURE

PREDICTING SULFOSULFURON FATE IN SOIL USING COMPUTER SIMULATIONS

A. Paporisch[1,2], Y. Laor[3], B. Rubin[1], H. Eizenberg[2]

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Sulfonylurea herbicides, such as sulfosulfuron, are used for weed management in various crops. In Israel, sulfosulfuron (37.5 g ha^{-1}) is pre-planting incorporated (PPI) to the soil to control the root-parasitic weed *Phelipanche aegyptiaca* in open-field transplanted tomatoes, taking into advantage its long-term residual activity. However, the application protocol does not account for environmental factors, such as weather or soil type, that affect the fate of the herbicide in the soil. Studying sulfosulfuron fate in the environment using computer simulations would allow a thorough analysis of these factors. In this study we examined the accuracy of predicting sulfosulfuron degradation and transport in the soil using computer simulations. The fate of sulfosulfuron was measured in three clay soils, in 30 cm long columns, using a sorghum bioassay, or monitored after PPI in two tomato fields, from which two of the above soils were taken, by soil sampling and analysis in LCMS/MS. The conditions of these experiments were simulated in Hydrus-1D software and the expected concentrations were compared to the observed. In the soil columns, sulfosulfuron transport pattern following application to the top 10 cm (40 ng g^{-1} soil) and irrigation to field capacity, was similar in all three soils. High linear correlation (R^2=0.95) was found between the expected and the observed concentrations along the column and the absolute error between expected and observed was low (+/-0.4-3 ng g^{-1}). In the field studies, high linear correlation (R^2 =0.96 or 0.79) between expected and observed concentrations was found in both fields. However, the absolute error was higher (+/-0.1-14 ng g^{-1}). The relatively high accuracy of predictions allows further analysis of different scenarios to identify key environmental factors affecting the fate of sulfosulfuron.

Keywords: Sulfonylurea, Residual herbicides, Herbicide transport, Hydrus 1D, Egyptian broomrape

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SESSION 3 - HERBICIDE FATE IN ENVIRONMENT

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SESSION 1 (Part I) - NON CHEMICAL WEED CONTROL AND INTEGRATED WEED MANAGEMENT IN VEGETABLES

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BIODIVERSITY OF COVER CROPS IN VINEYARDS: THE INFLUENCE OF SOIL AND CLIMATE IN THE DÃO WINEGROWING REGION, PORTUGAL

LOURENÇO G[1], PINA A[1], CAMPOS A[1], SANTOS S[1], SANTOS T[1], LOPES S[1], RODRIGUES P[1,2], COSTA C A, [1,2,3]

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Cover crops are an essential component of the biodiversity on wine-growing ecosystems as they support a range of ecosystem services, such as the natural control of pests or the increase of soil organic matter. The maintenance of cover crops in permanent crops, such as vineyards, should be managed according to local soil and climatic conditions in order to fulfil their ecological function without compromising the crop balance, particularly in regions and periods of water scarcity or in climate change scenarios.

In this sense, an attempt was made to identify plant species that are better adapted and that could be indicated as the most adjusted for the maintenance of permanent cover crops, as ecological infrastructures with an important role in crop protection and soil conservation, in different climatic water regimes in the Dão region, Portugal.

Weed and soil and climate conditions were monitored, in different vineyards (Silgueiros, Nelas, Santar, Carregal do Sal, Tábua) and different cultivars ('Touriga Nacional' and 'Encruzado') in march, april and September, 2017. A total of 3362 plant *taxa* were identified, from 19 families, in the three floristic surveys, with higher abundance in April 17th (1926 specimens). The most representative families were Asteraceae, Malvaceae and Poaceae.

Cover crop diversity was different over time and among sites, and it was possible to confirm a significant influence of date and site, soil (pH and phosphorus content) and climate conditions (average of the average temperatures, precipitation, reference evapotranspiration and accumulated hydric deficit) on the present plant species.

Keywords: accumulated hydric deficit, diversity, indexes, floristic survey.

More applications along the season and in the subsequent years will be necessary to obtain consistent conclusions, but these preliminary results highlight the herbicide effect of alternative compounds to the synthetic herbicides, and how its efficacy depends on the growth-stage of the weed.

Acknowledgements

This work is supported by the project Plan Estatal - Retos de la Sociedad, Ref: AGL2017-83325-C4-2-R financed by the Ministerio de Industria y Competitividad, and also included in the action stablished by the program Grups Operatius from DARP, Generalitat de Catalunya.

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Urbano, J.M.; Borrego, A.; Torres, V.; León, J.; Jimenez, C.; Dinelli, G.; Barnes, J. 2007. Glyphosate-resistant hairy fleabane (*Conyza bonariensis*) in Spain. *Weed Technol.* 21, 396–401.

Ran Lati

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Weeds are the main biotic factor that limits the agricultural productivity, while herbicides are the most common tool for weed control. Realizing the upcoming challenges of future agriculture has led to increased interest in alternative non-chemical weed control practices and/or integration of new weed management strategies. This trend was mainly motivated by the rapid development of herbicide-resistant weeds and the need to conserve viable herbicides and modes of actions. Other catalysts have been increasing environmental awareness and the rising demand for pesticide-free food. Technological breakthroughs have motivated the academia and the industry to put efforts and research into the field of robotics and machinery. This allows the development of new tools for mechanical weed control and their integration into current management. Additionally, new control tactics that showed efficacy in the past but could not be commercialized due to technological gaps become viable. Here, we provide three examples of new non-chemical tactics: intelligent intra-row cultivator, advanced non-automated intra-row cultivator and electrocution. We view the efficacy trials that we have held, and discuss the potential contribution that can be achieved by their adoption into current managements. We point their drawbacks and limitations and emphasize the necessity in combing several methods to achieve long term effective and sustainable weed control.

COVER CROPS USE IN IWM (INTEGRATED WEED MANAGEMENT) APPROACH IN VEGETABLES

Husrev Mennan

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Weed control is a major concern for organic and conventional farmers around the world and non-chemical weedcontrol methods are now the subject of many investigations. The primary objective of this study was to review the effects of various cover crops on weed control and weed community composition in conventional and organic vegetable production. Field studies were conducted from 2004 to 2010 at the Black Sea region in Samsun, Turkey. The experiments were conducted in tomato, pepper, kale, and lettuce. The treatments in tomato and pepper consisted of ryegrass (*Lolium multiflorum* L.), oat (*Avena sativa* L.), rye (*Secale cereale* L.), wheat (*T. aestivum* L.), gelemen clover (*Trifolium meneghinianum* Clem.), Egyptian clover (*Trifolium alexsandrinum* L.), common vetch (*Vicia sativa* L.), hairy vetch (*Vicia villosa* Roth.) and a bare ground with no cover crop. The most consistent effects of these cover crops on weed management occur during the cover cropping period rather than the following incorporation. They provide early season weed suppression but not full-season weed control. These results indicate that effective weed control should include a combination of practices designed to suppress weeds throughout the entire year. The inclusion of a cover crops in a crop sequence allow the integration of weed management and nutrient management in organic production systems, with additional benefits on other important agro-ecosystem properties such as soil fertility, soil moisture retention, and biodiversity.

Table 1. Treatment rates for the two application dates.

Treatment	Dose rate (L/ha)		Volume application rate (L/ha)	
	Jul 18	Feb 19	Jul 18	Feb 19
(T1) Acetic acid + N32	245 + 105	122,5 + 52,5	350	175
(T2) Pelargonic acid + $K_2S_2O_5$	-	7 + 28 (kg/ha)	-	200
(T3) Pelargonic acid	32	16	200	200
(T4) Fulvic + humic acid	70	35	700	700
(T5) Camelina oil	500	250	500	250
(T6) Hydroxyphosphate complex	30	15	150	150

The results obtained at the advanced stage application (July 2018) showed the highest efficacy for the fulvic + humic acids with an average weed coverage reduction of 77%. The other compounds showed lower efficacy levels: hydroxyphosphate complex, 33 %; pelargonic acid, 30 %; acetic acid + N32, 25 % and camelina oil with only 5 % (Figure 1). Although the inflorescences showed necrosis with the fulvic + humic acids, avoiding dispersion of the achenes, plants did not die with any of the five compounds tested. In the applications carried out in February 2019 at the rosette stage with low coverage of *C. bonariensis*, again fulvic + humic acids showed the highest efficacy reducing the weed coverage (92%), followed by the pelargonic acid and the mix of pelargonic acid + $K_2S_2O_5$ (77%), the acetic acid (64%), camelina oil (48%) and the hydroxyphosphate complex (37%) (Figure 1).

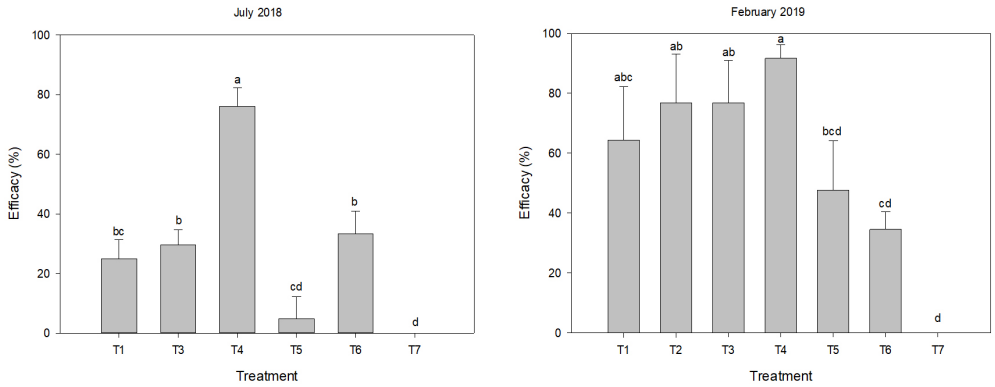

Figure 1. Efficacy of the treatments. Columns with different letters indicate significant differences at $p < 0.05$ (Student's T-Test). Vertical bars show standard error.

HERBICIDE EFFECT OF DIFFERENT ORGANIC COMPOUNDS TO CONTROL *CONYZA BONARIENSIS* IN VINEYARDS

Carlos Cabrera, Francisco Valencia-Gredilla, Aritz Royo-Esnal, Jordi Recasens

Weed Science and Plant Ecology Research Group. ETSEA. Agrotecnio. University of Lleida. Spain
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Six organic compounds were tested in a field trial to control *Conyza bonariensis* in two different growth stages along the vine rows in a vineyard in the NE region of Spain. The results showed that the highest efficacy was obtained by the fulvic + humic acids at the rosette stage of the weed.

Conyza bonariensis (L.) Cronquist has become one of the most noxious weed in perennial crops in Spain in the last decades (Bastida *et al*. 2005). The continuous use of non-selective herbicides (i.e. glyphosate) has even favoured the appearance of herbicide resistant biotypes (Urbano *et al.,* 2007). In some Spanish vineyards the chemical control of this species is very difficult, especially when plants are in advanced growth stage. Due to this situation, it becomes necessary to find new alternative control methods to synthetic herbicides. With this aim, a field experiment was carried out in the vineyards of Raimat (Lleida, NE Spain) to evaluate in two different growth stages the herbicide effect of six treatments that combined six different organic and one inorganic compounds against *C. bonariensis*: acetic acid (20°) + nitrogen fertilizer (N32) (T1); pelargonic acid 3,1% w/v + potassium metabisulfite ($K_2S_2O_5$) (T2); pelargonic acid 68% w/v (T3); fulvic acid + humic acid 80% (T4); camelina oil (T5) and a natural hydroxyphosphate complex (T6). The experiment was established in a complete randomized design with four replicates, in plots of 3 m x 0.8 m along the vine rows and one control without application (T7).

In July 2018, five of the total selected compounds were tested at double dose (Table 1) at an advanced growth-stage of the weed (BBCH 60-65) and high coverage in order to study the effect on plants with already developed inflorescences. In February 2019, all selected compounds were tested again at normal dose (Table 1) at the rosette stage (BBCH 12-15) of the earliest emergences and with low weed coverage (1-5 %). Data were subjected to ANOVA and means were separated by Student's T-Test.

EVALUATION OF ALLELOPATHIC EFFECTS OF *CORIANDRUM SATIVUM* L.

Euro Pannacci, Giulia Contini, Alessio Morelli, Daniele Ottavini, Francesco Tei

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Allelopathy has been exploited as a weed control tool in order to reduce the use of herbicides and improve weed management strategies, both in the integrated and organic farming systems. Interesting results were obtained by selecting allelopathic crop types, using allelopathic cover crops and developing herbicides from allelopathic compounds. Herbicides derived from allelopathic compounds may have new target sites, important in managing herbicide resistance. Many crops have been observed to have allelopathic activity. In particular, *Coriandrum sativum* L. was found to have allelopathic properties, although available results are few and without practical relevance. The aims of this study were to evaluate allelopathic potential of different plant tissues of *C. sativum* at different growth stages and their activity against wheat (*Triticum aestivum* L.), *Lolium multiflorum* Lam., *Amaranthus retroflexus* L. and *Conyza canadensis* (L.) Cronquist respectively one of the main cereal crop and three most problematic weeds worldwide due to their herbicide resistance.
Plants of *C. sativum* were collected at flowering and at harvest stage in central Italy, divided in leaves, stems and roots tissues, dried, ground to a fine powder, soaked in distilled water for 24-h and then filtered obtaining aqueous extract (25% w/v). Petri dishes bioassays were carried out with leaves, stems and roots aqueous extracts of *C. sativum* (0, 2.5, 5, 10, 17.5 and 25% w/v concentrations) in order to compare their effect on seed germination and seedlings growth of *Sinapis alba* L., used as test specie. Subsequently, aqueous extracts of aerial biomass (stems + leaves) of *C. sativum* were applied in Petri dishes bioassays against wheat, *L. multiflorum, A. retroflexus* and *C. canadensis*. Fifty seeds of each species were treated with the six-extract concentrations mentioned before, placing Petri dishes in a growth chamber in a completely randomised design with three replications. Germination percentage, radicle and hypocotyls lengths were determined. Data were subjected to a non-linear regression analyses by using a dose-response model and the EC_{50} and EC_{90} levels (*Effective Concentration*) were derived. EC levels showed that the extracts from roots had a lower inhibitory effect on seed germination, radicle and hypocotyls length of *S. alba* than leaves and stems extract and their allelopathic activity was higher at flowering stage than at harvest stage. The extract of aerial biomass did not affect germination of *T. aestivum*, but inhibited seed germination and growth of the tested weeds.
These laboratorial results pointed to the possibility to use *C. sativum* allelopathic potential in practical relevance, in order to reduce the use of herbicides and improve the management of herbicide resistant weeds. Nevertheless, studies under field conditions are needed.

Keywords: Allelopathy, seed germination, weeds, bioassays, Integrated weed management

ILLUSTRATING THE TEMPORAL AND SPATIAL DISTRIBUTION PATTERNS OF WEEDS: THREE CASE STUDIES

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Traditionally, herbicides application is carried out with the assumption that weeds are evenly distributed in the field. This assumption means that the herbicides are applied uniformly without reference to spatial variation of the weeds. Site-specific weed management counter this assumption and suggest that if weeds are not randomly distributed in the field than farmers can specifically target weeds infested areas in the field. Various studies showed that different weed species in different crop systems tend to spatially aggregate. Compared to the relatively well-studied spatial aspects of weeds in agricultural plots, temporal aspect were less studied. Few studies have attempted to quantify spatial stability of weed patches between years and the temporal trend in weeds density within patches. In addition, studies tend to focus on crop systems and less on orchards. However, the cropping system might be relevant as usually orchards needs less agro-managements field operations, which might disperse seeds in the field and the use of unmanned aerial vehicle (UAVs) in orchards is limited as weeds detection under the canopy is problematic. Thus, the issue of temporal consistency in patch location between years might be important in orchards. In this overview, I will present three case studies. The first case focused on the distribution of squirting cucumber in almond orchards over three years. The second case investigated how herbicides application affected the distribution of *Amaranthus* species in processing tomatoes. In the third case study we used UAV to map weed populations in onion fields. Together, these case studies shows that weeds distribution is not random in space and in time. Better understanding of the spatio-temporal aspects of weeds distribution will aid in better weed control and in applying precision agriculture practices.

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SESSION 1 (Part II) - NON CHEMICAL WEED CONTROL AND INTEGRATED WEED MANAGEMENT IN VEGETABLES

European Weed Research Society Working Group Meeting:
"Weed Management Systems in Vegetables" and "Weed management in arid and semi-arid climate"

13 -15 May 2019, Oeiras, Portugal

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SESSION 2 (PART II) - WEED CONTROL IN ARID AND SEMIARID CONDITIONS

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TUBERS CHARACTERIZATION OF *CYPERUS ROTUNDUS* (L.) PALLA., EVALUATION AND EXTRACTION OF THEIR ESSENTIAL OIL PROPERTIES.

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Nutgrass, *Cyperus rotundus L.* (Palla), belongs to the third largest monocotyledonous family: Cyperaceae and it constitute the weedy plants with the highest presence in industrial horticulture crops, of great economic importance, in the agricultural fields of the Vale do Tejo. The tubers are characterized chemically by the presence of quinines, flavonoids and sesquiterpenes. Due to its chemical characteristics, a number of pharmacological and biological activities have been reported for this plant, including: anti-inflammatory, antimicrobial, antioxidant, antipyretic, antimalarial, among many others.

In order to determine and characterize the phytochemical composition of the essential oils (EOs), tubers were collected at a depth of 25 cm in two distinct geographical areas: Ribeira de Santarém (Santarém) and Valada (Cartaxo), in two periods (December and February).

The EOs were isolated by hydrodistillation from the tubers collected in December and January, in Ribeira de Santarém and Valada. It was obtained an average extraction yield of 0.08% and 0.07% on the tubers collected at Ribeira de Santarém in december and january and 0.1% and 0.08% at Valada on the same months.

Keywords: *Cyperus rotundus*; phytochemically composition; essential oil; hydrodistillation

WEED CONTROL WITH COMPOST: IMMEDIATE AND RESIDUAL EFFECT

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Stevia rebaudiana Bertoni is a promising crop for semiarid climates and coastal areas, like the Mediterranean basin, which includes the region of Algarve (south Portugal), where this work was developed. The objectives of this work were: 1) to compare the feasibility of the eco-friendly stevia weed control strategy with compost; 2) to identify the affected weed species; 3) to evaluate the effect of the type of compost application to the soil in two consecutive years.
Stevia was planted on a sandy soil, a haplic arenosol (Vt) on rows width 0,75 m, at the density of 44 500 plants ha^{-1}, with drip irrigation and weekly foliar fertilization.
Treatments consisted on the application of a 5 cm layer of compost (Nutriverde®), on soil surface (CS) or incorporated (CI), and no compost application (NC). On CS and CI treatments, compost was applied on a 0,5 m width, along plantation lines. The trial was set up in six randomized plots, of 3 m x 0.50 m each, with four replications, in a total of 24 plots. Each plot was divided into three subplots (0.90 m x 0.50 m), one plot per treatment (Fig. 1). During the trial period the weeds were regularly identified and quantified, on sampling areas of 0,45 m^2, one per subplot.
In the treatments with compost some weed species did no occur and others were significantly reduced, particularly when compost was used as mulch (CS). A few species occurred only in some compost treatments. For these reasons, weed control effectiveness with the compost is possible, but will depend on the local species. The application of compost to the soil increased the yield (fresh and total weight) and growth (plant height) of stevia, particularly when compost was applied on soil surface.
In the second year of the trial, the weeds increased in CI tratment, approaching the observation in NC treatment. CS continued to show the lowest numbers of weeds and the higher yield.
It was shown that compost can be an important tool to reduce weeds and contributing for an eco-friendly agricultural production of stevia.

Keywords: mulch, organic farming, *Stevia rebaudiana* Bertoni, eco-friendly

THE INTERFERENCE OF *LOLIUM RIGIDUM* L. WITH MALT BARLEY UNDER MEDITERRANEAN CONDITIONS. (continuation)

of inhibited root elongation and root diameter and area. We noticed a statistically important increase on the percentage of inhibition on rigid's ryegrass root growth, by increasing the number of barley seeds per beaker. More specifically, the highest inhibition was observed for 12 and 15 barley seeds per beaker with values of percentage reduction of root elongation, root diameter and root area, 26.24 % , 42.04% and 33.07% for 12 seeds and 39.73%, 47.45% and 31.56% for 15 seeds, respectively.
According with this research, the increasing barley's seed dose may affect the reduction of rigid ryegrass population with aim to be combined with other means in an integrated weed control.

Keywords: malt barley, rigid ryegrass, competitive potential, allelopathic potential, integrated weed management

*The experiment was funded by Athenian Brewery SA

THE INTERFERENCE OF *LOLIUM RIGIDUM* L. WITH MALT BARLEY UNDER MEDITERRANEAN CONDITIONS.

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Malt barley has in the last decade an increased importance for brewery industry in Greece. *Lolium rigidum* L. (rigid ryegrass) since four years is emerged in great populations reducing significantly the malt barley yields, while the registered herbicides are insufficient to control the weed. The aim of this study is to evaluate: i) the competitive potential of a new malt barley variety using higher crop density on rigid ryegrass occurrence as mean of an integrated weed management and ii) the allelopathic potential of the studied variety. The field experiments were carried out in the experimental farm of Agriculture University of Athens and the laboratory assays in the Laboratory of Agronomy.

In field experiment during the 2017- 2018 growing season, we evaluated the effect of a new malt barley variety (Planet) in two seed doses (140 and 200 kg/ha) on rigid ryegrass occurrence as well as on the barley yield and its qualitative traits. A randomized complete block design with 4 replications was used for the following experiment. Furthermore, we studied the following phenological and morphological traits in both barley and rigid ryegrass: growth rate of the biological cycles; height; number of tillers; and the rate of the height and tillers increase. We noticed that in higher crop density (299.47 plants/ m^2) the dry matter of rigid ryegrass was reduced significantly compared to the lower one (201.8 plants/m^2), with values 0.058 kg/m^2 and 0.0175 kg/m^2 respectively. Additionally, the highest population of rigid ryegrass with 54 plants/$m^2$was observed when barley was at the stage of booting. Concerning the growth rate, the differentiation between the two species was observed in the stage of tillering for both densities with barley having the highest rate, at significant statistically level, compared to rigid ryegrass with values, 0.446 and 0.412 respectively. The height of barley plants also showed higher values compared to rigid ryegrass in both densities, with values 61.075 cm for barley and 29.21 cm for rigid ryegrass in high seed density, whereas in low seed density the values of height were 58.85 cm for barley and 28.73 for rigid ryegrass, respectively. Seed dose had no effect on barley's yield and its qualitative traits.

We also evaluated the allelopathic effect of the studied variety on rigid's ryegrass seedlings. As a screening method we used the Equal- Compartment- Agar method (Wu *et al*., 2000). We studied the inhibitory effect of different number of barley seeds per beaker (1, 4, 8, 12, 15) on 12 seeds of rigid ryegrass. We evaluated the percentage

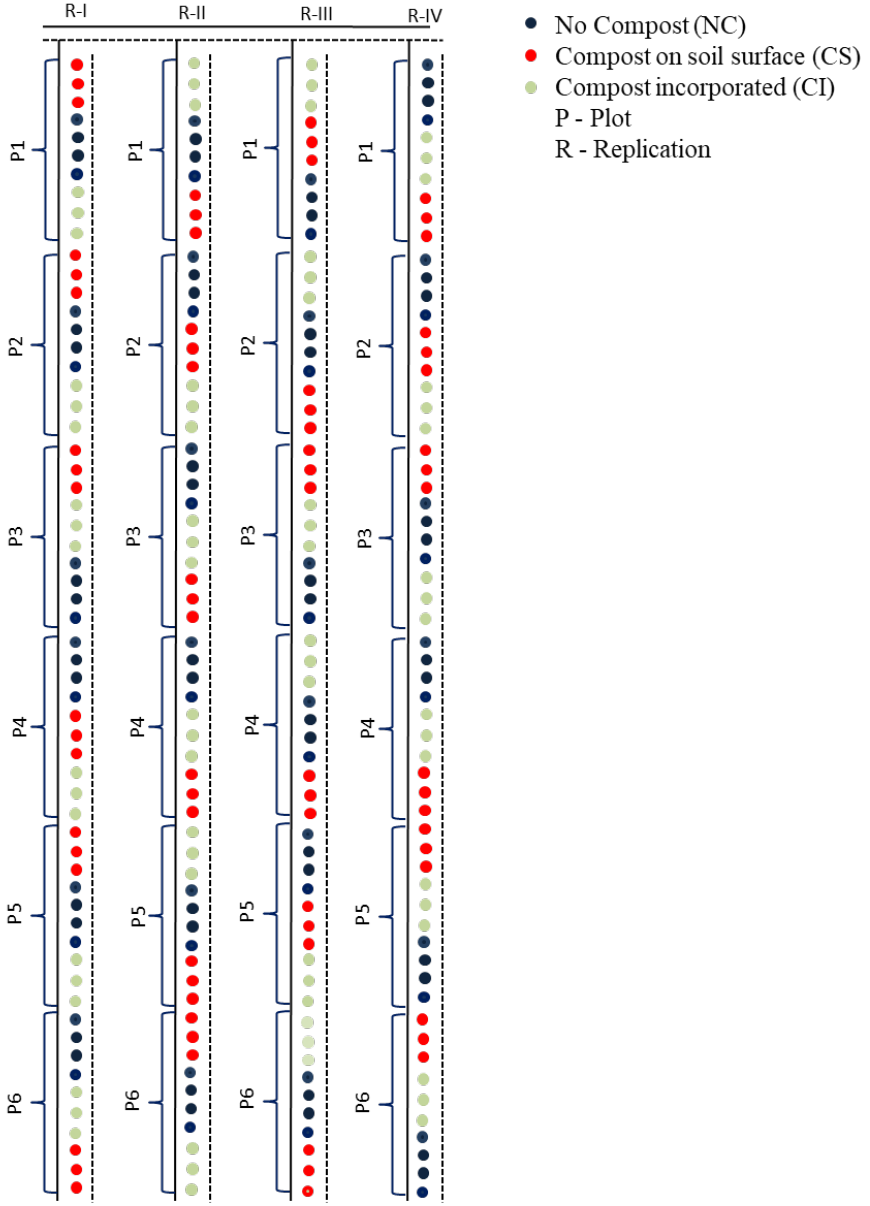

Figure1. Experimental design. Each coloured ball represents one stevia plant.

THE APPLICATION OF INTEGRATED WEED MANAGEMENT (IWM) IN OREGANO CROP. EVALUATION OF THE SYSTEM ON THE QUANTITIVE AND QUALITIVE CHARACTERISTICS OF THE FINAL PRODUCTS.

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Weeds constitute the major yield loss in oregano (*Origanum vulgare* L. subsp. *hirtum* (Link) Ietsw.). Therefore, the aims of this study were: a) to evaluate the efficacy and selectivity of mechanical, chemical and physical means against weeds, b) to investigate their impact on oregano yield and essential oil quality, c) to evaluate their possible use in an IWM program. Field experiments were conducted during 2014 and 2015 in Agrinio (Western Greece) and in A.U.A. The dominant weeds in Agrinio were *Cyperus rotundus* L. and *Sorghum halepense* Pers. whereas in A.U.A. were *Amaranthus retroflexus* L., *Tribulus terrestris* L., *C. rotundus* L. and *Malva sylvestris* L. A randomized complete block design was used in all experiments. In 2014, two pre-emergence herbicide applications, one post-emergence, two glyphosate rates, three flaming propane doses, weedy control and weed-free control (mechanical method) were evaluated. However, in 2015 the examined treatments were the pre-emergence application of metribuzin+pendimethalin at 0.14+0.1365 kg a.i. ha^{-1}, the post-emergence application of cycloxydim+metribuzin at 0.3 L + 0.175 kg a.i. ha^{-1}, the post-emergence application of glyphosate at 0.54 kg a.i.$ha^{-1}$and the propane flaming at the rate of 119 kg ha^{-1}. The treatments were evaluated by determining weed density and their dry matters, oregano herbage and essential oil yields. The results indicated that the post-emergence application of herbicide mixture or mechanical method gave similar weed control. In addition, these treatments increased oregano herbage and essential oil yields without any effect on the chemical profile of essential oils. Herbicide residues were not detected in any of the examined samples. In conclusion, mechanical mean or a reduced rate of post-emergence glyphosate application is qualified to be used in an IWM program for oregano as it controls annual and perennial weeds, reduces cost of weed control and has less herbicide impact on the environment.

FACTORS AFFECTING THE INFESTATION LEVEL OF TOMATO BY PHELIPANCHE RAMOSA

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There are 22 known Orobanchacea taxa in Portugal (Franco, 1970). Crenate broomrape (*Orobanche crenata* Forsk) L. attacks fabaceae crops, particularly faba bean (*Vicia faba* L.) causing serious yield losses since the 1970's. Recently hemp broomrape (*Phelipanche ramosa* L. Pomel; syn. *Orobanche ramosa* L.) was identified in tomato crop from Ribatejo, one of the most fertile agriculture regions in the country, however the precise origin of recent introduction is unkown. The potential spread of this holoparasite in broomrape free areas where potential host plants are grown constitutes an important issue. *P. ramosa* occurrence in tomato fields is the result of an interaction of biotic and abiotic factors together with agronomic factors related to cropping system.
Farmers have often to deal with high yield losses due to the lack of effective mangement measures. A survey to assess the distribution and importance of hemp broomrape in intensive tomato cropping system in Ribatejo, was carried out with a questionaire to 30 farmers (100 fields). Questions adress critical agronomic factors such as cropping system (monoculture vs rotation), weed management practices for the last five years and also farmers perception on importance of particular weeds. The results of the questionnaire survey will be correlated with field surveys on floristic composition and structure of tomato fields to point out in which part of the technical profile the farmers must change agricultural practices. This study is part of a larger project on sustainable production of intensive horto industrial crops from Ribatejo (EPI-PDR2020 030857, HORTINF).

Keywords: plant parasite, Orobanchaceae, integrated weed management

Moreover, loss of apical dominance and early initiation of reproductive structures were observed in glyphosate-treated plants grown under high temperature combined with elevated CO_2 level. To investigate the physiologic mechanism of reduced glyphosate sensitivity, translocation was examined using ^{14}C-glyphosate.

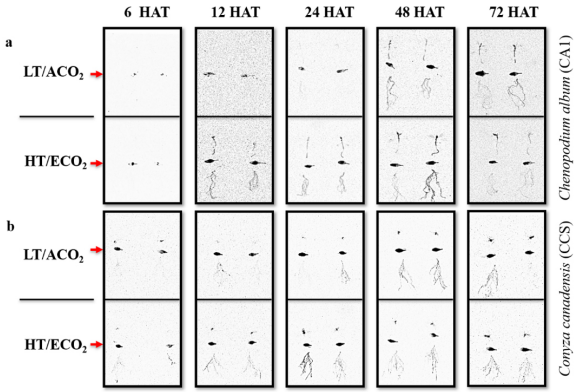

Figure 2. Phosphor images of ^{14}C-glyphosate translocation in plants of *C. album* (**a**) and *C. canadensis* (**b**) grown under different environmental conditions and harvested at 6, 12, 24, 48 and 72 hours after treatment (HAT) with glyphosate. LT/ACO_2 - Low temperature (18/12°C) combined with Ambient CO_2 (400 ppm), HT/ECO_2 - High temperature (32/26°C) combined with Elevated CO_2 (720 ppm). Plants were divided into three parts: treated leaf (indicated horizontally by the red arrow), shoot (above treated leaf), and roots (below treated leaf) prior to imaging (adapted from Matzrafi et al., 2019).

In plants that were subjected to high temperatures and elevated CO_2 level, glyphosate was more rapidly translocated out of the treated leaf to shoot meristems and roots than in plants grown under control conditions (Fig. 2). These findings suggest that the environmental conditions both at and after herbicide application should be considered before treatment. Additional information on the herbicide label that states the optimal recommended environmental conditions after herbicide application may help to reduce future weed control failures under the projected climate change, of higher temperature and CO_2 level.

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PROPANE BASED FLAMING- ALTERNATIVE MEAN TO CONTROL WEED IN DIRECT SEEDED ONION (*ALLIUM CEPA* L.)

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Onion (*Allium cepa* L.) is an important vegetable crop in Israel and many parts of the Mediterranean region. Its leaf morphology and low vigorous make him a weak competitor with weeds. Moreover, the reduction in herbicide availability due to regulation requires adoption of alternative weed control methods. Propane flaming is an alternative strategy to control weeds in onion. However, most studies were held on transplanted onion and there is no information about the safety of this method on direct seeded onion. Thus, our objectives were to: 1. characterize the time window for safe flaming application in direct seeded onion, 2. evaluate the tolerance level of various onion varieties for flaming. For these purposes, six onion varieties were grown in a net-house and flamed at different phenological stages (pre-emergence, flag-leaf, 2nd, 3rd and 4th true leaf) using a single propane dose (1.45 kg km^{-1}). Then, field validation was held using the tolerance cultivars. In the net-house, the pre-emergence treatment resulted with no biomass reduction, while at the flag leaf treatment >95% biomass reduction was observed for all varieties. At the first and second true leaf treatments a great difference in the tolerance of the tested onion varieties was observed, starting from complete tolerance (0% biomass reduction) and up to completed susceptibility (95% biomass reduction). The field validation revealed that safe flaming treatments can be used starting from the 3rd leaf stage. Our results demonstrate the potential use of flaming for weed control in onion and the importance of setting an accurate time window and propane doses to ensure the crop safety.

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Herbicide efficacy is strongly associated with environmental conditions thus it is important to maintain appropriate environmental conditions at the time of herbicide application. In recent years, we have witnessed an increase in extreme weather events, associated to climate change and, at the same time, an increase in reports on reduced herbicide sensitivity under unfavorable environmental conditions. In general, high temperatures and elevated CO_2 levels were shown to reduce herbicide efficacy, however, herbicide response in different environment conditions seems to be dependent on active ingredient and on species or biotypes (R/S) (Matzrafi, 2018). In our study, populations of two annual weed species, *Chenopodium album* (CA1) and *Conyza canadensis* (CCS), were tested. Populations were collected in areas where no herbicide resistance was previously reported. Plants were treated with glyphosate at the labeled field rate (867 g ae ha^{-1}) and grown under controlled conditions with different temperatures and CO_2 levels.

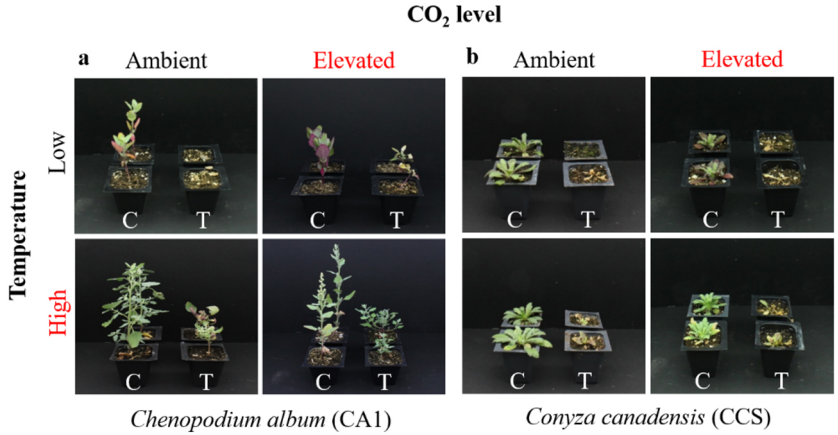

Figure 1. Plant response to glyphosate under different environmental conditions, at 21 days after treatment (DAT). Glyphosate-treated (T) and untreated (C) plants from population CA1 of *C. album* (**a**) and population CCS of *C. canadensis* (**b**) grown under different temperatures and CO_2 levels. Low temperature = 18/12°C, High temperature = 32/26°C, Ambient CO_2 = 400 ppm and Elevated CO_2 = 720 ppm (adapted from Matzrafi et al., 2019).

Reduced glyphosate sensitivity was found in both *C. canadensis* and *C. album* in response to high temperatures, enriched CO_2 levels, and the combination of both treatments (Fig. 1).

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WORKSHOP ON PARASITIC PLANT MANAGEMENT UNDER MEDITERRANEAN CLIMATE

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RESISTANCE RISK ASSESSMENT FOR ALS INHIBITING HERBICIDES IN RICE WEEDS

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Rice cropping systems in south of Portugal, account for 40 % of total area and are located in a transition area from semi-arid to sub humid region (581 mm annual precipitation). Salt and weeds are the main constraints to rice production. *Echinochloa* species are the most problematic weeds in rice, particularly late watergrass (*E. phyllopogon*) populations resistant to ALS-inhibiting herbicides.
A herbicde resistance survey to assess resistance risk in this area was carried out with a questionnaire to 30 rice producing farmers. Questions adressed critical agronomic factors such as cropping system (monoculture vs rotation) herbicide history (same or different MOA, mixtures and sequences) weed management practices and water management for the last five years and also farmers perception on herbicide efficacy to particular weeds. The results of the questionnaire survey will be correlated with suspected and confirmed cases of herbicide resistance in the same rice fields. This study is part of a larger project on sustainable production of rice in Portugal (EPI-PDR2020 031998).

Keywords: E*chinochloa phyllopogon*

BIOLOGY AND MANAGEMENT OF EGYPTIAN BROOMRAPE (*Phelipanche aegyptiaca)* IN CABBAGE (*Brassica oleracea* var. *capitate)*

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Cabbage (*B. oleracea* var *capitate*), a biennial crop belonging to the Brassicaceae family. In Israel alone 2,200 hectares of cabbage are been cultivated. Egyptian broomrape (*Phelipanche aegyptiaca*), a member of the Orobanchaceae family, is a parasitic plant that considered as a main troublesome weed in vegetables and field crops around the world and causes severe yield loss. Broomrape germinates and attaches to the cabbage roots in responds to chemical compounds that are exudes from the cabbage roots to the rhizosphere. Once established, the broomrape becomes a major sink that draw all its growth requirements from the host resulting with crucial damage to the host plant. One of the most effective ways to manage broomrape in the field is applying herbicides. In this work two herbicides (glyphosate and ethametsulfuron-methyl) were examined for crop selectivity and broomrape control efficacy in cabbage at the sub-surface broomrape's developmental stages. The main objective of this research is to develop a decision support system for broomrape management in cabbage, using the following sub-objectives: (1) characterizing the parasitism dynamics in the soil sub-surface stages; (2) detecting herbicides which will not harm the cabbage but will be toxic for the attached broomrape; (3) characterizing the cabbage root exudates which stimulates the broomrape germination. In addition to growing the cabbage with the broomrape in different temperature regimes in growth chambers, we employed minirhizotron camera, which allows non-disturbing observations upon the broomrape development in situ (in the soil subsurface in the field), to characterize the broomrape parasitism dynamics. Another objective is to compare different varieties of cabbage for and examine their susceptibility to different broomrapes collected from different hosts. Our results show that (1) glyphosate under a rate of 72 gr ha^{-1} and ethametsulfuron methyl in all rates cause no harm to the cabbage but effectively controlled Egyptian broomrape. (2) *P. aegyptiaca* seeds that were collected from cabbage infected field germinate on cabbage's roots in higher rate than *P. aegyptiaca* seeds that were collected from *P. aegytiaca* infected to other crops. *P. aegyptiaca* germinate at the presence on the cabbage's roots between in temperature range of 12-30^{0}C. However, the optimal temperature growth for the host and the parasitic is (day/night) 24/18^{0}C.

NEW IMAGE-DRIVEN METHODOLOGIES FOR EARLY BROOMRAPE DETECTION PARASITISM

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Broomrapes are root parasitic weeds that cause severe damage to dicotyledonous crops worldwide. Herbicide application on a field scale can effectively control them, but increasing public concern over environmental pollutions motivates adoption of precise weed management practices. The main challenge in developing such methods lies in the fact that most of the broomrapes life-cycle occurs underneath the soil surface, and by the time their shoots emerge, the damage for the crop has already been done. Detection of their early impact in a pre-emergent stage is vital. The objective of this presentation is to view state of the art image-driven models for early broomrape detection that are based on hyperspectral and 3-D plant morphological analysis. We further detail our study that evaluated new 3-D modeling approaches for that purpose and demonstrate how 3D growth parameters (extracted via 3-D sensing techniques) of the crop can indicate broomrape infection. Additionally, we show how application of 3-D segmentation methodology allowed estimation of organ-level parameters which were more affected by the broomrape infection. We discuss the potential field applicability of this new 3-D detection model and compare its advantages/disadvantages to the hyperspectral-based detection approach.

MODELING EMERGENCE OF FIVE CALIFORNIA WEEDY RICE ACCESSIONS UNDER VARIOUS FLOODING AND BURIAL DEPTHS (continuation)

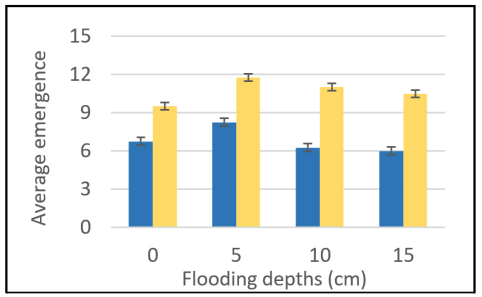

Figure 1. Average emergence of Type 3 (yellow bars) compared with the control (blue bars) under various flooding depths at 1.3cm burial depth.

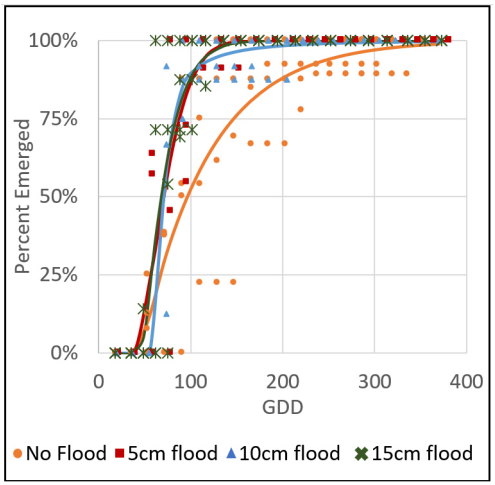

Figure 2. GDD required for type 3 to achieve emergence under various flooding depths at 1.3 cm burial depth.

Conclusions

For growers' immediate need to control weedy rice, this experiment demonstrated the greatest reduction in emergence with both tillage and flooding depths greater than 5cm. The GDD model will be combined with the results of a future germination experiment to create a hydrothermal time (HTT) model. This HTT model will provide a more accurate depiction of when weedy rice is germinating and emerging in real-time the field. This data will be validated during the 2019 and 2020 growing season to ensure accuracy of both the GDD and HTT models.

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Linquist, B., Al-Khatib, K., Swett, C., Espino, L., Leinfelder-Miles, M., Brim-DeForest, W., & McKenzie, K. (2018). Rice Production Manual. Davis, CA.

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This process allowed for successful germination of all rice accessions. Four flooding depths of 0, 5, 10, 15 cm in combination with four burial depths of 1.3, 2.5, 5, and 10 cm were arranged in a randomized complete block design using 45.7 x 66 x 38 cm clear, polycarbonate tubs. Each block contained 15 pseudo-replicates of each rice accession with four replicates per treatment combination. HOBO Pendant® Data loggers were placed in one replication of each treatment combination to determine water temperature over time. Emergence, defined by a visible cotyledon of 5mm at the soil surface, was collected daily for 21 days. Once the experiment was complete, plants were harvested at the soil surface, placed in paper bags separated by block and accession, and dried at 70°C for 3 weeks to collect dry-weight data. Once the experiment was complete, the data was subjected to an ANOVA and Tukey's HSD using R software to determine the treatment effects on rice accession emergence; preliminary GDD models were created using Microsoft excel.

Results and Discussion

Burial depth played a more significant role in reducing total emergence compared with flooding depth. None of the rice accessions were able to emerge from burial depths deeper than 5cm, and 1.3cm yielded the highest emergence, shown in figure 1. More rice accessions, including M206, emerged from the 5cm flooding depth compared with any other flooding treatment.

Figure 1. Average eergence of Type 3 (yellow bars) compared with the control (blue bars) under various flooding depths at 1.3cm burial depth. A Weibel model was used to best fit the data to create the GDD prediction, shown in figure 2. In general, the presence of flooding increased the velocity of emergence compared with no flood, i.e. flooding accelerated GDD to emergence for type 3. These findings could be due to the selection pressure from long-term, continuously flooded fields as well as aerial seeding methods.

SESSION 1 (Part III) - NON CHEMICAL WEED CONTROL IN CEREALS AND INVASIVE WEEDS

European Weed Research Society Working Group Meeting:
"Weed Management Systems in Vegetables" and "Weed management in arid and semi-arid climate"

13 -15 May 2019, Oeiras, Portugal

MODELING EMERGENCE OF FIVE CALIFORNIA WEEDY RICE ACCESSIONS UNDER VARIOUS FLOODING AND BURIAL DEPTHS

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Introduction

California growers have unique production methods compared to other rice growing regions of the world including aerial seeding and continuous annual flooding. Reduced weed pressures, including weedy rice (*Oryza sativa* L. *spontanea*), have been historically credited to the continuous flooding practices as well as voluntary adherence to purchasing certified seed (Linquist et al., 2018). However, a 2016 survey found 4,000 infested hectares with likely additional under-reported populations due to weedy rice similarities with herbicide-resistant *Echinochloa crus-galli* (Espino, et al., 2017). Five phenotypically distinct accessions of weedy rice, simply referred to as type 1, 2, 3, 4, and 5, respectively, were identified as the dominant accessions across all farms surveyed. Because deep-tillage is a common and necessary practice, seed bank management became a priority for long-term mitigation due to the high shattering rate of weedy rice (Rathore et al. 2013). Currently, there are no herbicides available for controlling weedy rice in California, so alternative ecological approaches are necessary for reducing weedy rice in growers' fields. Besides cultural practices such as hand-weeding, growers are able to utilize deep flooding depths of up to 30 cm to reduce weed pressures. The objective of this experiment was therefore to determine which burial and flooding depths would promote the emergence of weedy rice. Additionally, the data from this experiment was compiled into a preliminary growing degree day (GDD) model in order to increase efficiency of management strategies for weedy rice.

Methodology

All five weedy rice accessions as well as M206, a commonly cultivated variety of rice in California used for comparison, were sown into soil collected from the Rice Experiment Station in Biggs, California. Dormancy of all weedy rice accessions was broken by enclosing seeds in plastic bags and placing them in a dark incubation chamber at 50°C for five days; once this step was complete, all rice accessions including M206 were wetted with deionized water in the same plastic bags and placed back into the dark incubation chamber for three days at 30°C.

INFLUENCE OF SEASONAL RAINFALL AND DIFFERENT TILLAGE SYSTEMS ON THE TOTAL WEED DENSITY AND WHEAT YIELDS IN MONOCULTURE *VS.* ROTATION

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The soil moisture regime in semiarid Mediterranean cereal systems depends on several variables including precipitation (annual and seasonal, soil composition and agricultural practices and the agro-ecosystem (crop + weeds).
We compared wheat crops and weed density over two years (2014-2015 and 2015-2016). We looked at monoculture vs. rotation systems (wheat, fallow, barley, vetch) under 3 different systems of soil management (conventional tillage, minimum tillage and no tillage).
Both years had a total rainfall of around 300mm per year but with totally different seasonal distribution. In the first year, 2014-2015, it was rainy in autumn (145 mm) whereas winter and a spring were relatively dry (120 mm in 6 months). In 2015-2016 the opposite happened, autumn was very dry (44 mm) and there higher levels of precipitation in winter and spring (247 mm in 6 months).
We studied the effects on wheat yields and weed populations (density), comparing the year, the soil tillage system and the cropping system. Tillage and cropping systems affected wheat yields and the accumulate rainfall until March (time of weed sampling) influenced the weed density. Mediterranean climate under semiarid conditions affects the weed populations and the combination of different agronomic practices in the field lead to changes on weeds.

A DEMOGRAPHIC ROLE FOR HYBRIDIZATION IN BIOLOGICAL INVASIONS

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The anthropogenic-mediated introduction of exotics has brought into contact taxa that have been otherwise separated by geographical barriers for millennia. This novel encounter, contingent on the degree of reproductive isolation, can result in hybridisation between introduced and resident species (either native or another colonizer). While the stimulating effect of hybridization in driving biological invasions has almost exclusively been attributed to genetic mechanisms enhancing "invasiveness" of hybrid lineages, here we show hybridization can facilitate the establishment and speed up the spatial range expansion of invasive species through a purely demographic mechanism without the requirement for any local adaptations. As the founding population in most new species introductions is likely to be small, the colonizer is susceptible to demographic Allee effects driven by pollen or mate limitations. Using a plant population simulation model, coupled with empirical data from the invasion, two Cakile species (*C. maritima* and *C. edentula*; Brassicaceae) in Australia, we show that Allee effects can potentially be overcome via neutral hybridization with a resident species. Conservation programmes should therefore account for this cryptic role that hybridisation could play in biological invasions.

TEMPERATURE-BASED PREDICTION MODEL FOR *AMBROSIA CONFERTIFLORA* DEVELOPMENT

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Ambrosia confertiflora (DC.) Rydb. (Synonyms: *Franseria confertiflora* (DC.) Rydb.; *Franseria tenuifolia* Harv. & Gray) is an invasive perennial plant species considered among the most troublesome weeds worldwide. This noxious weed causes severe damages in agriculture, nature reserves, roadsides and disturbed areas. The plant species has two reproductive strategies, by seed and by vegetative propagation true its rhizome. Since the biological data about this weed is limited, our objective was to develop thermal growing-degree-day (GDD) models for predicting seed germination and rhizome emergence under constant temperature regimes. For germination, the base temperature was 6°C, with an optimum temperature of 26°C. Seed germination was completely inhibited at temperatures over 36°C. Germination under controlled conditions was best explained as a function of GDD by a sigmoidal Log-logistic regression (RMSE=5.73). According to the prediction model, germination began at 50 GDDs and maximal germination occurs at 450 GDDs. For rhizome emergence, the base temperature was 11°C, with an optimum temperature of 17°C and maximum temperature of 28°C. This process was best explained as a function of GDD by a logistic equation (RMSE=10.54). According to the prediction model emergence from rhizome began at 30 GDDs and continued until maximal emergence at 120 GDD. Rhizomes were also buried in different depths: 0, 2, 4, 6 and 8 cm to calculate the thermal time for the production of new shoots from different depths. Shoot emergence from rhizomes was best explained as a GDD function by a three-parameter logistic equation (RMSE=3.22). According to the prediction model, 110 GDDs after planting, new shoots began to emerge from all examined depths (plowing layer). From these prediction models, it is clear that the temperature is in strong association with the above ground and sub-surface development of *A. confertiflora*. The quantification of the different interactions on a time scale of GDD can serve as an efficient tool for *A. confertiflora* control.

INTEGRATED WEED MANAGEMENT THROUGH GENETIC WHEAT ARCHITECTURE MANIPULATIONS

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Weeds are a major biotic factor affecting wheat (*T. aestivum*) quantity and quality yield. Most wheat varieties are semi-dwarf and characterized by slow growth rate and low competitive ability with weeds. Developing new wheat varieties with faster growth (i.e. early vigor) can improve their competitiveness ability. The aims of the current study were to (***i***) evaluate the competitiveness ability of early vigor wheat varieties, and (***ii***) characterize the spatial morphologial that contribute to their competitiveness ability. To test the weed\crop competitiveness potential of early vigor trait, we compared triticale (*T. triticale*) variety, X1010 (high early vigor), commercial triticale (low early vigor) and near isogenic wheat lines (NILs) with early vigor. In addition, spatial morphological were extracted and evaluated using 2D and 3D image driven models. Weeds biomass production was 40% lower (P=0.001) under competition with high early vigor triticale as compared to low vigor triticale. The morphological traits that contributed to competitive ability of early vigor triticale were volume, perimeter and coverage area of the canopy. Screening of NILs with various genetic backroads reveal-the NIL-OC1 had a significant advantage in rate establishment over its recurrent parent Omer. therefore, we continued with this NIL to field-based evaluation. Under field conditions the development of weeds was 15% lower (P=0.003) under competition with the NIL OC1 as compared to Omer. In addition, three weeks after wheat germination, OC1 development was significantly higher in terms of coverage area indicating on the relationship between early vigor and the competition ability. This results shows the contribute of early vigor variety for suppress weeds in integrated weed management. Additionally, Close and remote sensing can facilitate Identification of variety with improved competition ability.