





BOOK OF ABSTRACTS

Scientific Workshop on Parasitic Plants Orobanche/Phelipanche spp.



Organised by ZeroParasitic Project

Tunis (INRAT), 14-16 March 2023



Edited by Mohamed Kharrat & Dimosthenis Chachalis



Table of content

Session 14
Progress in Exploring Resistance Mechanisms to Parasitic Weeds4
Different broomrape species discrimination by HRM analysis and host (tomato) differential gene expression of parasite responsive genes5
<i>Solanum</i> biodiversity for providing broomrape resistance in tomato and the underlying plant- parasite molecular communication6
Phenotypic partial resistance screening to broomrape of chickpea (<i>Cicer arietinum</i> L.) collection in Tunisia7
Prospection of some resistance mechanisms to <i>Orobanche foetida</i> and <i>O. crenata</i> in faba bean Tunisian varieties and breeding lines8
Session 29
Progress in Breeding for Resistance to Orobanche spp. and Phelipanche spp9
Breeding for resistance to <i>Orobanche</i> spp. in faba bean (<i>Vicia faba</i> L.) in Tunisia: More than thirty years' experience of an active research program in the Mediterranean region
Fba bean breeding for tolerance to broomrape11
Molecular defence triggers of <i>Phelipanche</i> and their recognition by tomato receptors12
Field screening and management of 12 tomato land races for detection of resistance to orobanche
Response of some Tunisian sunflower (<i>Helianthus annuus</i> L.) accessions to <i>Orobanche cumana</i> Wallr. Parasitism14
Session 315
Parasitic Weed Management and IPM Approaches to Combat Parasitism15
Approaches to reduce parasitism by the broomrape <i>, Orobanche crenata</i> Forsk in faba bean (<i>Vicia faba</i> L.) fields
Utilising stimulants and biocontrol agents to manage broomrape parasitism17
Control of <i>Orobanche foetida</i> in faba bean (<i>Vicia faba</i>)18
Over a decade of research on biocontrol of broomrape in Tunisia and Algeria : achievements and prospects
Status and management of parasitic weeds of food legumes in the highlands of Ethiopia21
New insights into the cardiopreventive activities of two parasitic plants: <i>Orobanche</i> and <i>Cuscuta</i>
Session 423
Diversity and Distribution of Parasitic Plants and Tools for Surveillance23
Genetic diversity and population structure of Orobanche spp. et Phelipanche spp. from Tunisia24
Local sensing technologies (UAV _s) to study broomrape parasitism in industrial tomato





Session 1

Progress in Exploring Resistance Mechanisms to Parasitic Weeds



Different broomrape species discrimination by HRM analysis and host (tomato) differential gene expression of parasite responsive genes

<u>M. Gerakar</u>i¹, I. Fotou¹, I. Naoumis¹, V. Kotsira², S. Tastsoglou², D. Chachalis³, A. G. Hatzigeorgiou², A. Kapazoglou⁴, E. Tani¹

¹Laboratory of Plant Breeding and Biometry, Department of Crop Science, Agricultural University of Athens, IeraOdos 75, 11855 Athens, Greece ²DIANA-Lab, Department of Computer Science and Biomedical Informatics, Univ. of Thessaly, 351 31 Lamia, Greece ³Benaki Phytopathological Institute, 8 Stefanou Delta str., Kifisia, 14561, Athens, Greece

⁴Institute of Olive Tree, Subtropical Crops and Viticulture (IOSV), Department of Vitis, Hellenic Agricultural Organization-Di mi tra (ELGO-Dimitra), Sofokli Venizelou 1, Lykovrysi, 14123 Athens, Greece Corresponding author email: <u>mgerakari@hotmail.com</u>

Phelipanche spp. is a holoparasitic weed, widely distributed across Mediterranean countries, as well as in countries of Western Asia and is one of the major enemies of many cultivated of high economic importance such as tomato (Solanum lycopersicum). The development of tolerant varieties to this parasitic weed through breeding efforts is a difficult task due to the complexity of the mechanisms that render resistance, its complicated physiology and the low coefficient of heritability of resistance. Various weed management strategies have been applied to control effectively this parasitic weed but in the majority they failed. Nevertheless, the most sustainable, economic, and effective method of dealing with the problem seems to be the breeding approach. The first approach is through the development of molecular tools aiming at the identification of the infectious strains of *Phelipanche* species and the detection of genetic diversity between the different strains through the HRM (high resolution melting) technique. HRM is a highly accurate assay, allowing the detection of genetic variations as small as single base polymorphisms (Single Nucleotide Polymorphism-SNP). The second approach is through screening and comparative evaluation of tomato introgression lines and commercial hybrids, potentially resistant to broomrape was carried out, combining high throughput techniques (Next Generation Sequencing-NGS) as well as low throughput techniques (qPCR) for further validation of the most promising Differentially Expressed Genes-DEGs, aiming to identify genes related to tomato resistance against broomrape. One of the main scopes of the second approach is to unravel genes with significant differences in expression between tolerant and sensitive tomato genotypes and to further study their mode of function, aiming at their exploration in to breeding programs.

Keywords: Phelipanche, sequencing, qPCR, HRM

The research work was partly supported by the Hellenic Foundation for Research and Innovation (HFRI) under the 3rd Call for HFRI PhD Fellowships (Fellowship Number: 118.0005).



Solanum biodiversity for providing broomrape resistance in tomato and the underlying plant-parasite molecular communication

<u>Purificación Andrea Martínez-Melgarejo</u>, Maialen Ormazabal, Cristina Martínez-Andújar, Francisco Pérez Alfocea

Department of Plant Nutrition, CEBAS-CSIC, Murcia, Spain Corresponding author email : <u>alfocea@cebas.csic.es</u>

The broomrape species *Phelipanche ramosa* (L.) is a root holoparasitic plant that is widespread in Mediterranean countries and causes severe damage to crops of great economic importance such as the tomato (Solanum lycopersicum L.). Breeding for resistance is one of the most promising strategies to alleviate such issues but the success of this approach has been hampered by the scarce knowledge about the molecular and genetic basis involved in defence mechanisms against parasitism, and the limited availability of sources of tolerance identified in tomatoes so far. However, an advantage of the tomato, as some other horticultural species, is that the varieties of agronomic interest can be grafted onto rootstocks conferring tolerance to biotic and abiotic factors, which opens an interesting empirical perspective for a direct alleviation of this problem in the tomato crop and other graftable species. From a scientific perspective, grafting onto tolerant rootstocks also offers a specific root-targeted approach to gain insights about the physiological, molecular, and genetic components of such resistance. With both empirical (to identify resistant rootstocks) and scientific (to identify underlying mechanisms), a wide collection of *Solanum* species and accessions is being prospected in the frame of Zeroparasitic project. The assessed germplasm collection includes: S. galapagense, S. peruvianum, S. chilense, S. chmielewskii, S. pennellii; introgression lines derived from S. lycopersicum cv M82 and S. pennellii acc. LA716, and their parental lines; mutants affected in the broomrape germination promoting hormone strigolactones (CCD7, ST1); and other relative species such as S. melongena and S. aethiopicum. Initial in vitro screening experiments based on *P. ramosa* germination and infection capacities identified five genotypes as totally resistant, four with high-medium resistance and the rest as sensitive. Those results were further confirmed under greenhouse conditions. To test the initial hypothesis that those lines could transfer the resistance level to a tomato cultivar, all the resistant and some sensitive genotypes were used as rootstocks of the sensitive commercial variety cv Moneymaker. To better understand the mechanisms involved in the rootstock-conferred resistance, root and broomrape tissues in the broomrape-plant interface are being analysed in order to identify particular hormonal patterns (strigolactones, cytokinins, auxins, abscisic acid, jasmonic acid, salicylic acid, gibberellins and ethylene precursor ACC) that could explain the observed tolerance or sensitivity traits.

Keywords : Phelipanche ramosa, Solanum lycopersicum, plant hormones, rootstocks.



Phenotypic partial resistance screening to broomrape of chickpea (*Cicer arietinum* L.) collection in Tunisia

Mustapha Rouissi¹, Khalil Khamassi², Ghassen Abid³, Mahmoud Mhamdi^{4,5}

¹University of Carthage, Institut National de la Recherche Agronomique de Tunisie (INRAT), Agricultural Applied Biotechnology Laboratory (LR16INRAT06), Rue Hédi Karray, 1004 Menzah 1, Tunis, Tunisia ²University of Carthage, Institut National de la Recherche Agronomique de Tunisie (INRAT), Field Crop Laboratory (LR16INRAT02), Rue Hédi Karray, 1004 Menzah 1, Tunis, Tunisia ³Centre of Biotechnology of Borj-Cedria (CBBC), Legumes and Sustainable Agrosystems Laboratory, P. B. 901, Hammam-Lif 2050, Tunisia ⁴University of Carthage, National Agronomic Institute of Tunisia, Horticultural Science Laboratory, 43 Av. Charles Nicole 1002, Tunis, Tunisia ⁵University of Sousse, Institut Supérieur Agronomique de Chott-Meriem, 4042, Sousse, Tunisia Corresponding author email : mustapha rssi@yahoo.fr

Chickpea is the second grain legume grown in Tunisia. It plays an important role in crop rotations through the biological nitrogen fixation. It is also an interesting source of protein for human nutrition balance. However, the development of chickpea has been constrained with several biotic pathogens and parasitic weeds. The attack by the parasitic plant *O. foetida* is one of the emerging problems in the favourable regions of the north-west of the country. An international and old landraces collection of chickpeas was screened in the field and controlled condition on Petri dishes for their resistance levels to *O. foetida*. The results showed a significant variability regarding the resistance behaviour of the different studied genotypes to *O. foetida*. The variety 'var 15', which is the most cultivated in Tunisia 'Beja1', showed a moderate level of sensitivity compared to the tested genotypes. The variety 'ACC14' is the most resistant to attack by the parasitic plant followed by 'ACC21' and 'ACC23'.

Keywords : Cicer arietinum L., Chickpea, Orobanche foetida, resistance.



Prospection of some resistance mechanisms to *Orobanche foetida* and *O. crenata* in faba bean Tunisian varieties and breeding lines

Imen Trabelsi¹, Zouhaier Abbes², Moez Amri², Mohamed Kharrat²

¹Agronomic Sciences and Techniques Laboratory, INRAT, Rue Hédi Karray 1004 El Menzah Ariana, Tunisia ²Field Crop Laboratory, Carthage University, INRAT, Rue Hédi Karray 1004 El Menzah Ariana, Tunisia Corresponding author email : <u>trabelsiimen11@yahoo.fr</u>

Broomrapes (Orobanche and Phelipanche spp.) are weedy devastating root parasitic plants. They are causing enormous yield losses for many food crops. In absence of effective control methods, breeding for resistance remains the most promising and easy control strategy. Breeding efforts made in several countries led to the development of partially resistant cultivars. Four varieties with good resistance levels were recently released in Tunisia; Najeh (2009), Chourouk (2015), Chams (2017) and Zaher (2018). Some of those varieties and selected lines were subjected to a series of experiments under field and control conditions to explore some potential resistance mechanisms. Under high infested field conditions, results showed that the seed yield for these resistant varieties and lines was less affecte d by the parasite compared to the susceptible check. This could be associated with the low infestation level expressed mainly by the low tubercle numbers and emerging Orobanche spikes dry weights. The mini-rhizotron experiments showed that the low induction of seed germination and the small number of attachments and the delay of their development are major components of resistance in these varieties and lines to O. crenata, and O. foetida. This was confirmed by root exudates experiments where three strigolactones (SLs) were detected, Orobanchol, ent-2'-epiorobanchyl acetate and unknown SLs with high production levels in the susceptible check compared to the resistant ones.

Keywords: Faba bean, Orobanche crenata, Orobanche foetida, resistance, strigolactones, Vicia faba.



Session 2

Progress in Breeding for Resistance to Orobanche spp. and Phelipanche spp.



Breeding for resistance to *Orobanche* spp. in faba bean (*Vicia faba* L.) in Tunisia: More than thirty years' experience of an active research program in the Mediterranean region

<u>Mohamed Kharrat</u>¹, Moez Amri², Khalil Khamassi¹, Zouhaier Abbes¹, Imen Trabelsi¹, Laila Dakhli², Hamadi Ben Salah¹

¹Institut National de la Recherche Agronomique de Tunisie, Laboratoire des Grandes Cultures, Université de Carthage, Rue Hédi Karray 1004 Tunis, Tunisie ²Centre Régional de Recherche sur les Grandes Cultures de Béja, Laboratoire des Grandes Cultures, Route de Tunis Km 5, Béja, Tunisie Corresponding author email : kharrat.mohamed@inrat.ucar.tn

Breeding for resistance to broomrapes (Orobanche spp.) in faba bean (Vicia faba L.) in Tunisia was initiated in the late 1980s. The first research activities started with large screening and evaluation of local and introduced germplasm through ICARDA for identification of potential resistance sources. This resulted with the selection of four lines which were preselected in Latakia (Syria) and Cordoba (Spain) and derived from crosses performed in Cordoba using the Egyptian resistant line F402 (Giza 402). The Tunisian faba bean hybridization program started with the first crosses in 1990 using the selected lines and local small seeded Tunisian populations. The selection in segregating generations was done at Beja Research Station in a naturally infested field by Orobanche foetida under insect proof tunnels for at least six generations using the pedigree method. Lines showing better resistance levels compared to the resistant parents were selected, increased and evaluated for their agronomic performances in preliminary and multilocation advanced yield trials. Superior lines with good resistance to Orobanche and high agronomic performances were proposed for registration in the National Plant Varieties Catalogue. The programme released four faba bean varieties carrying good resistance to Orobanche : cvs. Najeh, Chourouk, Chams and Zaher registered in 2009, 2015, 2017 and 2018, respectively. Najeh, Chourouk and Zaher are small seeded faba bean (FBSS) varieties while Chams is an equina type. The last released variety "Zaher", combines resistance to broomrape with the good nutritional quality trait low tannins. All these varieties are commercialised by seed companies and largely adopted by farmers. Recently, the program also adopted the recurrent selection through poly-cross strategy in specific gene pools regrouping most of Orobanche resistant sources and other sources of potential important agronomic traits (seed size, quality, disease resistance ...). Through this method, the programme succeeded to develop five superior large seeded broomrape resistant faba bean genotypes that will be proposed for registration in coming years.

Keywords: Orobanche, faba bean, resistance, breeding, Tunisia



Faba bean breeding for tolerance to broomrape

L. Ghaouti, Z. Forahi, R. Mentag

Department of Production, Protection and Plant Biotechnology, Institut Agronomique et Vétérinaire Hassan II, B.P. 6202, Rabat-Instituts, Morocco Corresponding author email : <u>lamiaeghaouti@gmail.com</u>

Faba bean (Vicia faba L.) as a legume is an important crop for sustainable agriculture in the Mediterranean area, considering its role as an ecosystem service crop and a provider of protein for human and animal nutrition. However, the area dedicated to faba bean has been in continuous decline due to several factors, among which the biotic stress constitutes a major component. Broomrape (Orobanche crenata) is one of the main constraints responsible for this reduction. Control strategies have mainly focused on agronomic practices and the use of herbicides, although success has been marginal. The development of tolerant varieties is one of the most sustainable and eco-friendly options. In this regard, a phenotypic screening in field conditions was performed in 2021-2022 involving 32 genotypes of faba bean from different geographical origins in the absence and presence of broomrape. Both susceptible check (Aguadulce) and resistant checks (Chourouk, Najeh, VF136 and Giza843) were used. The trial was set with replicates in Merchouch station using the split-plot experimental design. The ANOVA revealed significant to very highly significant differences between the two treatments and between the genotypes for most of the studied traits. The interaction between treatment and genotype was also significant. Principal component analysis exhibited distinct groups: the tolerant genotypes characterised by a low hundred seed weight, a low number of seeds per pod and the susceptible genotypes have a high number of seeds per pod and a high hundred seed weight. Fabia, a Spanish variety, was scored as the most tolerant, based on the yield although it was the most infested genotype. The German varieties Fuego and Condor and the Moroccan line 78-R21 showed the lowest levels of infestation, but registered the highest yield loss in the presence of broomrape.

Keywords : Vicia faba L., Orobanche crenata, genotype, tolerance



Molecular defence triggers of Phelipanche and their recognition by tomato receptors

Mouna Khalloufi, Anna Kudra, Isabell Albert, Markus Albert

FAU Erlangen-Nürnberg, Department of Biology, Molecular Plant Physiology, Staudtstr. 5, 91058 Erlangen – Germany Corresponding author email: markus.albert@fau.de

Phelipanche ramosa and Phelipanche aegyptiaca are obligate holoparasitic plants and cause serious crop yield losses in tomato fields, since the Solanum lycopersicum is susceptible while the wild tomato species Solanum pennellii is resistant to Phelipanche spp. If this resistance is the result of principles such as pattern- or effector-triggered immunity (PTI/ETI) is yet unknown. Commonly, the two-layered plant innate immune system is involved in the detection of microbial pathogens as well as other plant parasites and requires a recognition of pathogen- or damage-associated molecular patterns (PAMPs/DAMPs) by pattern-recognition receptors (PRRs). Here, we aimed to identify Phelipanche spp. PAMPs that initiate plant defence responses and their corresponding PRRs of tomato. We exploited 55 introgression lines (ILs) of the susceptible S. lycopersicum and the resistant S. pennellii and screened these plants for their capability to respond with ethylene or reactive oxygen production, when treated with Phelipanche extracts or isolated Phelipanche molecules. We identified a translation initiation factor of *P. ramosa* that triggers defence responses in tomato. Currently we are cloning a receptor candidate gene that has been mapped to tomato chromosome 7. Furthermore, we demonstrated that an additional pattern is present in P. aegyptiaca extracts detectable by the tomato receptor protein CuRe1 which is described as a receptor for a Glycine-rich protein of parasitic Cuscuta spp.

Keywords: broomrapes, parasitic plants, plant immunity, plant defence, resistance, pattern recognition receptors, pathogen-associated molecular patterns.



Field screening and management of 12 tomato land races for detection of resistance to orobanche

Adel Alabed, Nizar Haddad, Khalid Abu Laila, Masnat Alhiary

National Agricultural Research Center (NARC) P.O.Box 639 Baga, 19381 Jordan Corresponding author email : <u>adel_alabed@yahoo.com</u>

Field sampling and collection of broomrapes during the period of March – May 2021 in several locations mainly within Jordan Valley had been performed. At least, 45 specimens were collected from: Ghour Al-Safi, Ghour Al-Mazra'a, Ghour Viva, and one location Baq'a outside Jordan Valley. Identification of the collected broomrapes specimens showed presence and abundance of the species Orobanche ramosa (Syn. Phelipanche ramosa) and collected samples from Bag'a showed the species Orobanche cernua. Preliminary field evaluation for commercial E 7-Oraban which is registered as fertiliser that minimise damage caused by broomrape was compared with a commercial herbicide Rimsulfuron the results showed that as the field shown previously high infestation rate with broomrape with non-measured infestation density, the E 7-Oraban product showed infestation rate similar to that treated with Rimsulfuron the herbicide with compare to significant infestation in non-treated part of the field. We considered that as a good indicator for the potential antagonism for the product. During the cropping season 2022/2023, twelve landraces of tomato and two commercial cultivars entries were screened for the detection of resistance to Orobanche Spp. The screening was done for O. ramosa in the field at Dier Alla agricultural research station. The screening was done in naturally infested field incidence and severity of orobanche infestation and orobanche number were recorded among the 12 landraces only three landraces were infected with orobanche with average incidence of 4 parasite plants per treatment the remaining landraces showed resistance to orobanche with zero infestation while the susceptible commercial cultivars were highly infested with orobanche with infestation rate more than 100 parasite plants per plot.

Keywords: Broomrapes, parasitic plants, plant resistance tomato management.



Response of some Tunisian sunflower (*Helianthus annuus* L.) accessions to *Orobanche cumana* Wallr. Parasitism

<u>Taoufik Hosni</u>¹, Zouhaier Abbes¹, Leila Abaza², Sana Medimagh¹, Hamadi Ben Salah¹, Mohamed Kharrat¹

 ¹Field Crops Laboratory, National Institute for Agricultural Research of Tunisia (INRAT), Carthage University, Hedi Karray Street, 1004, El Menzah, Ariana, Tunisia.
 ²Laboratory of Olive Biotechnology, Centre of Biotechnology of Borj-Cedria (CBBC), B.P. 901, 2050 Hammam-Lif, Tunisia Corresponding author email : <u>hosnitaoufik@hotmail.fr</u>

The parasitic weed Orobanche cumana constitutes a major constraint on sunflower production in Tunisia. In this study, thirty-three sunflower accessions were subjected to field and controlled conditions (pots and Petri dishes trials) assessment for resistance/susceptibility to Tunisian O. cumana. The different experiments were able to classify the sunflower accessions studied according to their level of resistance to the pathogen into three groups. The first group included the sunflower accessions resistant to broomrape. They did not show any emerged broomrape shoot, they presented the lowest percent germination of the parasite and their major agro-morphological parameters were not affected by parasitism. The second group contained the sunflower accessions having a partial resistance to the parasite. They are characterised by a low infestation rate and a moderate number of O. cumana tubercles. The third group included the sunflower accessions susceptible to broomrape. They were distinguished by a great infestation level and the highest number of tubercles. Moreover, O. cumana decreased most agro-morphological parameters in the susceptible accessions compared to control. The results also showed that O. Cumana infection did not affect the seed oil content for resistant accessions. There is no direct correlation between fatty acids composition and broomrape infestation. These results would be useful in breeding programs to develop new resistant varieties of sunflower.

Keywords : Helianthus annuus, Orobanche cumana, resistance, screening



Session 3

Parasitic Weed Management and IPM Approaches to Combat Parasitism



Approaches to reduce parasitism by the broomrape, Orobanche crenata Forsk in faba bean (Vicia faba L.) fields

<u>E. M. H. Hegazi¹</u>, W. E. Khafagi², Manal A. Attia³, A. Abou Zeid⁴, M. A. El Eryan¹, Nagat M. Aly⁵, Safaa M. Abd El-Rahman³, A. K. Mahmoud⁵, H. K. Abou Taleb², Amany M. Abu Shall¹, Mervat A. Hasaneen², Sania F. Showiel²

¹Faculty of Agriculture, Alexandria University, Alexandria, Egypt, ²Plant Protection Research Institute, Agricultural Research Center (ARC), Sabahia, Alexandria, Egypt, Research Center (ARC), Alexandria, 21616, Egypt, ³Insecticide Bioassay Department, Central Agricultural Pesticide Laboratory (CAPL), Sabahia, Agricultural Research Center (ARC), Alexandria, 21616, Egypt, ⁴Faad Lagurage Research Department, Field Cross Research Institute, (CDI), Agricultural Research Center (ARC), Egypt,

⁴Food Legumes Research Department, Field Crops Research Institute (FCRI), Agricultural Research Center (ARC), Egypt, ⁵Mammalian Toxicology Department, Central Agricultural Pesticide Laboratory (CAPL), Agricultural Research Center (ARC), Egypt. Corresponding author email: <u>eshegazi@gmail.com</u>

The Broomrape Orobanche crenata Forsk is a serious parasitic weed causing considerable losses in many major crops including faba bean (Vicia faba L.). In Egypt, losses of O. crenata parasitism may reach 40 to 100 %. Little is known about the effect of different control strategies on O. crenata seed bank. The present study aimed to cover : 1. Effect of intercropping different ratios of fenugreek and flax, using two faba bean O. crenata susceptible and resistant cultivars on emergence of the parasite spikes, in soil of low and high seed bank of the parasitic plant, 2. Effect of faba bean sowing date (20 days intervals) on the parasitic weed infestation and dry pod weight per plot of Giza 843 and Nubaria 1 cultivars (in Nubaria, farm), 3. Effect of irrigation pattern in Nubaria 1 faba bean cultivar plots of low infested soil by O. crenata on the total mean number of grown O. crenata spikes recorded thereafter, 4. Effect of removing pattern of well-developed O. crenata weeds on number of newly emerged ones thereafter and 5. Collecting information on the biological control agent, (Phytomyza orobanchia fly). Intercropping fenugreek or flax with faba bean can reduce crenate broomrape infestation, but the effectiveness varied greatly when different ratios of seeds of inhibitor crop were used. Also, late sowing date significantly reduced the number of emerged O. crenata shoots for both the resistant and the susceptible cultivars. In Egypt, irrigation scheduling for faba beans significantly affected the number of emerged O. crenata shoots. In grown faba bean plots, the number of parasitic shoots in non-irrigated plots was significantly less compared with those in irrigated once or twice. The efficacy of P. orobanchia under natural conditions is limited by low temperatures, cultural practices and natural enemies. To strengthen the natural population and its impact, inundative releases of P. orobanchia adults at the beginning of Orobanche emergence have to be undertaken. Field data on the larvae of P. orobanchia were collected.

Keywords: Orobanche crenata, parasitic weed, faba bean, intercropping, sowing date, irrigation, biological control, Phytomyza orobanchia fly, seed bank



Utilising stimulants and biocontrol agents to manage broomrape parasitism

Dimosthenis Chachalis, Anastasia Tsekoura, Aggeliki kousta, Dimitrios Argyris

Laboratory of Weed Science, Benaki Phytopathological Institute, Agricultural Economics Research Institute, 14561 Athens, Greece. Corresponding author email : <u>d.chachalis@bpi.gr</u>

In Greece, broomrapes (*Orobanche/Phelipanche* spp.) cause severe problems in industrial tomatoes in the main production *area* (Thessaly region). Seed germination of these species is a very complex phenomenon, affected by the environmental conditions and highly regulated by the interaction of host-parasite. In the current study, results are presented from controlled-environmental conditions experiments. Different types of stimulants were studied such as: the typical GR-24, a new aqueous formulation stimulant (NE-1), and tetralone. Studies were done regarding the effects of temperature, duration of pre-conditioning, type of the stimulant and rates during the two discrete phases: the preconditioning and germination phase. Regarding the broomrape species, the three most important species in Greece were studied such as: *P. ramosa, P. aegyptiaca,* and *O. cumana*. Results identified the optimum environmental conditions in the host-parasite interaction and highlighted possible means for effective control utilising stimulants and biocontrol agents.

Keyword: broomrapes, parasitism, stimulants, soil seed bank depletion.



Control of Orobanche foetida in faba bean (Vicia faba)

<u>Amal Bouallegue</u>¹, Siwar Thebti^{1,2}, Zouhaier Abbes¹, Hadhami Abidli¹, Imen Trabelsi¹, Moez Amri³, Mohamed Kharrat¹

¹Institut National de la Recherche Agronomique de Tunisie, Laboratoire des Grandes Cultures, Université de Carthage, Rue Hédi Karray 1004 Tunis, Tunisie ²Centre Régional de Recherche sur les Grandes Cultures, Laboratoire des Grandes Cultures, Route de Tunis Km 5, Béja, Tunisie Corresponding author email: <u>amal.bouallegue@hotmail.fr</u>

Orobanche foetida is one of the most devastating constraints for faba bean production in Tunisia. Several methods have been used to control this parasitic weed without complete success. In this study, three control strategies were tested at the research station of Oued Beja during the two cropping seasons 2020/2021 and 2021/2022. The effect of intercropping strategy to control O. foetida was tested by using combinations of two contrasting faba bean varieties and two fenugreek doses (20 and 40 seeds/m²). Results showed that the two doses of fenugreek decreased significantly the Orobanche number in both varieties without significant increase in faba bean seed yield. The effect of different herbicides to control O. foetida in faba bean was also evaluated. All used herbicides (except Cle thodim and Pendimethalin) decreased significantly *O. foetida* number and improved faba bean grain yield. Finally, the use of some chemical and biochemical resistance inducers as another control strategy to control O. foetida showed that especially priming with Benzothiadiazol (BTH) or Salycilic Acid (SA) reduced significantly the Orobanche number and induced higher yields compared to the untreated control. In the petri dishes experiment, all inducers decreased Orobanche seed germination and tubercle number. This reduction varied from 25.8% to 38.4% for seed germination and from 20.5% to 72.7% for tubercle number, as compared to the control. These results attest that intercropping with fenugreek, the use of herbicides or chemical and biological inducers can be used in an integrated strategy management to reduce O. foetida infestation in faba bean.

Keywords : Orobanche foetida, intercropping, herbicides, inducers, resistance, faba bean.



Over a decade of research on biocontrol of broomrape in Tunisia and Algeria : achievements and prospects

Nadjia Zermane¹, Meriem Boutiti², <u>Thouraya Souissi³</u>

¹University of Algiers, Faculty of Sciences, 2 Didouche Mourad street, 16002 Algiers, Algeria. ²Laboratory of GVRF, University of Carthage, Institut National de la Recherche en Génie Rural, Eaux et Forets, rue Hédi Karray, 1004 Menzah 1, Tunisia ³Laboratory of IWM, University of Carthage / Institut National Agronomique de Tunisie, 43 Avenue Charles Nicolle, 1082 Tunis, Tunisia Corresponding author email : <u>souissi.thouraya@iresa.agrinet.tn</u>

Broomrapes (Orobanche spp. and Phelipanche spp., Orobanchaceae) are one of the major constraints to crop production in Tunisia and Algeria. Species of economic importance common to both countries include O. crenata (on Fabaceae) and Phelipanche ramosa (on Solanaceae). Tunisia records in addition O. foetida (mainly on Faba bean) and O. cumana (on sunflower). From the early 2000s research on biocontrol of broomrape was initiated by our team work at the national institutes of agronomy in Tunisia and Algeria (INAT and ENSA, respectively) with intermittent internships in Germany (University of Kassel, Witzenhausen) and Italy (ISPA-Bari and University of Frederic II-Naples). Studies were conducted using host specific rhizobacteria and phytopathogenic fungi as well as plant extracts and metabolites. Some rhizosphere bacteria showed strong biocontrol activity against Orobanche spp. under controlled conditions (up to 76% and 63% reduction of broomrape shoot emergence and dry weight, respectively) and positively influenced faba bean growth. As for fungi, the two Fusarium oxysporum, For1 and For2 isolated from infected broomrapes, inhibited seed germination and reduced the number and dry matter of tubercles of O. crenata and O. foetida (up to 87% and 88% respectively) while increased the height and dry matter of the host plant faba bean in pot experiments. Plant extracts and metabolites showed promising results as was the case with phytotoxic bi- and tri-cyclic sesquiterpene lactones (Inuloxins A, C, D) extracted from aerial parts of Dittrichia (Inula) viscosa which caused up to 100% inhibition of crenate broomrape seed germination in vitro. Our studies yielded very promising biocontrol agents. Future investigations must focus on application methods and the development of marketable formulations of bio pesticides.

Keywords : Orobanche, Algeria, Tunisia, biocontrol, rhizobacteria, fungi, plant compounds



Status and management of parasitic weeds of food legumes in the highlands of Ethiopia

Seid Ahmed¹, Admassie Kassa², Banatlem Zeleke², Cherinet Alem³

¹Breeding Team, ICARDA, INRA Instituts, Av. Hafiane Cherkaoui, Rabat, Morocco
 ²Amhara Regional Agricultural Research institute, P.O.Box 527, Bahir Dar, Ethiopia
 ³Breeding Team, ICARDA, ILRI campus, PO Box 5689, Addis Ababa, Ethiopia
 Corresponding author email: <u>s.a.kemal@cgiar.org</u>

The productivity of cereals, vegetables, food legumes and oil-seed crops is very low to meet food and nutrition security due biotic and abiotic constraints. Food legumes (faba bean, field pea, chickpea, lentil, and grass pea) are key crops for food, incomes, animal feed and rotation with cereals in Ethiopia. However, the production and productivity of these crops are threatened by parasitic weeds mainly by Orobanche crenata and many farmers abandoned growing these crops in the northern parts of the country. Farmers practise several hand weeding and rotation with cereals (6-8 years) but with little or no success to save their crops. Since 2013, coordinated research has been piloted to develop and validate integrated parasitic management (IPWM) on faba bean between Ethiopia and ICARDA with financial support from Embrapa-Brazil. The action research on IPWM on faba bean was done partially resistant cv. Hashengie (ILB-4358), application of nitrogen fertiliser and two applications of sub-lethal application of glyphosate at flowering stages of the crop was adopted by farmers in the project site. In 2021/2022 cropping season, on-farm demonstration of IPWM (partially resistant variety, fertiliser application and two application of herbicide) was conducted in three districts in Northern Ethiopia and the innovations gave an average productivity of 2.2 t/ha as compared with 1.2 ton/ha from farmer local faba bean landraces. The innovation will be scaled to cover more farmers in the coming cropping season.

Keywords : Legumes, innovation, Ethiopia, integration, resistance



New insights into the cardiopreventive activities of two parasitic plants: *Orobanche* and *Cuscuta*

<u>Arij Bédoui</u>^{1,2}, Hanen Baccari^{1,2}, Anouar Feriani¹, Moez Amri³, Mohamed Ali Borgi¹, Mohamed Kharrat², Zouhaier Abbes²

¹Laboratory of Biotechnology and Biomonitoring of the Environment and Oasis Ecosystems. Faculty of Sciences of Gafsa, Gafsa, Tunisia. ²Field Crops Laboratory, INRAT, Carthage University, Ariana, Tunisia ³African Integrated Plant and Soil Research Group (AiPlaS), University Mohammed VI Polytechnic (UM6P), Ben Guerir, Morocco Corresponding author email : <u>ferianianwer@yahoo.fr</u>

Orobanche and Cuscuta are parasitic plants distributed in Southern Africa and in the Mediterranean region. In Tunisia, these two species are distinguished by both morphological characters and ecological traits. Despite their parasitic nature, these plants have a rich history of being used in traditional medicine due to their richness in bioactive compounds with potential therapeutic applications. Several authors have reported the antioxidant, antiinflammatory and insecticidal effects of Orobanche and Cuscuta. To our knowledge, no scientific report is available on their cardioprotective capacity in experimental animals. The goal of the current work was to explore the way in which the aqueous extract from Orobanche (AEO) and Cuscuta (AEC) exerts possible cardioprevention against ISO-induced myocardial infarction in rats. The biomolecules content was evaluated using LC-MS analysis. On the 29th and 30th days, two successive injections of isoproterenol (ISO) were given to Wistar rats to provoke myocardial infarction following pre-treatment with either AEO (60 mg/kg b.w) or AEC (60 mg/kg b.w). Results showed that AEO and AEC offered cardioprevention by normalising the ST segment and reducing the elevated cardiac risk parameters (AST, ALT, CK-MB, LDH and cTn-I). The altered lipid biomarkers (TC, TG and LDL-C) together with the plasma ionic levels (K⁺, Na⁺ and Ca²⁺) were improved. Additionally, AEO and AEC inhibited the cardiac oxidative stress generated by ISO injection though enhancing antioxidant enzymes (GSH, CAT, SOD and GPX) which reduced lipid peroxidation and protein oxidation. Moreover, AEO and AEC reduced DNA fragmentation as well as the infarct size observed by TTC staining. The histopathological findings revealed less muscle separation and fewer inflammatory cells in the AEO and AECtreated rats. All observed effects highlighted the potential application of Orobanche and Cuscuta extract in food and pharmaceutical industries against ROS-induced damage

Keywords: Orobanche, Cuscuta, isoproterenol, oxidative stress, LC-MS, cardioprevention.



Session 4

Diversity and Distribution of Parasitic Plants and Tools for Surveillance



Genetic diversity and population structure of *Orobanche* spp. et *Phelipanche* spp. from Tunisia

<u>Khalil Khamassi</u>¹, Zouhaier Abbes^{1,2}, Mustapha Rouissi³, Eleni Tani⁴, Anastasios Katsileros⁵, Mohamed Kharrat¹

¹University of Carthage, Institut National de la Recherche Agronomique de Tunisie, Field Crop Laboratory (LR16INRAT02), Rue Hédi Karray, 1004 Menzah 1, Tunis, Tunisia ²University of Carthage, Institut Supérieur des Sciences et de Technologie de l'Environnement De Borj Cedria, Tunisia

³University of Carthage, Institut National de la Recherche Agronomique de Tunisie, Agricultural Applied Biotechnology Laboratory (LR16INRAT06), Rue Hédi Karray, 1004 Menzah 1, Tunis, Tunisia ⁴Agricultural University of Athens, Department of Crop Science, 11855 Athens, Greece ⁵Agricultural University of Athens, Laboratory of Plant Breeding and Biometry, 11855 Athens, Greece Corresponding author email : <u>khalilkhamassi9@gmail.com</u>

Assessment of genetic diversity is an essential component in order to understand Orobanche and *Phelipanche* species geographical spread and parasitism or virulence evolution. However, previous studies showed that many taxa of Orobanche that raise in the wild, which are considered to be different species, possibly will be morphotypes of the same taxon and there are many confusions on how to classify these species. Indeed, most of these species' genomes are not yet sequenced. As consequence these is no robust molecular markers tool available yet that can discriminate at the inter specific level; particularly for Orobanhce foetida. Therefore, a protocol to evaluate genetic variability on sampled broomrape was established. Two approaches were adopted. The first one was a baseline molecular analysis and population structure study based on dominant marker such as RAPD; they were carried out to compare inter and intra specific genetic variability within O. foetida, O. crenata and P. ramosa. The hierarchical analysis based on Jaccard index revealed two groups; one composed only by samples belonging to O. feotida and the second consisted of two sub-groups respectively with samples belonging to O. crenata or P. ramosa. This first step will help with applying different other molecular techniques such as: ISSR, SSR and HRM. The second approach consists of a morphological characterization based mainly on the flower components (calyx, standard, corolla, stigmata, stamens...). Significant variations were also observed in the shape of the calyx and the colour of the corolla and stigma. Seeds' morphology study using electronic microscope is ongoing and it may show more information regarding the intra and inter variability. The goal of those analyses is to find out a standard method to use in order to study a large collection of samples from different infested regions and host.

Keywords : Tunisia, Orobanche spp., Phelipanche spp., RAPD, population structure, morphological characterisation



Local sensing technologies (UAVs) to study broomrape parasitism in industrial tomato

<u>Anatonis Kavvadias</u>¹, Aggeliki Kousta², Anastasia Tsekoura², Dimitris Argyris², Dimosthenis Chachalis²

¹Hydroexigiantiki, Marousi 15125, Athens, Greece. . ²Laboratory of Weed Science, Benaki Phytopathological Institute,14561 Athens, Greece. Corresponding author email : <u>akavvadias@gmail.com</u>

In Thessaly region (Greece) an industrial tomato field study area with a previous record of broomrape parasitism was established, in 2020 (5 ha) and in 2021 (1 ha). A UAV equipped with a multispectral sensor with five bands (RGB, Green, Red, Red-Edge and Near-Infrared) was used as follows: in 2020 [a sequoia sensor, flight altitude 80 m above ground, spatial resolution: 8 cm/pixel, 5014 images, a grid of 100 assessed points, in three flying dates (30/06, 14/08 and 31/08] and in 2021 [a Mica Sense Red Edge sensor, flight altitude 50 m above ground, spatial resolution: 5 cm/pixel, 3405 images, a grid of 139 assessed points, in three flying dates (16/07, 26/08 and 16/09)]. Three types of vegetation indexes were calculated as follows: NDVI, CI (chlorophyll index) and SAVI (soil-adjusted vegetation index). In each grid point, ground truthing measurements were taken such as: the chlorophyll values (SPAD) and the detection of parasitism (yes/no). For the data analysis, the followings were done: exclusion of all pixels with no vegetation index (NDVI<0.4), creation of a square plot 1.5x1.5 m around each control point, and finally the calculation of the mean NDVI in each square plot. The statistical analysis was based on the creation of correlations between SPAD/NDVI/CI for each month of both parasitism and non-parasitism square plots. The statistical significance was measured as parasitism (Y) and non-parasitism (N) to demonstrate the temporal progression of indices in each square plot. Results are discussed in the context of the validity of the current UAV sensing technologies to map broomrape parasitism in industrial tomato.

Keywords : Broomrapes, parasitism, drones, GIS mapping.



Studies on Orobanche foetida in the genomic era in Tunisia: Status and perspectives

Amal Boukteb^{1,2}, Mohamed Kharrat¹, Mariem Bouhadida¹

¹Field Crop Laboratory, National Institute of Agricultural Research of Tunisia, Carthage University, Tunis, Tunisia
²Faculty of Science of Tunis, University of Tunis El Manar, Tunis, Tunisia Corresponding author email : <u>amal.boukteb@fst.utm.tn</u>

The fetid broomrape is distributed in the Mediterranean region as a wild plant parasite. However, since 1992, it has become a real threat to legumes in Tunisia causing serious damages which may reach 90% yield losses. Analysis of the genetic diversity of this parasite is important to better understand its evolution and spread. Our work consisted in testing the genetic diversity within and among O. foetida populations growing on different legume species using molecular markers. Moreover, we tested the behaviour of these species with different populations of O. foetida by in vitro co-culture to highlight the presence of host differentiation process. Furthermore, we studied the genetic diversity and population structure of O. foetida collected from 18 faba bean fields in Tunisia using the robust technique Restriction-site-Associated DNA sequencing (RADseq). This study showed that genetic differentiation occurred in the Tunisian *O. foetida* emphasising the isolation by distance effect. However, no strong population clustering was detected in this work based on the data sets and clustering methods used. Moreover, in order to characterise the gene expression of faba bean during the O. foetida attacks, roots from two faba bean accessions (resistant and susceptible) were investigated at different stages of the parasite development using RNASeq. Our study revealed a difference at gene expression level among genes involved in the orobanchol biosynthesis pathways between the susceptible and the resistant faba bean host. Our results trace the current real situation of the distribution of O. foetida populations in Tunisia and could be an insightful starting point to develop resistant faba bean variety against O. foetida based on gene expression studies, and a valuable reference for the upcoming research projects focusing on this parasitic plant.

Keywords : Orobanche foetida, genetic diversity, RADseq, gene expression, RNAseq



Remote sensing/GIS methodologies to map broomrape parasitism in industrial tomato

<u>Dimitra Zermasli</u>¹, Thanasis Zisos¹, Markos Bonazountas¹, Antonis Kavvadias², Aggeliki Kousta³, Dimosthenis Chachalis³

¹EPSILON MALTA, Malta. ²Hydroexiiantiki, Marousi 15125, Athens, Greece. ³Laboratory of Weed Science, Benaki Phytopathological Institute, 14561 Athens, Greece Corresponding author email : <u>ec-projects@epsilon.gr</u>

In Greece, broomrapes (Orobanche/Phelipanche spp.) cause severe problems mostly in industrial tomato in the main production area (Thessaly region; 4327 Km²). Imagery data were acquired from the United States Geological Survey (USGS) utilizing Landsat 8 satellite images that covered industrial tomato fields from the year 2018 to 2021. For each year, 3 satellite images (i.e. June, July and August) were collected. Standard procedures were used (atmospheric correction, clip of multiple rasters, contrast enhancement and GIS methodologies) prior to calculations of the NDVI and NDMI values. Then, a model was developed to correlate environmental conditions (the land temperature and the soil moisture), with the NDVI of the tomato field crops. Two critical periods for the biology of broomrapes were chosen for the Thessaly region as such : April for NDMI data (seed preconditioning/germination period) and July for NDVI cropping data (broomrape fully emerged and competition with the crop). As such, two discrete broomrape maps were developed: the germination/establishment risk maps (from March-May) and the trulyparasitism maps (from June-August). The risk of broomrape parasitism (as low, medium, or high), is set accordingly, based on a range of values for the two parameters that represent the worst-case scenario design. Currently, the model is under validation (i.e. observed vs. predicted values) for the industrial tomato in Thessaly region, Greece.

Keywords: Broomrapes, parasitism, modelling, risk mapping



Detection of the parasitic weed, Phelipanche ramosa in rapeseed fields in Tunisia

Sana Medimagh¹, Zouhaier Abbes¹, Myriam Chtourou², Taoufik Hosni¹, Khalil Khamassi¹, Mohamed Kharrat¹

¹Field Crop Laboratory, Carthage University, INRAT, Rue Hédi Karray 1004 El Menzah, Tunisia ²Laboratory of IWM, University of Carthage / Institut National Agronomique de Tunisie, 43 Avenue Charles Nicolle, 1082 Tunis, Tunisia Corresponding author email : <u>sana.medimagh.inrat@gmail.com</u>

Branched broomrape, *Phelipanche ramosa* L., belonging to the *Orobanchaceae* family, is a holoparasitic weed that subsists on the roots of many important crops. A survey was conducted in the rapeseed (*Brassica napus* L.) fields during 2021. *P. ramosa* was found in some rapeseed fields in the Bizerte region in north of Tunisia. Knowledge of the morphology and biology of branched broomrape is important for its identification in the field. The frequency of broomrape in the evaluated rapeseed fields was calculated and the average density of *P. ramosa* was 18 weeds/m². This situation can be considered a further threat for many potential host crops cultivated in the region. To our knowledge, this is the first study reporting *P. ramosa* infection on rapeseed in northern Tunisia. Since rapeseed is produced in rotation with cereals, branched broomrape could pose a serious threat to production of host crops if proper precautions are not urgently taken to prevent the spread of branched broomrape.

Keywords: Branched broomrape, Phelipanche, rapeseed, Tunisia



Session 5

Socio-Economic Impacts - Awareness Raising



Analysing the economic and social sustainability of weed management: the case of Orobanche in industrial tomato in Greece

Efstratios Michalis, Athanasios Ragkos

Agricultural Economics Research Institute, Hellenic Agricultural Organization -DIMITRA, Kourtidou 56-58, Athens - Greece Corresponding author email : <u>efstratiosmichalis@gmail.com</u>

The purpose of this study is to demonstrate the socioeconomic impact of Orobanche parasitism. The study area is Thessaly, Central Greece, while the case study focuses on industrial tomato, a crop of particular economic importance for the area, as it supports local agro-industry and value chains. For the purpose of the socioeconomic appraisal, technical and economic data were collected from five typical farms cultivating industrial tomato in the study area, based on a typology according to farm size (small -; medium -; and large-sized farms). The analysis of economic sustainability combines a comparative technical and economic analysis of the three farm types – which demonstrates how differences in size are translated to differences in weed management expenses – and a linear programming model, which demonstrates how each farm type is affected by external conditions. The results can be of use within a Cost-Benefit Analysis framework. When it comes to social sustainability, a sample of 50 farmers was interviewed in order to shed light on their preferences with regards to sustainable weed management practices. Results demonstrate that such practices are not yet widespread in the area and that farmers are not convinced about their effectiveness.

Keywords : Broomrapes, parasitism, farm typology, linear programming.



Factors influencing Tunisian farmers' decisions to adopt measures to fight against orobanche

<u>Ahmed Yangui¹</u>, Taheni Mlayeh¹, Zouhaier Abbes², Mohamed Kharrat²

 ¹Laboratory of Agricultural Economics (LER), National Agricultural Research Institute of Tunisia (INRAT), Carthage University, Rue Hédi Karray, 1004 Menzah 1, Tunisia.
 ²Field Crop Laboratory (LGC), National Agricultural Research Institute of Tunisia (INRAT), Carthage University, Rue Hédi Karray, 1004 Menzah 1, Tunisia. Corresponding author email : <u>yangui.ahmed@gmail.com</u>

Broomrapes (Orobanche spp.) is a serious root parasite threatening the livelihood of the farmers with its over whelming effect on some crops, mainly leguminous in Tunisia as well as in the world. They cause considerable yield losses, which can reach 100% of crop yield in severely infested fields, and even more serious problems that their seeds can persist in soil up to 20 years and could easily spread to other fields increasing rapidly the infested areas. Therefore, it is important to understand what determinant factors influencing the decision of farmers to adopt new measures to fight against orobanche and why farmers hesitate to adopt more sustainable weeds management approach. To this end, a survey was conducted with 74 farmers from five different zones (Beja, Jendouba, Bizerte, Nabeul and Kairaoun) where the presence of broomrape is important. The survey aims to assess the farmers' awareness face the presence of orobanche and their behaviours to control this parasite. The results show that farmers from North-West zones like Beja, Jendouba and Bizerte are more awareness about the effect of broomrape than the other farmers. This could be explained that the farmers from this area are more affected by this parasite than other one. Furthermore, the results reveal that farmers' typology has a significant effect on their decisions to adopt new and/or sustainable solutions to fight against orobanche. Indeed, more than 70% of our sample are small and old farmers, with very low instruction level. Consequently, the majority of the farmers have higher level of risk aversion to adopt new solutions, and mainly preventive and sustainable methods to protect against orobanche effect. Additionally, the known about this category are stub born farmers which take their decisions based solely and mainly on their own knowledge leading that is not easier to convince this category about the presence of new integrated weed management to fight against orobanche.

Keywords : Farmers' behaviours, Orobanche, integrated weed management, behavioural factors



Integrated control management of the parasitic weed orobanche (*O.foetida*) on the faba bean (*Vicia faba*) in north of Tunisia

Walid Gharbi¹, Messad Khammassi¹, Haykel Chebbi¹

¹Institut National Des Grandes Cultures (INGC), B.P. 120 Bousalem 8170, Tunisia. Corresponding author email : <u>walidingc@gmail.com</u>

Orobranche (Orobanche foetida) is one of the most serious hindrances in faba bean production throughout Tunisia and the Mediterranean Basin. The Tunisian government puts in place a national strategic programme to promote this legume. However, Orobanche causes severe yield losses and its spread in many regions forces farmers to abandon faba bean cultivation. No single measure provides effective control, and an integrated approach comprising cultural (late sowing date), biological methods (use of resistant or tolerant varieties), chemical methods (glyphosate treatments) and allelopathic (barley and fenugreek mixed with faba bean) needs to be adopted. To meet these objectives, experimental field trials were carried out over three successive seasons (2019/20 to 2021/22) in the INGC experimental station in Bousalem/Jendouba. The effect of late sowing date, resistant and susceptible faba bean cultivars (Najah, Chourouk and Bachaar), glyphosate treatments and allelopathic effect was evaluated. Results revealed that the late sowing date could decrease the density of orobanche per m^2 by 40% to 90 %. Also, on early sowing date the Najah variety could decrease orobanche density to 62 % compared to susceptible variety (Bachaar). Two treatments with Glyphosate (60 g a.i..ha-1) separated by two weeks could help farmers to reduce orobanche density and increase faba bean yield from 0.9 tons to 1.8 tons per hectare. The results also showed that the allelopathic effect of barley (10 kg/ha) mixed with faba bean and combined with glyphosate treatments can increase faba bean yields and decrease density of orobanche by 50 and 56 percent, respectively. Likewise, density of broomrape decreases by nearly 50 percent with the allelopathic effect of the fenugreek (5 kg/ha) mixed with faba bean and combined with two glyphosate applications.

Keywords : Allelopathic, density, faba bean, integrated, management, Orobanche, treatments, yield



Approaches for the adoption of good agricultural practices in field crops; case of Tunisia

Dorsaf Hlel, Radhouen Nciri, Mouhanned Jemli, Hayet Maaroufi

Transfer and support department, National Institute of crop field crops (INGC), B.P. 120, Bousalem 8170, Jendouba, Tunisia Corresponding author email : <u>dorsafhlel@gmail.com</u>

Like many agricultural transfer and dissemination structures in Tunisia, the INGC is today faced with the major challenge of scaling up: "The great challenge today is to know how innovative agricultural technologies in field crops can be made available and adopted by farmers". Good Agricultural Practices (GAP) are essential to guarantee food security, the economic, social and environmental sustainability of agricultural societies in Tunisia. In this perspective, the INGC has developed since 2018 a new development and transfer approach: "The Leader Farmer (AL) in field crops". The Leader Farmer, thus becomes not only a relay of innovative agricultural practices, but also an active partner thanks to their expertise, experience and ability to innovate and adopt new agricultural practices, interface between the farmers of his locality and the structures of public research and development. It is at the heart of an innovation network, enabling the dissemination of information, targeted mobilisation of public resources (subsidies, donations, credits, etc.), access to the market and services, etc.

Keywords : Approach, agricultural technologies, Leader Farmer, sustainability, active partner



Strategy to reduce the impact of Orobanche in Tunisia

Salwa Benfredi¹, Mouna Mhafdhi¹, Kamel Khalifa¹, Mohamed Habib Ben Jamâa¹

¹General Directorate of Plant Health and Control of Agricultural Inputs, 30 Alain Savary 1002, Tunis, Tunisia. Corresponding author email : <u>mounamhafdhi@gmail.com</u>

In Tunisia, Orobanche attacks on cultivated legumes cause significant losses. This issue is continually progressing and becoming an obstacle to the development of this crop, particularly for faba beans. The main species which attacks this crop are *Orobanche foetida* and *O. crenata*. In order to protect pulses against the damage caused by this dangerous parasitic plant, the General Directorate of Plant Protection and Agricultural Input Control in Tunisia has established a joint and multidisciplinary technical national committee tasked with developing and implementing a national strategy to combat this parasitic weed of pulses (Decision No. 167 of February 10, 2021). In this context, the General Directorate has developed an action plan and has begun to implement its actions from the 2021/2022 agricultural cropping season, in collaboration with stakeholders, as National Institute of Agricultural Research of Tunisia (INRAT), Livestock and Pasture Office (OEP), General Directorate of Agricultural Production (DGPA), and active actors in the field. It has also implemented the following measures:

- Creation of regional committees at the level of regional representation of the Ministry of Agriculture, Water Resources and Fisheries, mainly in affected production areas.
- Development of technical support on Orobanche (poster, flyer ...).
- Launching procedures for the approval/registration of herbicides against Orobanche in faba bean crops.
- Organisation of a training session for technicians, field awareness-raising days for farmers, and a training day for technicians and members of the technical national committee to present the results of applied research by the National Institute of Agricultural Research in Tunisia on this issue.

Keywords : Orobanche, strategy, Tunisia



List of Authors

Authors Name	Page
Abaza, L.	14
Abbes, Z.	8, 10, 14, 18, 21, 23, 27, 30
Abd El-Rahman, S.M.	16
Abid, G.	7
Abidli, H.	18
Abou Taleb, H. K.	16
Abou Zeid, A.	16
Abu Laila, K.	13
Abu Shall, A.M.	16
Ahmed, S.	20
Alabed, A.	13
Albert, I.	12
Albert, M.	12
Alem, C.	20
Alhiary, M.	13
Aly, N.M.	16
Amri, M.	8, 10, 18, 21
Argyris, D.	17, 24
Attia, M.A.	16
Baccari, H.	21
Bédoui, A.	21
Ben Jamâa, M.H.	33
Ben Salah, H.	10, 14
Benfredj, S.	33
Bonazountas, M.	26
Borgi, M.A.	21
Bouallegue, A.	18
Bouhadida, M.	25
Boukteb, A.	25
Boutiti, M.	19
Chachalis, D.	5
Chachalis, D.	17, 24, 26
Chebbi, H.	31
Chtourou, M.	27
Dakhli, L.	10
El Eryan, M. A.	16
Feriani, A.	21
Forahi, Z.	11
Fotou, I.	5
Gerakari, M.	5
Ghaouti, L.	11
Gharbi, W.	31
Haddad, N.	13

ZEROPARASITIC.eu



Hasaneen, A.M.	16
Hatzigeorgiou, A. G.	5
Hegazi, E. M. H.	16
Hlel, D.	32
Hosni, T.	27
Jemli, M.	32
Kapazoglou, A.	5
Kassa, A.	20
Katsileros, A.	23
Kavvadias, A.	24, 26
Khalifa, K.	33
Khalloufi, M.	12
Khamassi, K.	7, 10, 23, 27
Khammassi, M.	31
Kharrat, M.	8, 10, 14, 18, 21, 23, 25, 27, 30
Kotsira, V.	5
Kousta, A.	17, 24, 26
Kudra, A.	12
Maaroufi, H.	32
Mahmoud, A. K.	16
Martínez-Andújar, C.	6
Martínez-Melgarejo P.A.	6
Medimagh, S.	14, 27
Mentag, R.	11
Mhafdhi, M.	33
Mhamdi, M.	7
Michalis, E.	29
Mlayeh, T.	30
Naoumis, I.	5
Nciri, R.	32
Ormazabal, M.	6
Pérez Alfocea, F.P.	6
Ragkos, A.	29
Rouissi, M.	7, 23
Showiel, S.F.	16
Souissi, T.	19
Tani, E.	5, 23
Tastsoglou, S.	5
Thebti, S.	18
Trabelsi, I.	8, 10, 18
Tsekoura, A.	17, 24
Yangui, A.	30
Zeleke, B.	20
Zermane, N.	19
Zermasli, D.	26
Zisos, T.	26

35



