Biologicals/Biopesticides/Biostimulants & EU policies

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Preface

Dear Participants,

It is with great pleasure that we welcome you at INTOMED's first Online International Symposium on Biologicals/Biopesticides/Biostimulants and EU policies. During these unprecedented times, it is of vital importance to find ways to come together and support the excellence in research and innovation.

Our project, INTOMED, aims to establish new knowledge in the field of microbe-plant-arthropod interactions and explore the feasibility of new products, solutions and services for the sustainable control of pests and pathogens in three major crops in the Mediterranean, tomato, olive and citrus. Through our first Symposium, we aim to bring together researchers, members from the public sector and industry to consider integration opportunities and best practices in biological control in the context of current EU policies. During this event we will have the opportunity to discuss broadly what we can all contribute towards a sustainable agriculture in the Mediterranean.

We are really thankful to our collaborating partner, Democritus University of Thrace and the Agricultural Entomology & Zoology Laboratory of the Department of Agricultural Development, for the organization of the Symposium as well as all our collaborating partners in Greece, Spain, France, Portugal and Tunisia, for their support.

Thank you, for your participation.

Kalliope Papadopoulou

Project Coordinator

Keynote Talk

A new approach to sustainable olive fly management: Entomopathogenic fungus *Metarhizium brunneum* targeting preimaginals in the soil reduces adult populations in the spring

Quesada-Moraga E., Garrido-Jurado I., Yousef-Yousef M.

Universidad de Córdoba, Departamento de Agronomía, ETSIAM, 14071 Córdoba, Spain
e-mail: cr2qumoe@uco.es

Biological control is a pillar of tephritid flies IPM programs, with emphasis on the use of entomopathogenic fungi (EPF) under different strategies, but mainly directed towards the adults (i.e. bait sprays, lure and infect etc.). However, these flies spend part of their life cycle in the soil, which offers the opportunity to control this serious pest by the exploitation of soil-dwelling natural enemies such as EPF. During more than 10 years, the research group "Agricultural Entomology" from the University of Cordoba (Spain) has explored the use of *M. brunneum* EAMa 01/58-Su strain conidia in soil applications targeting soil dwelling preimaginals of *Bactrocera oleae* (Rossi) beneath the tree canopy. As a first step, the efficacy of the method has been shown over multiyear field assays, in which an experimental mycoinsecticide has been applied beneath the tree canopy in late fall, leading to 50–70 % reduction of *B. oleae* adult population emerged from the soil during spring. Secondly, several aspects of the method related to food safety and environmental sustainability have been also addressed. The strategy has demonstrated to be safe for (1) non-target arthropods, including soil arthopofauna and the *B. oleae* cosmopolitan parasitoid *Psyttalia concolor*, and (2) olive oil consumers as far as no fungal propagules in olive oil samples resulting from olives previously contaminated with EPF conidia are detected. Finally, the compatibility of these soil fungal treatments with the commonly used herbicides in olive orchards has been shown, even when the fungus is mixed with the herbicide in the same tank. A decision-making model using a multiple logistic regression to optimize conidial dose as a function of soil temperature and moisture has also been developed, as well as the influence of soil type on the availability, movement and virulence of the fungal conidia. Ongoing research is directed towards optimizing the type of fungal inoculum and evaluating the efficacy of the strategy in wide area experiments throughout the Mediterranean basin to finally deploy a new tool to manage *B. oleae* across the EU.

Panel: Biologicals/Biopesticides/Biostimulants

Keynote Talk

Eliciting tomato plant defenses by exposure to HIPVs: a sustainable approach to manage agricultural pests

Pérez-Hedo M. & Urbaneja A.
Instituto Valenciano de Investigaciones Agrarias (IVIA). Centro de Protección Vegetal y Biotecnología, (IVIA), CV-315, Km 10.7, 46113 Moncada, Valencia, Spain
e-mail: aurbaneja@ivia.es

Modern agricultural policies across the globe are committed to a significant reduction in chemical pesticide dependency, however pest management strategies are still based on the use of synthetic pesticides. There is an urgent need to find new, sustainable and biorational tools for pest managements programs. Plants communicate with each other and activate defense mechanisms against pests using Herbivore Induced Plant Volatiles (HIPVs). The use of such HIPVs could be an ecologically sustainable alternative. However, as of now there had been no comprehensive studies on HIPVs, from selection to practical use in industry production. In this research, we take advantage of this communication language between plants to develop a new sustainable method for pest management. We demonstrate how exposure of tomato plants to one selected Herbivore Induced Plant Volatile using polymeric dispensers enhances resistance to key tomato pests in commercial greenhouses. These dispensers maintained commercial tomato plant defenses activated for more than two months reducing herbivore pest damage without reducing plant productivity. Transcriptomic and metabolomic analyses of primed plants confirmed that genes involved in specialized defense were upregulated. We anticipate our results to be a starting point for new biorational strategies to pest management based on plant communication and the activation of their natural defenses.

Keynote Talk

Environmental RNA interference in two-spotted spider mite, *Tetranychus urticae*

Grbic M.
University of Western Ontario, Dep. of Biology, London, Ontario N6A5B7, Canada
e-mail: mgrbic@uwo.ca

Comprehensive understanding of pleiotropic roles of RNAi machinery highlighted the conserved chromosomal functions of RNA interference. The consequences of the evolutionary variation in the core RNAi pathway genes are mostly unknown, but may lead to the species-specific functions associated with gene silencing. The two-spotted spider mite, *Tetranychus urticae*, is a major polyphagous chelicerate pest capable of feeding on over 1100 plant species and developing resistance to pesticides used for its control. A well annotated genome, susceptibility to RNAi and economic importance, make *T. urticae* an excellent candidate for development of an RNAi protocol that enables high-throughput genetic screens and RNAi-based pest control. Here, we show that the length of the exogenous dsRNA critically determines its processivity and ability to induce RNAi in vivo. A combination of the long dsRNAs and the use of dye to trace the ingestion of dsRNA enabled the identification of genes involved in membrane transport and 26S proteasome degradation as sensitive RNAi targets. Our data demonstrate that environmental RNAi can be an efficient reverse genetics and pest control tool in *T. urticae*.

Looking for peptides in plant defense: systemin as a model

Pastor V., Pastor-Fernández J., Sanmartín N., Manresa M., Sánchez-Bel P. & Flors V.
Metabolic Integration and Cell Signaling Laboratory, Plant Physiology Section, Department of Ciencias Agrarias y del Medio Natural, Universitat Jaume I, Castellón, Spain
e-mail: pastorm@uji.es

Early recognition of a biotic threat is crucial for plant survival. The perception of an attack is mediated by the production of MAMPs/DAMPs that may serve as a warning signal and initiate the plant defense response. Peptides are one of those signals that can trigger plant immunity. The plant peptide Systemin was already discovered around 30 years ago, and despite of being described as the first hormonal peptide, its perception, regulation, and effects in immunity remained elusive. Recently it has been discovered the receptor of Systemin as well as its processing from the propeptide Prosystemin. Interesting advances in plant defense are coming with the study of peptides and their application in plant defense. By using tomato mutants overexpressing or silencing *PROSYS* we could start to decipher the action of this peptide at the metabolic level. We are currently studying the relation between the production of Systemin and the protection against *Botrytis cinerea* in mycorrhizal plants since both events are connected through JA. Going further in the study of plant peptides in defense, a screening for protection phenotype in Arabidopsis against the fungus *Plectosphaerella cucumerina* was performed. Application of peptides produced by different plant species, including Systemin, results in a phenotype of resistance which is not linked with an antifungal effect, suggesting that they are protecting the plant through the promotion of the plant immune system. This surprising finding arises the question of its possible functionality and application to protect several different crops.

Developing tools to decipher the mechanisms of Systemin-Induced Resistance

Pastor-Fernández J., Pastor V., Sánchez-Bel P., Sanmartín N. and Flors V.
Metabolic Integration and Cell Signaling Laboratory, Plant Physiology Section, Department of Ciencias Agrarias y del Medio Natural, Universitat Jaume I, Castellón, Spain
e-mail: jupastor@uji.es

Systemin is short peptide from tomato that is considered a peptidic hormone. It is released upon wounding, pest and pathogen attack triggering a signalling cascade of plant defense responses, functioning as an amplifier of the plant immune system, termed phytocytokine. It is well studied that changes in endogenous levels of its precursor protein, Prosystemin, influences in the levels of tomato resistance against herbivores and pathogens. However very little is known about the induced-resistance triggered by its exogenous application. In our work we found that Systemin induces resistance against the necrotrophic fungi *Botrytis cinerea* through the amplification of several plant defense responses. On the one hand, we used Virus Induced Gene Silencing (VIGS) in order to study the implication of MPKs in the observed induced resistance against the fungi, as an early signalling triggered by the peptide. On the other hand, in a more holistic approach we made a non-targeted analysis of the proteomic and metabolomic rearrangement triggered by Systemin after a pathogen challenge and found that not only defense related molecules but also many pathways of the central metabolism were affected. Moreover, we observed that at the

metabolomic level the major changes occurred after the infection, displaying a typical priming profile.

Developing decision support systems based on protection efficacy to promote the use of microbial biocontrol agents in the field

Pressecq T.[ab], P. Nicot[a], M. Tchamitchian[b], M. Bardin[a]
[a]INRAE, Pathologie Végétale, 84140 Montfavet, France; [b]INRAE, Ecodéveloppement, 84000 Avignon, France
e-mail: thomas.pressecq@inrae.fr

Microbial biocontrol agents are promising tools to reduce the use of chemical pesticides in agriculture. They represent one of the few means of intervention in organic farming, which makes the success of their use particularly important. Due to their special characteristics (living organisms), their deployment is more complex than applying chemical molecules. This can hinder their adoption and foster the variability of their efficacy. Taking this complexity into account would make their use more reliable. This complexity is difficult to envisage in simple product data sheets. Thus, to facilitate advice to farmers, it is necessary to develop decision support systems, integrating the biological properties of biocontrol agents, those of plant pathogens, and the characteristics of cropping systems. Therefore, our first objective is to identify and prioritize the factors governing the efficacy of microbial biocontrol agents. To this end, the conduction of surveys of farmers, advisers and producers of biocontrol agents and a meta-analysis of scientific and technical literature is currently underway. Preliminary results of this analysis will be presented during this talk.

The situation of the biological control against pests and plant disease based on biopesticides in Tunisia

Krida G. & Hamada W.
National Agronomic Institute of Tunisia. 43, Av Charles Nicolle, 1082 Tunis, Tunisia
e-mail: ghazi.krida.inat@gmail.com, w_hamada@yahoo.com

In Tunisia, different research centers, Institutes as well as University are focusing their work on the identification of biological control agents against plant disease and insects. Indeed, several attempts have been made to identify beneficial microorganism (bacteria and fungi) as well as plant extracts (including essential oils mainly) that could be used to reduce biotic stress on plants either as biofungicide, bioinsecticide or biostimulant (as a plant defense inducer). As matter of examples, different *Bacillus* species were isolated, purified, identified and characterized for their biological activities on targeted pest. Molecular tools have been used for the appropriate identification of the bacteria and subsequently the biological activity was assessed *in vitro*, controlled conditions (growth chamber) and later in experimental station for field trial. Subsequently, different successful research results which were obtained and were published in peer per view journals. However, only one project was able to give rise to an applied biopesticide which was developed at high scale level, went through official registration and was commercialized and used by farmers.

This was the case of a nematicide based on two Bacillus species which is used by some farmers mainly for protected crops (such as tomato and cucurbits). As a matter of the pesticide market, different biopesticides are commonly used by farmers. As matter of example, PrevAm, a natural product based on citrus extracts is used as fungicide (against powdery mildew and gray mold) as well as insecticide (white fly and mites). Beneficial bacteria are also available such as *B. subtilis* as biofungicide against mold in tomato, *B. thuriengiensis* against several pest insects such as the Citrus flower moth and the pomegranate butterfly *Deudorix livia, and B. sphaericus against mosquitoes*. It is also the case of beneficial fungi such as *Trichoderma* sp. used as biofungicide aganst soil born disease (*Fusarium* and *Pythium*). The last example is an extract from bacteria which is spinosad, a very common insecticide, used as example against fruit fly but also other insects. It is important to mention that Tunisian regulation encourage the introduction into eh market of biopesticide as the cost of registration is half of a conventional one.

Hormonal/Algal-mediated priming and biological control agents as alternatives to agrochemicals for the control of *Orobanche* in legumes

Mentag R.
National Institute of Agricultural Research (INRA-Morocco), Regional Center of Agricultural Research of Rabat, Av. Mohamed Belarbi Alaoui, BP. 6356, Rabat-Instituts, 10101, Morocco
e-mail: rachidmentag@yahoo.ca; rachid.mentag@inra.ma

Plants are targets of several pathogens including parasitic plants that can be highly destructive. *Orobanche crenata* is a root holoparasite of legumes crops such as faba bean, lentil and chickpea. It is a true agronomic scourge of the Mediterranean area because of its biological particularities which make it difficult to control. In fact, several control strategies have been developed, but only marginal successes have been achieved. The ineffectiveness and/or the drawbacks of the control methods currently available make the search for other solutions preserving the culture and the environment necessary. Last 3 years, several eco-friendly and sustainable methods such as the use of Hormonal or Algal-mediated priming and also the use of biological control agents have been developed by our group in the aim of controlling this parasitic weed. Results were conclusive and efficient treatments have been proposed. Thus, for faba bean and lentil, hormonal treatments using SA and IAA provided high protection levels reaching 75% compared to the untreated control plants. Also, foliar application of micro-algae extracts reduced both *O. crenata* severity and incidence on faba bean plants under both field and controlled conditions. Our results showed also that arbuscular mycorrhizal fungi have a direct effect on legumes infestation level by this parasitic weed. This effect results in reduced attachment, emergence and biomass of *O. crenata.* This protection against *O. crenata* was correlated with the accumulation of phenolic compounds, stimulation of PAL, POX and PPO enzymes activities. All these biocontrol tools will be valuable for elaborating an integrated pest management package for an efficient and sustainable control of *O. crenata* in legumes.

Exogenous application of RNAi molecules in plants: achievements, limitations, and perspectives.

Dalakouras A.[1, 2]
[1]*Institute of Industrial and Forage Crops, ELGO-DEMETER, Larissa, Greece*
[2]*Institute of Plant Breeding and Genetic Resources ELGO-DEMETER, Thermi, Greece*
e-mail: nasosdal@gmail.com

Exogenous application of double stranded RNA molecules in the field is a promising tool to trigger transgene-free RNA interference (RNAi) against a plethora of targets and thus combat weeds, viruses, viroids, fungi and insects. Here, we will provide a succinct overview by highlighting breakthrough achievements, underlining inherent limitations and, finally, suggesting ways to further increase the efficiency and applicability of this tool in modern crop protection platforms.

Efficacy of commercial fungal bio-fertilizers

Kokkoris V.[1, 2]
[1]*Department of Biology, University of Ottawa, Canada*
[2]*Agriculture and Agri-Food Canada, Ottawa Research and Development Centre, Ottawa, Canada*
e-mail: bill.kokkoris@gmail.com

The use of fungal bio-fertilizers in agriculture is rapidly expanding from greenhouse to large-scale field applications promising to reduce chemical fertilization while sustaining high crop yields. The application of such products is unregulated and although they are produced and used on a global scale, their efficacy is not consistent. It has been found that their efficacy, establishment and persistence differ from field to field. Furthermore, these products have the potential to spread beyond the agricultural fields and negatively affect non-target plants. In addition, commercialized fungi are mass produced *in-vitro*, which means that they are produced in unnatural lab conditions for long periods of time. This practice is increasing their ability to produce spores and is making them less synergetic to the plants by reducing the nutritional benefit. The unregulated spread of fungal bio-fertilizers that contain aggressive fungi, can be an inefficient practice that might have the potential to negatively affect natural ecosystems.

Panel: EU Policies

Keynote Talk

Pathways for advancing pesticide policies

Finger R.
ETH Zurich, Agricultural Economics and Policy Group, Zurich, Switzerland
e-mail: rofinger@ethz.ch

Numerous pesticide policies have been introduced to mitigate the risks of pesticide use, but most have not been successful in reaching usage reduction on goals. Here, we name key challenges for the reduction of environmental and health risks from agricultural pesticide use and develop a framework for improving current policies. We demonstrate the need for policies to encompass all actors in the food value chain. By adopting a multi- disciplinary approach, we suggest ten key steps to achieve a reduction in pesticide risks. We highlight how new technologies and regulatory frameworks can be implemented and aligned with all actors in food value chains. Finally, we discuss major trade- offs and areas of tension with other agricultural policy goals and propose a holistic approach to advancing pesticide policies.

Möhring, N., Ingold, K., Kudsk, P., Martin-Laurent, F., Niggli, U., Siegrist, M., Studer, B., Walter, A., Finger, R. (2020). Pathways for advancing pesticide policies. Nature Food 1, 535–540, doi: 10.1038/s43016-020-00141-4

Critical overview of the data requirement for microbial active substances used in plan protection products in the EU

Hernández Jerez A.F.[1, 2]
Department of Legal Medicine and Toxicology. University of Granada, Granada, Spain
Instituto de Investigación Biosanitaria ibs, Granada, Spain
e-mail: ajerez@ugr.es

Although current crop protection is based on the use of chemical pesticides, the impact of these compounds on human, animal and environmental health has led to the development of Integrated Pest Management (IPM) as an alternative approach. A component of IPM is biological pest control by using biopesticides, which include microbial active substances. These agents have proven potential for pest management and have little impact on non-target organisms. However, microbial plant protection products are subject to a mandatory authorization process to comply with legal requirements to ensure safety to human health and the environment. Microbial active substances are evaluated and registered following the same regulatory system as for chemical pesticides. However, many of the data requirements and evaluation criteria are not relevant to biological pest control agents. The data needed for the approval of a microbial active substance in the EU must be sufficient to perform a full risk assessment. The ability of microorganisms to proliferate makes a clear difference between chemical and microbial pesticides. Hazards arising from microorganisms should therefore be assessed differently from chemicals because of their inherent features. The potential of microorganisms to replicate and cause infection or pathogenicity in humans or animals must be carefully assessed, as well as their potential for multiplication in the environment. Although microorganisms are unlikely to be toxic by themselves, they may produce toxic metabolites. They may also cause sensitising reactions and non-specific effects such as an inflammatory response after exposure via inhalation. All relevant knowledge and information available in the literature should be provided by applicants, taking into account previous taxonomic names which may have been used in past publications. Data requirements (laid down in Reg.(EU) No. 283/2013 for active substance and Reg.(EU) No. 284/2013 for plant protection products) should be fulfilled at strain level unless it can be proved that it is not necessary for the particular strain in question.

PPPs and F2F, a concord or a tug of war?

Theodoris P.
Hellenic Republic, Ministry of Rural Development and Food, General Directorate of Agriculture, Directorate of Plant Protection, Department of Plant Protection Products, Athens Greece
e-mail: ptheodoris@minagric.gr

“Safeguarding Europe’s food sufficiency and security, as well as the sustainability and biosecurity of the general vegetation and all associated environmental, financial, social and cultural services it provides, requires effective plant protection and support of our agricultural production base, while at the same time the latter is called upon to cope with conditions of unfair global competition.

Although the European regulatory framework for authorizing and using plant protection products (PPP) is considered the stringiest in the world, certain nationally derived small-minded political agendas seek to discredit it, through misinformation, scaremongering and exaggeration, whilst unfortunately the proposal at hand, a patchwork of wishful goals and generalizations, many times contradictory, pays lip-service to the same narrative. Nevertheless, the proposed strategy could even be considered timid, exhausting itself in an attempt to restrict the use of PPPs, by setting as its pinnacle an uncritical percentage reduction target, without heed for the need to rationalize the evaluation procedures of PPPs, through the unification of its fragmented underlying legislation. An integrated new strategy regarding the use of PPPs should therefor intervene at the steps of the current authorization procedure where the discrepancies between the different competent authorities are primarily recorded, in order to make amends for the negative communication impact this practice has accumulated. It should set common safety denominators for food and feed commodities produced within or imported to the EU, eliminating the possibility for different residue tolerances between those two categories. It should alleviate the loss of competitiveness suffered by European food producers, allowing them access to plant protection tools deemed to be safe. It should facilitate the adoption of new technologies, opting for dynamic and flexible procedures without foregone deadlocks and exclusions. It should bring to the fore the nutritional wealth of minor regional crops, inextricably linked to our cultural backgrounds and rural sustainability, while protecting the entire wealth of our continent's vegetation and the multifarious services it provides, from the major phytosanitary threat of the Invasive alien species (IAS), by procuring an adequate and effective 'firewall' of chemical protection. To attain the aforementioned, scientific proof must be reinstated as decision making criterion, weighting all evidences available and not only those in line with opinions prevailing among centers of power. The implementation of the precautionary principle must also be subjected to the employment of the subsidiarity principle, exploiting not only the altiloquent centralized study of scientific modeling, but also regional expertise and realities. Equitable representation at the centers of power must be possible for all European citizens, by eliminating privileged relations, opportunities to express positions and community funding currently reserved for politically motivated single-issue pressure entities, exhibiting behind the scenes mentality. Decisions must be predictable and based upon legislation, minimizing the influence of minority driven 'citizen initiatives' peddled as referendums, or at least enable also their disapproval by the European citizens. In short, the new strategy has to break loose from the shortsighted politics, the bias and the populism of an ill-considered public image. Objectively and on the basis of equal participation, of veritable involved stakeholders, it has to analyze the current situation and assess the impact of the actions proposed. Only then can it become convincing and pertinent."

Regulation of Biopesticides in Tunisia and their use in national programs of pest control

Limem E., Ganhouba H., Mhafdhi M., Moussa C. & Adel J.
Plant health and control of agricultural products Directorate, Ministry of agriculture, water resources and fisheries. Tunisia
e-mail: essia.limem@hotmail.com

Biopesticides are among the most innovative tools of plant protection. In Tunisia, although the use of these products remains very limited, regulation encourages introduction of new biopesticides

and their marketing at large level. In fact, according to the article 3 of the decision of the minister of agriculture and environment of the 3rd of June 2011, Biopesticides are exempt of 50% of registration fees compared to conventional products. Although these incentives, use of biopesticides still not developed in Tunisia. Quantities imported are insignificant compared to conventional pesticides. In national programs, use of biopesticides is very recommended. For the control of Citrus Medfly, 13500 Ha of citrus orchards are treated by Spinosad through aerial and terrestrial spray. The same product is used in another formulation for the storage of about 40.000 tons of potatoes by artisanal way. Furthermore, Spinosad is used to control *Prays oleae* in the national campaign of treatment of olive pests within the organic orchards. In the official phytosanitary index, six products that are registered as biopesticides are used essentially as fungicides, nematicides and insecticides. Many other products are being tested in the field for their effectiveness, to be registered soon. Biopesticides are the tools of tomorrow for plant protection. The Ministry of agriculture is implementing a strategy to encourage their use for better production, to lead to safer products and to guarantee good health to users and consumers.

Fertilizer Products Regulatory Outlook

Giannakopoulou F., Katsoulieri Ag.
Hellenic Fertilizers' Association, 62 Panormou str., 11523, Athens, Greece
e-mail: fotini.giannakopoulou@spel.gr

The Fertilizer Products regulatory framework in Greece is today complex, unclear, fragmented, and lacks behind the new technological and research developments, especially for non-mineral fertilizers. According to the national regulation, products that are not included in EU 2003/2003 regulation, commonly included in 2 categories as: "special fertilizer products" or "products of special action in agriculture" and the producer should follow a registration procedure before introducing these products into the market. On the upside, most of EU countries are facing respective problems. As nearly half of the fertilizers on the EU market are currently not covered by the existing legislation, the European Commission envisages a replacement of the currently valid Regulation (EC) No 2003/2003, expanding its scope to secondary raw material by covering a wide range of fertilizer products, such as organic fertilizers, organo-mineral fertilizers, growing media or biostimulants. Among the new product function categories (PFC), biostimulants (of microbial and non-microbial origin) are included, targeting nutrient use efficiency, tolerance to abiotic stress and crop quality traits, while biostimulants with direct action against plant pathogen and pests are excluded. Thus, via this regulation, biostimulants have been recognized as a distinct category of agricultural inputs and the distribution of CE-marked biostimulants across Europe according to harmonized rules will be feasible. The new EU Fertilizing Products Regulation (EU) 2019/1009 will fully apply from 16 July 2022. The adoption of Fertilizing Product Regulation is part of the Circular Economy Action Plan and with this framework in place, the EU adopts new rules for placing fertilizing products on the EU market and provides the opportunity for the plant nutrition industry to use recycled by-products as raw materials for fertilizers. Moreover, it sets new definitions and new evaluation procedures for fertilizer products as well as new maximum concentration limits for contaminants. The new EU fertilizer regulation raises new challenges, opportunities and concerns to the industry. The new procedures to place fertilizing products on the market should ensure confidence of consumers and public authorities, and should meet the expectation of farmers for high quality food production.

Sustainable control of pests

Carvalho P.C.
Direção-Geral de Alimentação e Veterinária, Lisboa, Portugal
e-mail: pcarvalho@dgav.pt

The southern countries, due to their diversity of crops and climatic conditions, are subject to greater plant health risks. The increasing globalization of goods and movement of people promotes the entry and dispersion of plant pests, forcing greater care in the prevention and rapid action in case of detection of new pest outbreaks. The effect of climate change, the drastic reduction of active substances available in the EU, which makes it difficult for farmers to control common pests and which are currently causing major negative impacts on several traditional crops, must also be taken into account. The Green Deal and the Farm to Fork strategy, aim at defining European policies that will lead to an environmentally sustainable agriculture, allowing the production of healthier food while ensuring farmers' incomes. New forms of crop protection must be implemented such as further integration of various forms of plant pests control, by promoting the sustainable use of pesticides, together with the promotion of the use of bio-pesticides, bio-technical control and the coordination of plant health control among farmers. Similarly, the biological control agents should assume an increasing role, including in the control of quarantine pest, and to this end a harmonization of the European regulatory framework in this area is urgently needed. Strong support for innovation and research in the area of crop protection as well as encouraging precision farming should be on the agenda of the European Commission, to pursue the major objectives of the Green Deal, ensuring the economic and social sustainability of European agriculture.

Panel: Industry talks

Keynote Talk

The role of Bioprotection in the transition to regenerative agriculture

Lewis J.
IBMA - International Biocontrol Manufacturers Association AISBL Brussels, Belgium
e-mail: jennifer.lewis@ibma-global.org

Biocontrol markets are growing at over 10% per annum with a global market around 4 bn US$. The International Biocontrol Manufacturers Association is the voice of the bicontrol industry and has over 250 members 85% of which are SMEs producing novel solutions for bioprotection. IBMA covers the 4 main types of bioprotection, macrobials, microbials and semiochemicals and natural substances. Bioprotection provides solutions for regenerative agriculture, enhancing biodiversity above and below ground and so contributing to soil health and so indirectly to soil functions such as water management and carbon cycling. Healthy soil is key in providing a legacy for future generations of farmers and a healthy planet. The transition to a regenerative agriculture that puts biology first needs to start now as part of the climate change response. All available tools are required to ensure healthy plants, including plant nutrition, plant protection and digital techniques. The coming together of the technologies in these areas is key to ensuring a rapid transition to a resilient and regenerative agriculture Training and best practice sharing among advisers and farmers is a key part of the transition and this should be incentivised through the new CAP schemes at national level in the National Strategic Plans. For plant protection we need an enabling regulation that is fully adapted to bioprotection. Biostimulants are considered as fertilizers in the new fertilizer legislation due to be implemented in 2022. This is good news for biostimulants but risks delaying registration of plant protection uses as the onerous maladapted PPP regulation for bioprotection leaves registrants reluctant and sometimes unable to pay for the studies on plant protection products. This is a regulatory anomaly as often it is the same active substances used in biostimulants as used in bioprotection, albeit in different quantities and their "free" use in biostimulants means they will not be used as bioprotectants. Such distortion in the regulation risks delaying the transition to a biology first agriculture and is a further illustration of the need for an adapted regulation of bioprotection use in PPPs.

Perspective from the industry on the registration and development of microbial based biopesticides

Frati S.
Biobest Group NV, Westerlo, Belgium
e-mail: Sandro.Frati@biobestgroup.com

Microbial based biocontrol agents are meeting an enormous success, thanks to the higher attention of the public towards a sustainable management of the environment that translates also into legislative policies that encouraged the use of biological products whenever available. Historically biological pesticides were used only in organic farming, but this positive trend translated into an increasing diffusion of these products also in conventional and integrated crop protection strategies.
Microbial product present unique characteristics compared to their synthetic counterparts, that should reflect in different strategies both for their development and for the regulatory procedures. In order to overcome the challenge of feeding an increasing higher amount of people in the world without depleting the natural resources available, in the coming years scientists, industry and regulators will have to work together for a more organic and cohesive development of sustainable alternatives to chemicals for the protection of the crops.

NOVACRID, a fungal biopesticide to control locust and grasshoppers – from the lab to the market

Deloge M.[1], Dussart JF[2], Azeddine S[1], El Ayadi M[1], Monnier N[2], Chebil A[2], Thevenieau[2] F.
[1]R&D- Groupe Eléphant Vert, Agropolis GI5-GI6, commune Mejjate, Meknès, MOROCCO
[2] R&D- Groupe Eléphant Vert, 5 cours du Danube, 77700 Serris, France
e-mail: magali.deloge@elephant-vert.com

Locusts and economically important grasshoppers are among the most notorious insect pests, about a 100 species altogether worldwide. When locust populations build up, they exhibit gregarious and migratory behaviour, leading to the formation of hopper bands and spectacular swarms with an enormous potential for crop destruction threatening the livelihoods of more than 1/10 of the world's population. The potential invasion area of one species, the desert locust, covers 20% of the earth's land surface, reaching from the West African coast to the Indian subcontinent. Also, more than 3 million hectares are treated with insecticides every year against Locusts, in Central Asia. Eléphant Vert has developed NOVACRID in its laboratory, a biopesticide to control locusts and grasshoppers. It is composed of the strain *Metarhizium acridum* EVCH0077. The genus *Metarhizium* is naturally present in the upper layer of the soil almost everywhere in the world, but the distribution of the species *acridum* is rather tropical and subtropical. Field performance was evaluated in Asia and Africa. The efficacy of NOVACRID was exceeding 80% at low rate. The action of product is slower but more persistent than chemical products, with a comparable efficacy. This product is an alternative to chemical pesticide against locusts and grasshoppers. These aspects of development of these NEW product Novacrid®, from laboratory to the market, will be presented.

Applied aspects of priming and legal regulations

Artal J.M.
Francisco R. Artal S.L., Madrid, Spain
e-mail: gerencia@artal.net

Modern agriculture requires tools which keep safe farmers and consumers' health, as well as being respectful of auxiliary fauna and the environment. The strategies for controlling pests and diseases by means of highly effective active ingredients have become obsolete due to their high lethality and because by not being selective they damage the useful fauna. Modern agriculture requires the combination of different techniques and / or less aggressive technologies, which means we must develop technologies that allow a safe, sustainable and highly productive agriculture. Immunological activators “PRIMING” effect have proven to be an effective technology as a tool for improving crops production in combination with other methods. We show an example of the effectiveness of this new technology in tomato crops and comment the legal framework for the commercialization of alternative and environmentally friendly technologies.

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