9th Conference on Integrated Protection of Stored Products IPSP 2013

Programme & Abstracts

Agora - University Bordeaux 1
TALENCE, FRANCE

1 - 4 July, 2013

https://colloque.inra.fr/iobc-ipsp-2013conference

Table of content

Foreword

This year, the **9th IOBC 2013 Conference on Integrated Protection of Stored Products (IPSP)** will be organized for the first time in France by the INRA Research Unit, "Mycology and Food Safety" of the INRA Research Centre of Bordeaux-Aquitaine.

This scientific meeting, held every two years, under the auspices of the **International Organization for Biological and integrated Control (IOBC)**, regularly brings together scientists, engineers, industry players, stakeholders and professionals in post-harvest agro-food chain sanitation quality and safety to report the state of progress in applied research in stored product integrated protection.
The socio-economic reality of increasing safety and quality traceability concern by foodstuffs purchasers, processed food manufacturers, food supply chains, consumer demand, and the application of recent **European Regulations of** "**Hygiene package**" **and** "**Pesticide package**" in all food chains accelerate the need for greater production of applied research results. The real challenge of developing new approaches and the application of necessary changes in current programs of integrated pest management in food processing plants and in stored products is impeded by a global reduction of human and material resources available for research and development on pests and pathogens contamination of durable agricultural products and derived food products.

Regardless of this critical situation, the 9th IPSP 2013 Conference is **meeting the challenge for the transition towards an efficient control of post-harvest pests and pathogens with both the limitation chemical use and the improvement of risk control of infestation or contamination of durable foods by insect pests, molds or their impurities and toxins**. At IPSP 2013 Conference, the optimal solutions for tackling this difficult challenge will be presented through 90 communications comprising the scientific program. Their authors come from more than 25 countries, confirming the interest of the international scientific community for this IPSP Conference.

The Local Organizing Committee of IPSP 2013 wishes to thank all the contributors making this Conference intriguing and relevant. We are grateful to IOBC and INRA for their advice and support for the organisation. We really appreciate the financial support of our sponsors and organizations and wish to thank the Scientific Advisory Committee for their advice in building the scientific program of this Conference. Thank you also to all the authors of communications for making the work of the Organizing Committee possible.

Francis Fleurat-Lessard

Avant-propos

La **9ème Conference OILB-SROP sur la Protection Intégrée des Produits stockés (PIPS)** est organisée pour la 1ère fois par l'U.R. INRA "Mycologie et Sécurité des Aliments" (MycSA) du Centre INRA de Bordeaux-Aquitaine.

Cette Conférence biennale, placée sous les auspices de l'**Organisation Internationale de Lutte Biologique et Intégrée (OILB)**, regroupe des scientifiques, ingénieurs, acteurs économiques et professionnels du monde entier intéressés par la maîtrise de qualité et la sécurité sanitaire dans les chaînes alimentaires post-récolte et pour faire l'état d'avancement de la recherche appliquée en Protection Intégrée des Produits stockés. Dans le contexte socio-économique actuel, la sécurité sanitaire et la traçabilité sont prioritairement exigées par les traders de produits alimentaires, les entreprises de transformations, les distributeurs ou les consommateurs. L'application des récents règlements européens du "**paquet hygiène**" et du "**paquet pesticide**" dans toutes les chaînes alimentaires accélère les besoins en résultats de recherche. Le challenge à relever consiste à développer de nouvelles approches et applications pratiques de solutions innovantes en protection intégrée contre les ravageurs et les contaminations des chaînes alimentaires après récolte. Cet objectif est contrecarré par la diminution constante du nombre de chercheurs qui se consacrent à ce domaine de recherche dans le monde.

Toutefois, la 9ème Conférence PIPS 2013 contribue à relever ce challenge de la transition vers une maitrise des ravageurs, agents pathogènes ou contaminants des denrées après-récolte en limitant l'utilisation des pesticides tout en améliorant la prévision et la maîtrise des risques d'infestation ou de contamination des produits alimentaires durables par leurs impuretés ou leurs toxines. Pour la Conférence PIPS 2013, 90 communications ont été présentées pour contribuer à relever ce challenge. Leurs auteurs sont issus de plus de 25 pays différents, ce qui confirme l'intérêt de la communauté scientifique internationale pour cette thématique de la protection intégrée.

Le Comité d'Organisation de la Conférence PIPS 2013 remercie tous ceux qui ont contribué au succès et à l'attractivité de cette Conférence et en particulier l'OILB et l'INRA. Le soutien des entreprises et institutions qui ont participé financièrement à cette entreprise a été très apprécié. Le travail du comité scientifique pour effectuer la sélection difficile des communications orales ainsi que les efforts de l'ensemble des auteurs des communications (orales ou affichées) sont également à remercier pour la qualité et la rigueur scientifique de leurs prestations.

Francis Fleurat-Lessard

Integrated Protection of Stored Products

Protection Intégrée des Denrées Stockées

Working Group of IOBC/WPRS (*OILB/SROP*)

9th Conference 2013 – INRA Bordeaux-Aquitaine (France)

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IOBC Liaison Officer

Phyllis Weintraub (Israël)

IOBC IPSP WG Convenor

Christos Athanassiou (Greece)

Integrated Protection of Stored Products - 9th Conference
Bordeaux, France – 01-04 July 2013

Conference program general schedule

Time-table	Monday, July 1st	Tuesday, July 2nd	Wednesday, July 3rd		Thursday, July 4th
Location	Conference Hall	Auditorium Agora	(1) Auditorium Agora	(2) Room "Badiane"	Auditorium Agora
08:00-08:30		Delegates Registration & Poster setting			
08.30-09.00			Session 3 (2): Phytochemicals and semiochemicals in IPSP programs	Session 5 (1): Chemical control in stored product IPM programs	Session 4: Non-chemical control of pests and pathogens at post-harvest stage
09.00-09.30		Welcome address and Introduction talks			
09.30-10.00					
10.00-10.30		Session 1: Recent advances in IPSP and current trends in post-harvest IPM			
10.30-11.00					
11.00-11.30					
11.30-12.00					
12.00-12.30			Lunch		Lunch
12.30-13.00		Lunch			
13.00-13.30					
13.30-14.00		Session 2: Biology and ecology of S-P pests and pathogens useful for IPSP	Bordeaux City discovery		Session 5 (2): Chemical control in stored product IPM programs
14.00-14.30					
14.30-15.00					
15.00-15.30					Session 6: IPSP strategies and DSS
15.30-16.00					
16.00-16.30	Delegates Registration and poster installation				
16.30-17.00		Session 3 (1): Phytochemicals and semiochemicals in IPSP programs			Closing Ceremony
17.00-17.30					
17.30-18.00			Reception at INRA Wine Estate - Visit of INRA vineyard - Wine tasting initiation party		
18.00-18.30	Welcome cocktail				
18.30-19.00					
19.00-19.30			Banquet dinner at INRA wine estate reception room		
19.30-20.00					
20.00-20.30					
20.30-21.00					
21.00-22.30					

Timetable and List of oral presentations

Monday 01 July

16:00 – 19:00	**Registration & Poster setting (Hall and Cloister of Conference Center)**	
19:00 – 20:00	**Welcome cocktail** (Hall and Cloister of Conference Center)	

Tuesday 02 July (Conference Center – Hall and **Auditorium**)

08:15 – 09:00	**Registration (continue) & Poster setting**		
09:00 – 09:30	**Welcome Addresses**	INRA Officials	
09:30 – 09:45	**IOBC Liaison Officer and IOBC-IPSP WG Convenor introduction**	Phyllis Weintraub and Christos Athanassiou	
09:45 – 10:00	**Conference Organisation Notes by Local Host**	Francis Fleurat-Lessard	
10:00 – 12:40	**Session 1: Recent advances in IPSP and Post-Harvest IPM current trends** **Chairpersons: Phyllis Weintraub & M. Otilia Carvalho**		**Page**
10:00 – 10:30	Recent advances and future directions in IPM programs	J. Campbell	**19**
10:30 – 10:50	Metal silos has been turned into safe keeping facilities	G. Zakladnoy	**20**
10:50 – 11:10	Carifend TM and alternative method to protect stored tobacco	E. Birner	**21**
11:10 – 11:40	**Coffee break** (Poster visit recommended)		
11:40 – 12:40	**Session 1: continue**		
11:40 – 12:00	Field efficacy of *B. bassiana*, DE and Imidacloprid against stored grain insect pests	W. Wakil	**22**
12:00 – 12:20	Facilitating safe fumigation with QuickPHlo phosphine generators	P. Asher	**23**
12:20 – 12:40	Does hermetic grain storage make sense in Central Europa?	C. Adler	**24**
12:50 – 14:00	**Lunch (self-service)** (Poster visit recommended)		

14:00 – 15:50	**Session 2: Biology and ecology of S-P pests and pathogens in IPSP** **Chairpersons: George Opit & Christos Athanassiou**		**Page**
14:00 – 14:30	Tools for detecting pest contamination in stored raw materials	J. Riudavets	**31**
14:30 – 14:50	Corks damaged by *Nemapogon granellus* in Toscan wine	P. Trematerra	**32**
14:50 – 15:10	Stored product insects and their natural ennemies in Germany	M. Schoeller	**33**
15:10 – 15:30	Light filth tests on semolina and pasta	L. Limonta	**34**
15:30 – 15:50	Insecticidal effect of freezing on stored-product insects	J. Throne & C. Athanassiou	**35**
15:50 – 16:20	**Coffee break** (Poster visit recommended)		

Tuesday 02 July (Conference Center – Hall and Auditorium)

16:20 – 17:20	**Session 2: continue**		
16:20 – 16:40	Ten years of food complaints about cereal and by-products	S. Savoldelli	**36**
16:40 – 17:00	Populations grow of cigarette beetle on stored tobacco under different climates	M. Otilia Carvalho	**37**
17:00 – 17:20	Detection and mean retention efficiency of cracked corn and food baits for s-p insects	B. Subramanyam	**38**
17:30 – 19:00	**Session 3: Phytochemicals and semio-chemicals use in stored-product IPM** **Chairpersons: Catherine Regnault-Roger & Ali A. Isikber**		
17:30 – 18:00	Phytochemicals and semiochemical use in IPSP programs	L. Tapondjou	**51**
18:00 – 18:20	Suppression of *Plodia interpunctella* moth population by mating disruption	M. Kostyukovsky	**52**
18:20 – 18:40	High density trapping of *S. oryzae* in wheat with pheromone baited traps	F. Fleurat-Lessard	**53**
18:40 – 19:00	Effect of drying regime on insecticidal efficacy of Cameroonian neem	H.K. Tofel	**54**

Free evening

Wednesday 03 July (Two different meeting rooms: "Badiane" and Auditorium)

Auditorium

08:40 – 10:20	**Session 3: Phytochemicals and semio-chemicals use in stored-product IPM (continue)**		**Page**
08:40 – 09:00	Insecticidal formulation from *Ocimum gratissimum* oils and clays	P. Chalier	**55**
09:00 – 09:20	(Re)discovering cucujolides for *O. surinamensis* and *Cephalonomia tarsalis* control	J. Collatz	**56**
09:20 – 09:40	Screening of plant extracts as repellent against S-P insects	B.R. Guruprasad	**57**
09:40 – 10:00	Utilization of saturated atmospheres of *Syzygium aromaticum* and *Mentha pullegium*	A. Magro	**58**
10:00 – 10:20	Comparative insecticidal efficacy of fossilshield and neempro against *S. zeamais*	E. N. Nukenine	**59**
10:20 – 10:50	**Coffee break** (Poster visit recommended)		

Wednesday 03 July

Auditorium	(continue)		
10:50 – 11:50	**Session 3 Phytochemicals and semio-chemicals use (continue)**		
10:50 – 11:10	Mating disruption of stored product *Pyralidae:* large-scale trials in Europe	C. Athanassiou & *al.*	**60**
11:10 – 11:30	Small bin trial of pea extract mixed with pyrethrins to control stored-product insects (*possibly withdrawn*)	P.G. Fields	**61**
Session 4 11:30 – 11:50	Supercooling capacity of endoparasitoid *Venturia canescens* (Hym.; Ichneumonidae)	S. Andreadis	**73**

Wednesday 03 July

Room "Badiane"

08:40 – 10:20	**Session 5: Chemical control in stored product IPM programs** **Chairpersons: Shlomo Navarro & Yann Ciesla**		**Page**
08:40 – 09:10	Chemical Control in Stored Products (keynote 1)	F. Arthur	**97**
09:10 – 09:40	Relative importance of fumigation in stored-grain IPM in some EU countries (keynote 2)	P. Ducom, C. Reichmuth & E. Frérot	**98**
09:40 – 10:00	Phosphine fumigation of sunflower seeds: efficacy on insect pests and residues	S. Dauguet	**99**

Room "Badiane" (Continue)

10:00 – 10:20	Physical/chemical control agent thresholds for action on storage insects	C.H. Bell	**100**
10:20 – 10:50	**Coffee break** (Poster visit recommended)		
10:50 – 12:10	**Session 5: Chemical control in S-P IPM programs (continue)**		
10:50 – 11:10	Phosphine generator SGF-M2 and fumigation technologies with its use	G. Malushkov	**101**
11:10 – 11:30	Improved speedbox® as an effective instrument for phosphine fumigation	M. Kostyukovsky	**102**
11:30 – 11:50	Influence of egg morphology on ovicidal efficacy of fumigants	G. Opit	**103**
11:50 – 12:10	Effect of deltamethrin and spinosad on phosphine resistant strains of stored-product insects	G. Flingelli	**104**

Wednesday 03 July (afternoon)

12:20 – 13:30	**Lunch** (Poster visit recommended)
13:45 – 18:30	**Free afternoon for the visit of Bordeaux City**
18:30 – 22:30	**Friendly convivial evening and banquet dinner**
18:30 – 19:00	Visit of INRA vineyard and wine making facilities
19:00 – 19:45	Aperitif and drinks at INRA wine estate reception room
19:45 – 22:30	Banquet dinner at INRA wine estate reception room

Thursday 04 July (Conference Center Auditorium)

08:40 – 10:30	**Session 4: Non-chemical control of P-H pests and pathogens programs** **Chairpersons: Cornel Adler & Matthias Schoeller**		**Page**
08:40 – 09:10	Non-chemical control in stored grain and other durables	C. Adler	**71**
09:10 – 09:30	Mortality of *Carpophilus hemipterus* eggs and larvae under thermal disinfestation	S. Navarro	**72**
09:30 – 09:50	The use of the parasitoid *Anisopteromalus calandrae* for the control of grain weevils	M. Solà	**74**
09:50 – 10:10	Legume entomotoxic type I albumins promising candidate for stored cereal protection	L. Karaki	**75**
10:10 – 10:30	Efficacy of biofumigation in stored product pest management	S. Papadopoulou	**76**
10:30 – 11:00	**Coffee break** (Poster visit recommended)		
11:00 – 12:20	**Session 4: Non-chemical control of P-H pests and pathogens programs** (continue)		
11:00 – 11:20	Development of climatic mapping and self-diagnosis software for cooling aeration	E. Losser	**77**
11:20 – 11:40	Efficacy of DE against the rice weevil after a preventive treatment of wheat	Y. Ciesla	**78**
11:40 – 12:00	Efficacy of some microbial control agents and inorganic insecticides	M. Sabbour	**79**
12:30 – 13:40	**Lunch** (last Poster visit recommended)		
13:50 – 15:10	**Session 5: Chemical control in stored product IPM programs** **Chairpersons: Shlomo Navarro & Yann Ciesla**		
13:50 – 14:10	Improving phosphine fumigation by sealing and using close loop	E. Bonjour	**105**
14:10 – 14:30	Residual toxicity of spinetoram on various surfaces to adult *Acanthoscelides obtectus*	A.A. Isikber	**106**
14:30 – 14:50	Phosphine resistance in the Indian meal moth infesting dates	J. Mediouni Ben Jemâa	**107**
14:50 – 15:10	Efficacy of β-cyfluthrin and chlorpyrifos methyl + deltamethrin on concrete surfaces	Bh. Subramanyam	**108**

15:10 – 15:40	**Coffee break** (Poster removal)		
15:40 – 16:50	**Session 6: IPSP decision support tools and integrated approach** **Chairpersons: Bhadriraju Subramanyam & Francis Fleurat-Lessard**		**Page**
15:40 – 16:10	Aspects related to decision support tools and IPM in food chain	P. Trematerra	**119**
16:10 – 16:30	Technical and economic analysis of pest management practice in 14 grain elevators	K. Crepon	**120**
16:30 – 16:50	Influence of storage practices and kind of structure on insect presence in grain bulks	M.-P. Leblanc & F. Fleurat-Lessard	**121**
16:50 – 17:15	**Closing Ceremony**	C. Athanassiou & F. Fleurat-Lessard	

List of posters

Session 1: Recent advances in IPSP and Post-Harvest IPM current trends
Chairpersons: Phyllis Weintraub & M. Otilia Carvalho

Session 2: Biology and ecology of S-P pests and pathogens useful in IPSP
Chairpersons: George Opit & Christos Athanassiou

Session 3: Phytochemicals and semio-chemicals use in stored-product IPM
Chairpersons: Catherine Regnault-Roger & Ali A. Isikber

Session 4: Non-chemical control of P-H pests and pathogens programs
Chairpersons: Cornel Adler & Matthias Schoeller

Session 5: Chemical control in Stored-Product IPM programs
Chairpersons: Shlomo Navarro & Yann Ciesla

Session 6: IPSP decision support tools and integrated approach

(no poster)

Session 1

Recent advances in IPSP and current trends in post-harvest IPM

Chairpersons:

Phyllis Weintraub (Israel) and Maria Otilia Carvalho (Portugal)

Oral communications: 6

Posters: 3

Timetable:

Tuesday 2nd July, 10h – 12h 40

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1 - Recent Advances and Future Directions in Integrated Stored-Product Insect Management Programs for the Food Industry

Abstract type: **Oral presentation (keynote)**

Campbell J.
United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, Manhattan, Kansas, USA
E-mail: james.campbell@ars.usda.gov

Abstract: This is a time of change for pest management of stored-product insects in food facilities such as mills, processing plants, warehouses, and retail stores. In general, the food industry has seen declining availability of broad-spectrum insecticides and increasing pressure from customers for adoption of 'greener' pest management tactics with less chemical pesticide inputs. As a result, there is an increased emphasis on integrated programs to manage pest populations. I will present and discuss these broad industry trends and the current constraints on implementing more effective integrated protection programs. Next, I will cover recent scientific and technological advances that are helping or have the potential to help facilitate a more integrated pest management approach. Some of the advances covered will include improved implementation and interpretation of monitoring programs, increased information available on pest populations and treatment efficacy in commercial facilities, application of mating disruption to post-harvest facilities, and development of new reduced risk insecticides and improved application methods. Finally, I will present my perspectives on future trends in the food industry and the research opportunities these present for the continued development of effective and sustainable integrated pest management programs.

Keywords: Integrated pest management, food industry, monitoring, insecticides.

2 - Metal silo has been turned into safe keeping grain facility

Abstract type: **Oral presentation**

Zakladnoy G.[1], Dogadinssi A.[2], Abdiushev M.[2], Soskin M.[2] & Markov Y.[3]
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[2]*"Melinvest" OJSC, Russia*
[3]*Kubansk branch SSI RRIG of RusAgroAcademy, Russia*
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Abstract: Metal silos used for grain storing are built in Russia in big numbers. Abrupt temperature changes in autumn from high day time to low night temperatures lead to over moistening of the warm grain top and silo walls adjoining layers. As a result the grain germinates & is injured by insects & molds. The storing facilities of the kind do not have the proper stored grain conditions monitoring system, they neither have mechanism to protect grain from being spoilt by insects & molds – the fact leading to mass grain damage. We have found the solution to the problem by incorporating into the facility three innovative systems in addition to the traditional ones (cleaning, drying, cooling). These systems are: - Stored Grain Conditions Remote Monitoring System (GRMS); - Recycling Fumigation in the Unmovable Grain System (RFGS); - Anti Insects Grain Preservation with Liquid Insecticides System (GPS); GRMS has special compatible sensors that monitor grain conditions in 9 parameters. The data is displayed on the monitor showing the instantaneous parameters data. The given data is saved in the system memory & depending on the grain conditions one of the three evaluations appears on the display: "Normal", "Troubled", "Dangerous". The sensors are equipped with special mechanisms enabling them to follow the grain mass while it is loaded into or unloaded from the silo; RFGS envisages: interchange of the ventilation and fumigation processes; humidity withdraw from the above grain space; phosphine generator; gas-air mixture recycling; fumigation process monitoring and adjusting; GPS comprises a pneumatic in-line insecticide sprayer and grain handling equipment.

Keywords: Metal bin, grain, insects, molds, remote monitoring, phosphine recycling, fumigation, liquid insecticides

3 - Carifend™: an alternative method to protect stored tobacco, demonstrated by laboratory trials and semi-commercial test systems under diverse climatic conditions

Abstract type: **Oral presentation**

Storck T., Robin M.-E., Canadas Pedraza P., De Paredes J. G., Khakimova D., Schaffert S., Perez-Sanchez R., Austin J.W., Weichel L. & Birner E.
BASF SE, APM/VE - LI554, 67117 Limburgerhof, Germany
E-mail: erich.birner@basf.com

Abstract: Globally there are limited tools available to protect fumigated stored tobacco from re-infestation by Cigarette beetle *Lasioderma serricorne* (F.) and Tobacco moth *Ephestia elutella* (Walker). Carifend™ is a new system designed to keep stored tobacco free of re-infestation from stored product pests. Registration approvals were obtained in accordance with local country guidelines, such as in Ecuador, France, Germany, Russia, Mexico and Brazil. The Carifend™ -System is a physical and chemical barrier which prevents adult insect immigration to tobacco protected with the Carifend™ -net. In some instances where poorly managed fumigations occur, insects which may emerge from stored tobacco are prevented from further cross-contaminating other un-infested stored tobacco. Mitigation of contact to tobacco by immigration from outside and emigration to stored tobacco is achieved by contact with α-cypermethrin coated Long Lasting Nets (or LLINs) installed over tobacco. The described method ensures no direct contact between insecticide treated nets and stored tobacco. A key benefit is that the Carifend™ -System provides continuous protection. Efficacy tests were conducted using small scale Carifend™ -Mini-Cubicles with 1m cages under both laboratory and warehouse conditions for protection of tobacco. The investigations were supported by medium scale semi-commercial trials to demonstrate the practical implementation of this technology. A cage with dimensions 4 m width x 8 m length x 6 m height (= 192 m) was employed. Western Europe, Central Europe and Near Eastern locations were evaluated to demonstrate the potential of the Carifend™ -System to provide prolonged protection against *E. elutella* and *L. serricorne* under different climatic conditions. Results from both laboratory and field trials demonstrated unequivocally that stored tobacco was effectively protected with the Carifend™ System. Utilization of this technology in combination with good warehouse sanitation practices and initial fumigations prior to the installation of Carifend™ provided up to 100% control against adult insects of both species. The Carifend™ System represents one of the most recent developments in insecticidal-textile technologies for protection of stored goods, which reduces the dependence on costly fumigation, improves multi-functional facility use, and affords maximum protection to valuable stored goodsKeywords: Metal bin, grain, insects, molds, remote monitoring, phosphine recycling, fumigation, liquid insecticides.

Keywords: Stored tobacco, insect, IPM, Carifend™, tobacco quality, tobacco quantity, *Ephestia elutella*, *Lasioderma serricorne*, IPM, continuous control

4 - Field efficacy of *Beauveria bassiana*, diatomaceous earth and Imidacloprid against two major stored grain insect pests

Abstract type: **Oral presentation**

Wakil W.[1], **Schmitt T.**[2]
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[2]*Department of Biogeography, Faculty Regional and Environmental Sciences, Trier University, Germany*
E-mail: waqaswakeel@hotmail.com

Abstract: The insecticidal efficacy of *Beauveria bassiana*, diatomaceous earth (DE) and the neonicotinoid Imidacloprid against *Tribolium castaneum* Herbst and *Cryptolestes ferrugineus* Stephens was investigated during field trials conducted on farms located in two districts of Punjab, Pakistan. In each district, 40 kg lot of wheat grain were treated with *Beauveria bassiana* (3 x 10^{10} conidia kg^{-1}), DE (150 ppm) and Imidacloprid (5.0 ppm) alone as well as in their possible combinations. Each lot was divided into four sub-samples (10 kg each), packed in polypropylene bags, labeled and stored at the farms under natural environmental conditions up to 180 d. Sampling was carried out after ever y 30 d to record the total number of dead and alive adults, percent grain damage in treated and untreated (control) grains. The results revealed a significant difference among the treatments, test insect species and the storage period. For each district, the combined treatments provided better control of all tested insect species compared with alone treatments. The least number of surviving adults and minimum percent grain damage was observed for Imidaclporid and DE combination, but combine treatment of DE treatment with *B. bassiana* provided the long-term protection than rest of the treatments. For all grain protectants, *C. ferrugineus* was found to be more susceptible than *T. castaneum*.

Keywords: Neonicotinoid, *B. bassiana*, stored products protection, *C. ferrugineus*, *T. castaneum*, Pakistan.

5 - Facilitating safe fumigation with QuickPHlo-R phosphine generators

Abstract type: **Oral presentation**

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Abstract: Aluminium Phosphide has been the primary choice of commercial fumigators for decades in most countries, except in France and few other countries. The use of phosphine is increasing world over with Methyl Bromide phase out. Conventional formulations of Aluminium Phosphide and Magnesium Phosphide are used for more than the past half century without improvement in the method of application or formulation. There are many limitations to conventional phosphine formulations. Fumigation with phosphine is considered a laborious, dirty and a job with many safety concerns, including fire hazard. The QuickPHlo - R aluminium phosphide formulation and the QuickPHlo phosphine generator series are developed to overcome these limitations and consumer food contamination limitations. The formulation is very safe to use. The QuickPHlo - R phosphine generator is very operator-friendly. This generator has a built-in deactivation system and scrubber to treat the residue of aluminium phosphide formulation, drastically reducing levels of active ingredient to safe levels for disposal. This new innovative technology has many advantages which guarantee safety and efficiency of fumigations.

Keywords: Quick-flow aluminium phosphide formulation, generator development, reducing active dose, safety improvement.

6 - Does hermetic grain storage make sense in Central Europa?

Abstract type: **Oral presentation**

Adler C. & N'Domo A.-F.
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Abstract: In 2007 EU withdrew the authorization of dichlorvos for stored product protection. Already in 2008, grain storages in Germany reported increasing problems with attack by flying insects, mainly moths during warm summer months. In a national research project we now determine the efforts needed to render horizontal grain storages hermetic following the Australian example. The effects that this may have on the quality of grain stored for several years are also monitored. Another aspect of the project is a laboratory study on vacuum packaging and the effects of various residual oxygen contents and different grain moisture contents on wheat quality. This is done in order to identify suitable methods for long-term grain storage with a mechanical barrier avoiding pest attack. The long-distance orientation of stored product insects is usually influenced by volatile cues. During the project grain volatiles are determined in and around grain storages to prove the correlation between a gradient of attractive volatiles and attack by flying insects. The long-term grain storages tested may be a model for storages of organic grain that can achieve a higher market price per ton but also for grain storage in general. Since in 2007/2008 the world-market value of grain doubled, an improved grain storage technology may be economically even more advisable than before.

Keywords: hermetic storage, anoxia, vacuum, volatiles, grain quality

7 - Integration of *Isaria fumosorosea* with enhanced diatomaceous earth DEBBM for the control of *Rhyzopertha dominica*

Abstract type: Poster

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Abstract: The efficacy of *Isaria fumosorosea* alone and combined with enhanced formulation of diatomaceous earth, DEBBM was assessed against lesser grain borer *Rhyzopertha dominica* F. (Coleoptera: Bostrychidae) under laboratory conditions on stored wheat. The fungus was applied to wheat grains at the rate of 3.60×10^{6}, 3.60×10^{8}, and 3.60×10^{10} conidia kg^{-1} alone, or in combination with 15 and 30 ppm of DEBBM. The treated grains after the introduction of adult *R. dominica* were held at 20, 25 and 30°C and with 56 and 75% RH. The mortality counts were made after 7, 10 and 15 d of exposure. Overall, the fungus was more effective at 25°C with 56% RH and caused the highest mortality of *R. dominica*. The mortality rate was increased by increasing temperature, concentration and exposure interval. For individual treatments, DE alone at its higher dose rate suppressed the progeny production more compared with *I. fumosorosea* alone. The combined use of tested grain protectants synergized the effect of each other and caused the highest mortality at 25°C and 56% RH. The findings of the present study demonstrated that *I. fumosorosea* and new DE formulation DEBBM can be used in combination for the effective control of *R. dominica* in stored wheat.

Keywords: *Isaria fumosorosea*, *Rhyzopertha dominica*, enhanced diatomaceous earth, DEBBM, wheat.

8- The combination of the parasitoid *Bracon hebetor* Say and gamma radiation as an IPM efficient strategy for controlling *Ephestia cautella* (Walker)

Abstract type: Poster

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Abstract: Three experiments were carried out in addition to the control to study the efficacy of Bracon hebetor and gamma radiation in controlling Ephestia cautella under laboratory conditions (26±10C & 50-60% RH). In the first experiment B. hebetor was released alone, while in the second experiment, E. cautella males exposed to 0.25 kGy of gamma radiation as a dose causing inherited sterility was released alone too, and in the third experiment B. hebetor and E. cautella exposed to 0.25 kGy of gamma radiation were released together in comparison with the control experiment in which none IPM agents was released. The results revealed that the mean number of alive E. cautella larvae after two generations were 4.3, 0.6 and 0.0, respectively in these three experiments in comparison with 121.3 larvae in the control experiment. Furthermore, the results illustrated that the mean number of E. cautella pupae were 3.0, 1.0 and 0.0 respectively in these three experiments too in comparison with 96.0 in the control experiment. In conclusion these results showed the importance of using the two IPM agents in reducing the percentage of infested dates to a very low level which resulted in preserving it for suitable period before manufacturing and marketing it nationally or internationally.

Keywords: *Bracon hebetor*, biocontrol, *Ephestia cautella*, gamma-radiation, combination

9 - Using the parasitoid *Trichogramma evanescens* in date palm orchards alone and with pheromone traps in date warehouses to control *Ephestia* spp. in three Provinces in Iraq

Abstract type: Poster

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Abstract: *Ephestia cautella, Ephestia figulilella* and *Ephestia calidella* cause damages to the dates during the storage period i.e. during 3-6 months before their manufacturing and marketing. The infestation with *Ephestia* spp. started in orchards during maturation of dates and this infestation is transferred to date warehouses if no control method is applied. Therefore, it was carried out an experimental study in three selected orchards located in Alrashidia / Baghdad, Bohruz / Diyala and Al- hur / Karbala, the area of them being between 2.5 and 4 ha. In each of them, it was released 4000 to 4 500 *Trichogramma evanescens* parasitoids per ha twice a year, in autumn and spring. The results showed that the percentage uninfested dates at the harvest were 99.6, 98.5 and 99.0% in the above mentioned orchards, respectively; to be compared to 97.1, 96.7 and 98.0 % uninfested dates in control orchards located in the same provinces. After the harvest, three date warehouses were selected into the same provinces as case studies. Ten tons of dates were stored into each warehouses coming from the same orchards which were already protected through *T. evanescens* release. Then, 70 000 parasitoids per warehouse were released two times at two weeks interval, in association with nine pheromone traps baited with common pheromone of *Ephestia* species. The control warehouses were left without *T. evanescens* release but had the same monitoring pheromone traps set. The percentages of uninfested dates in warehouse trial were 99.5, 98.6 and 98.9%, respectively in comparison with 84.1, 87.7 and 89.2%, respectively into the control warehouses. The number of males of *Ephestia* spp. in pheromone traps were 0.5, 0.3 and 0.2 insect / trap / month in date warehouse located in Baghdad; 0.3, 0.4 and 0.2 insect / trap / month in the date warehouse located in Diyala, and 0.8, 0.2 and 0.1 insect / trap / month in the date warehouse in Karbala. In control warehouses it was observed 17.0, 13.8 and 6.0 insect / trap / month in Baghdad, 16.3, 8.3 and 3.0 insect / trap / month in Diyala, and 13.3, 6.0 and 2.0 insect / trap / month in Karbala. These results showed that the combination of biological control agent with pheromone mass-trapping led to a sharp reduction of *Ephestia* spp. populations either in orchards or in date warehouses. This association could be used within IPM program to control *Ephestia* spp. instead of Methyl bromide or any other chemical insecticide.

Keywords: *Trichogramma evanescens, Ephestia* spp., date warehouse, pheromone traps, control experimental trial

Session 2

Stored-product pests and pathogens biology and ecology in relation with IPSP

Chairpersons: Goeorge Opit and Christos Athanassiou

Oral communications: 8
Posters: 8

Timetable:
Tuesday 2nd July, 14h – 17h20

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10 – Tools for detecting pest contamination in stored raw materials

Abstract type: **Oral presentation (keynote)**

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Abstract: Detecting potential food contaminants contributes to ensure the quality of both stored raw materials and manufactured food products. During the storage period the presence of insects and /or mites on the commodities is usually detected conducting a visual examination. Although this is a simple method for detecting adults and some developmental stages, it does not provide accurate data on the presence of mites, and it is unreliable for the detection of eggs, small larvae and hidden insect infestation. On the other hand, the presence and abundance of pests in food processing facilities is usually monitored with pheromone and alimentary traps. However, it is usually difficult to relate trap captures to the exact size of the pest population that infest a product and, consequently, to the qualitative and quantitative damage that it could produce. Subsequent to the monitoring results, spatial analysis techniques might be used as a tool to improve pest management measures. Detecting the presence of pests and their remains is also an important aspect of the quality control of final food products. The presence of these contaminants is not allowed by most of the sanitary regulations and defect action levels for pests and their remains have been established for some food products. Several methods have been used for many years for the detection and quantitative estimation of pests in final food products, including the insect fragment test and the cracking flotation method. Faster immunoassay methods for the detection of the insect muscle protein, myosin, or for the detection of mites have been developed using specific antibodies. More recently, specific primers and the use of PCR methods for the molecular detection of insects in food products are being developed. Further research is required on the above topics for successful prevention of insect presence in food products.

Keywords: Quality control, Food contamination, Monitoring, Traps, Insect and mite detection

11 – Corks damaged by *Nemapogon granellus* (L.) in Tuscan wine cellars (Italy)

Abstract type: **Oral presentation**

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Abstract: European grain moth, *Nemapogon granellus* L. is cosmopolitan in the temperate regions of the world and includes indoor and outdoor populations. Larvae feeds on cereals, soybeans, almond, hazelnuts, walnuts, peanuts, bran, grass seed, clover, flax, ergot, dry fruits, chocolate, mushrooms, seeds, moldy cheese, prunes, chestnuts, garlic, decayed wood, lichens, tobacco, pharmaceutical products. Some authors reported the importance of *N. granellus* as a pest in wine cellars were larvae feed on and tunnel into the corks of wine bottles. This causes aesthetic damage to the corks, which must then be replaced before delivery to consumers. When tunnels ultimately connect both ends of the cork, the wine itself is affected, in which case bottles should be rejected due to alteration in the organoleptic properties of the wine. During 2011, heavy infestations of European grain moth occurred in some Italian wine cellars in Tuscany region, where caused serious damage on exposed wine-bottle corks. The moth attack was highlighted by the presence of debris on the cork external surface, due to the larval feeding and consisting in a dust layer including tiny pieces of cork and feces, all tied together by larval silk. Mixed and partially immersed in the dust layer were visible a number of pupal exuviae. The infestation occurred on red wine bottles (approximately 9,000) stored for aging for more than 20 years. We estimate that the infestation has been in place continuously at least for the last five years. IPM strategy was adopted monitoring *N. granellus* adults with pheromone traps, accompanied by careful cleaning of the rooms, shelves, and machinery, alternated to localized treatments using fogs with pyrethrum, and the replacement of the infested corks. In addition, application of cellars sanitation procedures reduced sources of pests as well as the possibility of insect reproduction particularly in areas where corks were present.

Keywords: *Nemapogon granellus*, damages, corks, red wine, IPM.

12 – Stored-product insects and their natural enemies in Germany: a species-inventory

Abstract type: **Oral presentation**

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Abstract: Native natural enemies are preferred for biological control, because they are not expected to negatively affect non-target organisms. In this publication, a recently compiled stored-product insect checklist for Germany is discussed in the context of insect ecology and biological control. The 213 insect species found to be associated with stored products in Germany were classified according to their feeding habits. About 16% of all species were found to be primary stored product pests. The most species-rich groups are secondary stored product pests and mould feeders with 28% and 29% of all species, respectively. The beneficials (9.1%) comprise 11 species of parasitoids (5.3%) and 8 species of predators (3.8%). The data is compared with data in Sinha (1974). Changes in distribution range were discussed for selected species and the impact for stored products protection and the study of invasive species were discussed.

Keywords: Stored products, *Pscocoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera*.

13 – Light filth tests on semolina and pasta

Abstract type: **Oral presentation**

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Abstract: Samples of semolina and pasta were collected in one mill and one pasta factory in Italy for several years. They were analyzed by AOAC light filth tests (225 g).
Samples of semolina were 195, collected from 2007 to 2012. The mean number of insect fragments detected was 4.9 and each year a mean of one first instar larva of *Stegobium paniceum* (L.) was found. Only in one sample a mite was detected.
Samples of pasta analyzed were 156, from 2009 to 2012, and the mean number of fragments was 10.1. Mandibles of *Sitophilus oryzae* (L.) and *Tribolium* spp. were the most identified filths.
Fragments derived mainly from infestation previous to milling, both in semolina and pasta samples; in fact fragments size was lower than the granulometry of semolina. Rodent hairs were found in few samples.

Keywords: Light filth test, insect fragments, pasta, semolina.

14 – Insecticidal effect of freezing on different life stages of various stored-product insect species

Abstract type: **Oral presentation**

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Abstract: The effect of exposure to zero degrees Fahrenheit, which corresponds to -17.8°C, was evaluated for the control of various life stages of the warehouse beetle, *Trogoderma variabile* Ballion (Coleoptera: Dermestidae) (eggs and adults), the red flour beetle, *Tribolium castaneum* Jacquelin du Val (Coleoptera: Tenebrionidae) (all life stages), the Indianmeal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae) (eggs), the Mediterranean flour moth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) (larvae), and the psocids *Liposcelis bostrychophila* Badonnel (Psocoptera: Liposcelididae) (all life stages) and *Liposcelis paeta* Pearman (Psocoptera: Liposcelididae) (eggs and nymphs). All these species/life stage combinations were placed in chambers adjusted at the above temperature, and exposed for different time intervals, ranging from 0.25 to 72 h. For all species, all life stages, with the exception of eggs, were very susceptible, given that mortality was 100 % in less that 1 h of exposure. In contrast, eggs were tolerant, regardless of the species and the egg age. For *L. paeta*, complete (100 %) egg mortality was recorded after 24 h of exposure, while for young eggs of *L. bostrychophila* survival was noted even after 48 h of exposure. In the case of *T. castaneum* egg hatching was recorded even after 4 h of exposure, but larvae that hatched from eggs that had been exposed for 1.5 h or more, did not survive. Finally, for *T. variabile*, complete egg mortality was noted only when exposure reached 24 h. The results of the present study provide useful data for the utilization of low temperatures for the control of major stored-product insect species

Keywords: low temperatures, stored-product insects, non-chemical control

15 – Ten years of food complaints about cereals and by-products

Abstract type: **Oral presentation**

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Abstract: More than two hundreds food complaints, coming from food industries, food stores, and customers, were analyzed in our Department in ten years. Most of food packages were delivered already open; sometimes the food samples were delivered without package. In the case of packaged food, infestation was subsequent to packaging.
Cereals and by-products were 48% of all samples: 32% were cake and biscuits, 31% pasta, bread and crackers 11%, rice 9%, flour 8%, ravioli 4%, others 5% (spelt, corn crackers, cereals soup).
Lepidoptera were 47% of pests, and *Plodia interpunctella* (Hbn.) was in 88% of samples. Coleoptera were 34% and *Sitophilus oryzae* (L.) was in 42% of samples. 9% of complaints regarded rodents' filths, mainly droppings.

Keywords: stored product infestations, stored product pests, cereal infestations.

16 – Populations grow of cigarette beetle on stored tobacco under temperate and tropical conditions

Abstract type: **Oral presentation**

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Abstract: The cigarette beetle, *Lasioderma serricorne* (F.) (Coleoptera: Anobiidae), is a well-known insect that infests a wide range of foodstuffs and it is the most serious pest of stored cocoa and tobacco. Cigarette beetle is a well-adapted species in tropical and temperate environmental conditions, although the variability of temperature is a very important ecological factor, which insects can answer in a differently way under the presence/absence of temperature fluctuation. The rhythms of temperature, together with light, moisture and food, control the seasonal and daily insects' activity.
Experiments were carried out to study the activity of adults under temperate and tropical conditions, in tobacco and cigarette factories and warehouses in Portugal and in a cigarette factory and warehouses in Cape Verde. The records of adults' activity were obtained monthly using traps with sex pheromones and the environmental conditions of temperature and relative humidity were achieved from thermo-hygrographs and data loggers. The population grow was calculated based on index of "relative" growth = dN/dt ("relative" because was supported on records obtained from trap catches) where is the variation of the adults caught in a given period (month) of time and is the period of time (month).
From the results, larvae hibernation was not observed in Cape Verde and the adults remain active all over the year while in the premises in Portugal there was an a period where their activity was lower or absent. The index of relative growth of the CB populations in Portugal was greater when compared with populations in Cape Verde. This different behavior indicated that temperature fluctuations may have a stimulant effect on the population growth.

Keywords: Cigarette beetle, stored tobacco, population growth rate

17 – Sampling adults of stored-product beetles: Detection and mean retention efficiency of cracked corn and food mixture baits

Abstract type: **Oral presentation**

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Abstract: The effectiveness of freshly cracked corn and cracked corn aged for 1, 2, 4, 8, 12 and 16 d in retaining adults of the rice weevil, red flour beetle, sawtoothed grain beetle, and flat grain beetle was evaluated in laboratory and field tests and compared with a food mixture bait (cracked corn and wheat, rolled oats, and kibbled carobs; 1:1:1:0.2 parts by wt). In the laboratory, choice tests were performed using 80 unsexed adults in 41.5 cm diameter wooden arenas with 5 g samples cracked corn in total darkness at 25-30°C and 45- 50% r.h. Adults of sawtoothed grain beetle were exposed to food baits for 48 h but all other species were exposed for 24 h. Field tests were done on four farms in Kansas where wire-mesh envelopes containing cracked corn and food-bait mixture were paired and 10 pairs were placed inside and outside buildings at each farm. In laboratory tests, freshly cracked corn and that aged for 1-16 d retained the same number of adults of each of the four species. In field tests, envelopes with cracked corn and food mixture bait showed similar insect detection frequency for seven insect species except for *Cryptolestes* sp. adults which were detected more frequently in food mixture than cracked corn bait. However, mean retention of the eight species was similar in both bait types. On farms, cracked corn retained species other than those tested in the laboratory. Therefore, cracked corn can be a cheaper and promising substitute for the food mixture bait to detect and monitor stored-product beetles on farms.

Keywords: Food baits, stored-product beetles, choice tests, field tests, monitoring

18 – Occurrence and identification of insect pests found in stored sunflower- and rape-seeds in France and damage risk assessment

Abstract type: Poster

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Abstract: Sunflower- and rape-seed samples were collected in French grain silos (34 in 2002 and 121 in 2003), at the surface of bulked grain with the method of surface non-random sampling during the spring season. Insects were counted after sample sieving and species identified and sorted in different groups of noxiousness. In rapeseeds, very few pests were found, except mites. On the other hand, sunflower-seed samples were regularly infested, mainly by secondary and mycophagous insects, which do not damage seeds. A parallel survey carried out among 85 grain store managers was processed to set up the relationships between the storage structures characteristics, the storage management practices and the pest infestation risks. It showed that good storage practices are limiting storage insect occurrence.

Keywords: Sunflower seeds, rapeseed, storage practices, insect pests, risk factor.

19 – Population density estimation of stored grain pests based on their acoustic emissions

Abstract type: Poster

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Abstract: Acoustic emissions of stored products pests can be used not only for detection or identification purposes but also for the estimation of pest's population density. Many recent studies have shown a strong correlation between the number of sounds and the number of insects. The sounds produced by adults of *Sitophilus oryzae*, *Rhyzopertha dominica*, *Oryzaephilus surinamensis*, *Cryptolestes feruginneus* and *Lasioderma serricorne* in stored wheat, *Prostephanus truncatus* in stored maize, *Acanthoscelides obtectus* in stored kidney beans and *Callosobruchus maculatus* in stored broad beans, were recorded in the laboratory in varying population density (0.1, 0.5, 1, 2, 10, 50, 200 & 500 adults/kg). The acoustic device consisted of a piezoelectric sensor mounted on the end of a probe that was pushed into the grain and a portable acoustic emission amplifier (AED-2010L, Acoustic Emission Consulting, Inc.) connected with a computer. All sound recordings took place in a sound insulated box in order to dampen background sound. Each recording lasted 3 minutes and was replicated 5 times. Sound files were processed with Labview v.11 (National Instruments) and peaks of the sound pressure (dB) – frequency (Hz) chart were counted. The number of sound peaks was increased with increasing population density in all cases. The highest number of sounds was recorded by *S. oryzae*, whereas *C. feruginneus* produced the fewest. The linear model was very effective in describing the relationship between number of sounds and population density. The coefficient of determination (R^2) ranged from 0.73 to 0.89, irrespective of pest species. Our results indicate that acoustic devices maybe very useful in estimating the density of a pest population inside the grain mass. The potentiality and limitations of this method are discussed.

Keywords: Acoustic detection, stored products, population density.

19bis –Detection of insect infestation in stored wheat based on their acoustic emissions

Abstract type: Poster

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Abstract: Acoustic detection of stored grain insects is based on their ability to generate sound (by feeding, flying, moving, probing for oviposition etc). In recent decades, acoustic devices of various kinds have been marketed for commodity inspection. The efficacy of acoustic devices in detecting the insects hidden inside the grain mass depends on many factors such as the sensor type, substrate structure, the interface between sensor and substrate, the assessment duration, the size and behavior of the insect, the density of the infestation, and the distance between the insects and the sensors. During the present study, adults and larvae of the most common pests of stored wheat have been detected in varying population density (0.1, 0.5, 1, 2, 10 & 50 per kg of wheat). Acoustic emissions of adults of *Sitophilus oryzae*, *Rhyzopertha dominica*, *Tribolium confusum*, *Oryzaephilus surinamensis*, *Trogoderma granarium*, *Cryptolestes ferruginneus* and *Lasioderma serricorne* and larvae of *T. confusum*, *T. granarium*, *Ephestia kuehniella* and *Plodia interpunctella* were recorded. The acoustic detector system consisted of a piezoelectric sensor mounted on the end of a probe that was pushed into the grain and a portable acoustic emission amplifier (AED-2010L, Acoustic Emission Consulting, Inc.) connected with a computer. All sound recordings took place in the lab using a sound insulated box in order to dampen background sound. Each recording lasted 3 minutes and was replicated 10 times. The system was 100% precise in negative predictions (predicting the absence of a pest when none is present) and considerably successful in positive predictions (predicting the presence of the pest when at least one individual is present in the grain mass). More analytically, prediction for infestation was rated falsely negative in 50-70%, 30-60%, 0-20% and 0-10% when actual population density was 0.1, 0.5, 1 and 2 adults / kg, respectively, irrespective of pest species. Respective values for larvae were 60-70%, 30-60, 0-40% and 0-30%. The system was always successful in detecting infestation when population density was > 2 individuals / kg irrespective of pest species or developmental stage. Our results are discussed on the basis of enhancing the use of acoustic devices as detection tools in storage facilities.

Keywords: Acoustic detection, stored wheat, piezoelectric sensor, sound analysis.

20 – The influence of plant characteristics on the field infestation and resistance status of certain cowpea cultivars to *Etiella zinckenella* and *Callosobruchus maculatus*

Abstract type: Poster

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Abstract: Characteristics of ten locally produced and imported cowpea cultivars were evaluated. Certain plant and/or pod characteristics influenced both infestation in the field and consequently in storage. Cultivars occupied small pods; small and coloured seeds with high density plantations showed less infestation by the tow pests. The resistance and relatively resistance cultivars were distinguished by the same abovementioned characteristics. Infestation by C*allosobruchus maculatus* caused 100% loss of seeds through 8-9 months post storage. The tow common locally produced cultivars, Kaha 1 and Cream 7, which recorded low percentages of shattering pods and the lowest mean numbers of field introduced bruchid eggs did not suffer from any weevil's infestation.

Keywords: *Etiella zinckenella*, *Callosobruchus maculatus*, cowpea, field and storage infestation.

21 – Susceptibility of different pulse grains to the infestation of the cowpea seed beetle *Callosobruchus maculatus* (F.) (Coleoptera : Bruchidae)

Abstract type: Poster

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Abstract: Four cultivars of broad bean and tow of both (cowpea and chickpea) were evaluated for susceptibility to the infestation by the cowpea seed beetle *Callosobruchus maculatus* (F.) under laboratory conditions. Experiments included antixenosis and antibiosis tests. Ovipositional preference "antixenosis" test clear that *C. maculatus* laid the highest number of eggs on cowpea, followed by broad bean and chickpea. Certain tested cultivars showed some sort of antibiosis by reducing the emerged adults, damaged seeds and consequently loss in weight. The lowest percentages of the emerged adults were recorded on broad bean cultivars. After one generation reared on each cultivar, the tested broad bean cultivars ranked the first and followed by chickpea and cowpea, respectively.

Keywords: *Callosobruchus maculatus,* susceptibility, pulse grains.

22 – Effect of different temperatures, exposure times and host density of *Ephestia cautella* (Walk.) larvae upon the efficacy of the parasitoid *Bracon hebetor* Say

Abstract type: Poster

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Abstract: Parasitism efficacy of the parasitoid *Bracon hebetor Say* against *Ephestia cautella* larvae at different temperatures, exposure times and host larval density were evaluated because it was appeared that this parasitoid could be used for controlling *E. cautella* larvae in date warehouses as part of IPM program which suggested to be used for controlling this pest instead of Methyl bromide.
The results showed that the parasitoid females had the ability to paralyze *E. cautella* larvae at the three temperature regimes (14°C, 26°C & 35±1°C) but it was succeeded to lay eggs only at 26°C & 35±1°C. Furthermore, the biotic potential appeared to be depended upon temperature, exposure times and host density. Finally the results illustrated that different temperatures, exposure time and host density did not affect the sex ratio of the produced progeny of the parasitoid since it did not differ from the expected sex ratio which was 1:1 (female: male).

Keywords: *Bracon hebetor*, *Ephestia cautella*, Ecology

23 – Mycotoxicological Analysis of stored groundnuts in Southwest of Algeria

Abstract type: Poster

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Abstract: The mycotoxins are the secondary metabolism's moulds. They develop on plants and during food storage. They could have an important effect on human and animals life. These toxins are found in their natural state as contaminants, in much vegetable food such as groundnuts. The aflatoxin kind and particulary the B_1 is the only considered as carcinogenic. The aim of this study is to show the presence of aflatoxin in our local cultivated groundnuts in Southwest of Algeria and in those from Mali, Argentine and China. Our procedure consists to: achieve a mycological study of the different samples of groundnuts and identification of *A.flavus*, followed a toxicological study. This will be made with some analysis methods like the TLC (Thin Layer Chromatography), in order to detect the aflatoxin B_1. Results showed that samples of Mali are considered as unsatisfactory, whereas those of China are acceptable. However, groundnuts from Argentina and locally produced, are suitable according to the inter-ministerial decree of January 24, 1998, relating to microbiological specification of some foodstuffs. Regarding the *A.flavus* strains, the toxicity test showed that 30% of them are considered as AFB_1 producers. However the TLC method showed the absence of B_1 aflatoxin, in all analyzed samples.

Keywords: Groundnuts, *Aspergillus flavus,* aflatoxin B1, detection, TLC

24 – The use of bio-test in the disinfestation of food industries

Abstract type: Poster

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Abstract: The proper use of bio-test in food industries, in the case of treatments with use of sulphuryl fluoride or hot air, is essential for assessing the results obtained.
In 2012 were given to several Pest Control Companies n. 490 bio-tests. Two special containers were prepared: one sized cm 7 x 5 x 4 h for placement on floors or in the crevices and the other, of sized cm 6 x 6 x 7 h to be hanged at different heights in empty silos. The treatments were carried out in mills and food industries. The species employed in the bio-tests were *Tribolium confusum* (stage egg, larvae, pupa, adult or mix population), *Ephestia kuehniella* (eggs and larvae), *Plodia interpunctella* (eggs and larvae), *Sitophilus oryzae* (adults and a mix population of eggs, larvae and pupae in rice) and *Lasioderma serricorne* (adults and a mix population of eggs, larvae and pupae in biscuits). Detailed operational guidelines were provided. Three TNT bio-test for controlling the pre-treatment mortality were also prepared for each group of bio-test at any treatment; one of the three to be kept in the laboratory and two others to be transported together with the Bio-test submitted to treatments.
All the insects of any stage placed in the TNT-Bio-test resulted fully alive. Overall complete mortality occurred in 368 of 387 total, while in 19 cases survival was recorded.
Obviously, at some points of the work processes have not been reached the desired saturation of sulphuryl fluoride at the temperature of hot air required to achieve a complete mortality. In these few cases and few sites localized treatments with pesticides became indispensable.

Keywords: bio-test, hot air, sulphuryl fluoride, food industries

25 – *Sitophilus zeamais*: water balance and behavior

Abstract type: Poster

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Abstract: Water availability and temperature are the two most important abiotic variables that influence the distribution and abundance of insects. Insects have physiological and behavioral mechanisms that enable their survival in the absence of water for a long period. These mechanisms for survival under conditions of water stress have been studied in several species. Despite its importance in stored grains there has been no study on the water balance in *S. zeamais*. Thus, this work aims to assess the water balance and aggregation behavior in pyrethroid resistant (with and without associated fitness cost) and susceptible strains, seeking to understand their potential. Our objective was to compare female and male adults of susceptible and resistant strains observing: (1) the moisture necessary for the survival; (2) differences in longevity (this response may be due to a balance of water in particular) and if these results may be related to insecticide resistance (and associated fitness costs); and also (4) if the aggregation behavior of this species could regulate water loss through the formation of groups of insects. The results indicated that *S. zeamais* was extremely vulnerable to low relative humidities in the absence of food. The three strains showed loss of water of approximately 30% which is a relatively low value, but enough to significantly compromise their survival. It was still possible to observe differences between the individual and the group in the conservation of water, but there are no differences between group size. The group retains more water than the insect isolated.

Keywords: *Sitophilus zeamais*, water balance, insecticide resistance

Session 3

Utilization of phytochemicals and semio-chemicals in stored product IPM

Chairpersons: Catherine Regnault-Roger and Ali A. Isikber

Oral communications: 12
Posters: 7

Timetable:
Tuesday 2nd July, 17h20 – 18h50
Wednesday 3rd July, 08h40 – 11h50

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26 – Phytochemicals and semio-chemicals use in IPSP programs

Abstract type: **Oral presentation (keynote)**

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Abstract: During storage, foods are currently destroyed by insects and other pests. These pests generally carried in their body fungus that can produce mycotoxins which cause risks to humans and animals; thus, the interaction between pest infestation and fungus contamination in stored food has been established. Generally damages caused by pest and fungi are reduced through chemical control, but there is a strong debate about the safety aspects of chemical preservatives since they are considered responsible for many carcinogenic and teratogenic attributes as well as residual toxicity. With the growing interest of the use of either essential oils or plants extracts as alternatives for stored product protection, screening of plant extracts, essential oils and derived components for their insecticidal and anti-fungal properties has become of increasing importance. As the matter of fact, several articles in the literature published plethora of compounds from plant origin exhibiting both insecticidal and fungicidal activities. There is therefore a need of knowledge on phytochemicals and plants that could be used as insecticides and fungicides. Here, we review chemicals of plant origin and species with insecticidal and fungicidal activities. An exhaustive literature search was conducted using scientific databases, chemical databases, botanical databases, and books to identify published papers related to insecticidal and fungicidal chemical compounds stemmed from plant species and it was established that 3 main chemical classes were most cited for these activities: alkaloids, phenolics, and terpenoids. This review presents plant species and some of their chemical constituents of importance exhibiting both insecticidal and fungicidal activities that could be used as alternative for integrated protection of stored products.

Keywords: Insecticide, Fungicide, Plants Phytochemicals, biopesticides, Integrated Pest Management

27 – Suppression of *Plodia interpunctella* moth populations by mating disruption in wheat warehouses in Israel

Abstract type: **Oral presentation**

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Abstract: Indian meal moth (IMM) *Plodia interpunctella* Hubner (Lepidoptera: Pyralidae) is a common and harmful insect pest in stored grain and dry food in Israel. Usually, chemical treatment, such as a fogging, residual insecticides or fumigation is used for IMM control. Despite the high efficacy of these traditional measures, their disadvantages, particularly their negative impact on the environment and public health have led to intensive research focused on safe and ecofriendly alternatives. In recent years, the use of sex pheromone for mating disruption of IMM was suggested.The purpose of the present investigation was to study the efficacy of mating disruption of *P. interpunctella* using sex pheromones in suppressing moth populations in wheat warehouses in Israel. The study was conducted in small-scale (15 m^3 filled with 3 ton of wheat grain) and two commercial-scale warehouses (each one of 3000 m^3 filled with 2000 ton of wheat grain) in the central part of Israel. The Prescription Treatment® brand ALLURE® MD (Whitmire Micro-Gen Research Laboratories, Inc., MO, USA) with 93% of active ingredient (Z-9, E-12-Tetradecadien-1-yl acetate) was used for mating disruption. Evaluation of IMM populations was performed using two methods: the first, using pheromone traps containing pheromone dispensers SP LOCATOR (AgriSense BCS Ltd, UK) and the second, using food traps containing culture media used for IMM rearing. The small-scale warehouse was initially tested as a control (without mating disruption) and then as a treatment (1 dispenser per 15 m^3). Two commercial warehouses were used for control and treatment (1dispenser per 30 m^2) in parallel. It was found that both of the tested methods are suitable for evaluation of the IMM population. In the small-scale warehouse, in the control, with the initial population of 40 introduced pupae, 543 males of F_1 were caught in the pheromone traps, on average, 136 males/trap, total F_1 population of 1086. Using food traps for evaluating efficacy, the total number of F_1 was 716 (both males and females), on average 144 / trap. On the other hand, after mating disruption the total number of F_1 adults was 231, on average 23/ trap, resulting in a 70% suppression of IMM in the first generation. However, when higher initial populations were tested (300 introduced pupae), the treatment was ineffective. On testing the efficacy of mating disruption in the commercial-scale warehouses, with the initial density of the population of 1 male/pheromone trap, the numbers of trapped males were significantly less compared with the non-treated warehouse after a month of treatment: 1.5 and 7.0 adults per trap respectively. However, in the second month the numbers of trapped moths in the treated and non-treated warehouses were almost equal: 19.3 and 20.5 adults per trap respectively. It can thus be concluded that mating disruption can indeed suppress populations of IMM in warehouses, however when populations reach high levels chance encounters prevail and thus mating disruption should be implemented within an integrated pest management program thereby maintaining pest populations at low levels.

Keywords: Grain storage, mating disruption, *Plodia interpunctella*

28 – *Sitophilus oryzae* mass-trapping in wheat bulks with high-density probe- and PC-traps baited with sitophilure and/or attractive oil and its impact on population dynamics: a pilot-scale study

Abstract type: **Oral presentation**

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Abstract: In large flat-storage facilities, primary insect pest populations that were quiescent at the end of winter season start again their multiplication when located in zones where temperature exceeds again the lower limit for development. This situation generally takes place close to the surface of the bulk. Early detection of insect presence in this zone is crucial in IPM programs. A pilot scale trial was carried out to evaluate the potential of high density trapping in this upper zone of a grain bulk. This trial had three objectives: i/ to evaluate the percentage of *Sitophilus oryzae* adults that can be catched through high-density network of traps displayed from the surface of the wheat bulk, baited with lure or attractant, *vs*. non-baited; ii/ to compare the yield of the different traps when baited or not with sitophilure and/or attractive oil; iii/ to evaluate the impact of trap catches on the rice weevil population dynamics. A randomized experimental design was built with 400 kg wheat batches stored in containers. After initial infestation of each wheat batch by a low density of hidden stages of *S. oryzae* and setting traps, the grain condition was continuously monitored and insect catches were checked every 3 weeks during 4 months of storage at 22 to 25°C. The percentage of weevils trapped by this high-density trapping (10 traps per 400-kg batch) reached more than 30% in the better case with a peak during the second month of storage. At the same period, it was observed a significantly reduction of weevil numbers in traps baited with sitophilure. Conversely, traps with attractive oil catch significantly more weevils. Nevertheless, in spite of the high number of weevils trapped, the population dynamics trends were not significantly affected by continuously trapping a part of the population in the conditions of this pilot trial.

Keywords: *Sitophilus oryzae*, probe trap, PC trap, high-density trap network, aggregation pheromone, attractive oil, trapping yield

29 – Effect of drying regime on the insecticidal efficacy of Cameroonian neem seed oil against *Sitophilus zeamais* Motsch. and *Callosobruchus maculatus* Fab.

Abstract type: **Oral presentation**

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Abstract: Neem products are known for their insecticidal properties. The bio-efficacy of botanical insecticides varies across geographical locations, making it unwise to extrapolate results from one region to another. Cameroonian neem seed oils extracted from dehusked and sun-dried (DSD), undehusked and sun-dried (USD), dehusked and shade-dried (DRD) and undehusked and shade-dried (URD) kernels were used. The oils were analysed for their azadirachtin and fatty acid contents. Maize grains and cowpea seeds were coated with the neem seed oils in order to evaluate their insecticidal efficacy on *Sitophilus zeamais* and *Callosobruchus maculatus* using parameters like adult mortality, progeny production, grain damage, population increase and persistence. The DSD seeds (85.20 µg/L) were richest in azadirachtin. The major fatty acids found were palmitic acid, stearic acid, oleic acid and linoleic acid, with similar contents among the drying regimes. All neem oils caused significant and increasing mortality to *S. zeamais* and *C. maculatus* related to the contents and exposure periods. Within one day of exposure and at the highest dosage (6 ml/Kg) 83.75%, 81.25%, 77.50% and 76.45% mortality were caused to *C. maculatus* by DSD, URD, DRD and USD, respectively, while to *S. zeamais* 31.25%, 20.00%, 18.75% and 17.50% mortality were achieved, respectively. For *C. maculatus,* maximum mortality of three times 100% and 98.69% were achieved for DSD, URD, USD (6 ml/kg, within 3 days), and DRD (6 ml/kg within 6 days), respectively. For *S. zeamais*, mortality of 100% was caused by DSD and USD (5 ml/kg) within 7 days. All neem oils inhibited the production of progeny in the weevils, reduced the percentage of grains or seeds damaged and mass losses for maize and cowpea. Oil extracted from dehusked and sun-dried kernels persisted longer on maize than on cowpea after two months of storage. Within five days of exposure, DSD oil (6 ml/kg) caused 100% and 17.5% mortality to *S. zeamais* and *C. maculatu*s, respectively. That sun-drying of neem seeds results in higher insecticidal efficacy could help farmers to dry their neem seeds easily in sun and could help avoid health risks, because sometimes during shade-drying, the seeds are attacked by fungi which may produce mycotoxins and thus be hazardous when admixed to food products. In the northern part of Cameroon where neem trees are widely available and the population is dominated by low-income farmers, neem seed oil could be adopted for the protection of maize and cowpea stocks.

Keywords: *Azadirachta indica,* drying regime, *Callosobruchus maculatus, Sitophilus zeamais,* toxicity, persistence

30 – Insecticidal formulation based on Ocimum gratissimum essential oil and montmorillonite clays for maize protection

Abstract type: **Oral presentation**

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Abstract: Bio-insecticides formulation was developed from natural Cameroonian clays using *Ocimum gratissimum* essential oil as active agent. The adsorption capacity of aroma compounds by clays was determined and improved by chemicals modifications of the clays (1). The treatment with acetyl trimethyl ammonium was particularly efficient and was explained by the increase of affinity of the adsorbate molecules toward the adsorbent. Insecticidal tests have been conducted against the maize weevil *Sitophilus zeamais* and have shown that the insecticidal effects of formulations have been improved after clays modifications. The mortality of *S. zeamais* decreased from 100% to 95%, 87% and 0% after 7 days respectively for the essential oil adsorbed on modified clay, on unmodified clay and for formulation without clay. The formulation prepared with unmodified clay completely lost insecticidal activity after 30 days, whereas the formulation with modified clay lost about 60% of its full insecticidal potency in the same time. The remnant effect of the formulations based on essential oil varied with the adsorbent used. The insecticidal effect of *O. gratissimum* essential oil persists during 107 days when it is adsorbed on the modified montmorillonite, while adsorbed on unmodified clay, it loses all its activity at the end of 45th day. These results allow us to assert that modified clays increase the duration of the insecticidal effect of essential oils and can be used for industrial application in the production of bio-insecticides based on essential oils. The findings suggest that formulations based on essential oils and modified clays should be considered as alternatives to synthetic insecticides for use in stored product pest control.

Keywords: bio-insecticide, *O. gratissimum*, montmorillonite, clay modification, *S. zeamais*, maize protection.

31 – (Re-)discovering cucujolides – Infochemicals for *Oryzaephilus surinamensis* and *Cephalonomia tarsalis* with potential for biological control

Abstract type: **Oral presentation**

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Abstract: The sawtoothed grain beetle *Oryzaephilus surinamensis* L. is a serious pest on numerous stored products worldwide. Males of this species produce a set of macrolide substances, which act as aggregation pheromones when present in a combined blend.
By analysis of beetle frass a so far unknown macrolide was detected and characterized. Subsequent bioassays demonstrated that this compound arrested female, but not male beetles when presented alone. This suggests a role of the macrolide as a sexual pheromone in *O. surinamensis*. Remarkably, females of the specialized parasitic wasp *Cephalonomia tarsalis* (Ashmead) were arrested by the compound in bioassays indicating that the macrolide is used for host finding. The particular discrimination abilities of *C. tarsalis* regarding the pheromone and other beetle-associated cues shows its high potential for use in biological control.

Keywords: *Oryzaephilus surinamensis*, *Cephalonomia tarsalis*, sexual pheromone, parasitoid, host finding, aggregation pheromone, macrolide

32 – Screening of plant extracts as repellent against Stored-product insects

Abstract type: **Oral Presentation**

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Abstract: Use of phytochemicals as natural insecticides to control stored product insects is an important area of work. Studies were conducted to test the repellency of *Trichilia connaroides* (Wight & Arn) and *Clerodendron inerme* methanol extract of leaf against three stored-product insects, the lesser grain borer *Rhyzopertha dominica* (F.), the red flour beetle *Tribolium castaneum* (Herbst) and the cowpea weevil *Callosobruchus chinensis* (L.). The area preference method was used to determine the response of insects to the repellents by measuring their movement from the treated region on filter paper strip. The average repellency of 1000, 750, 500, 250, and 100 ppm concentrate from *Trichilia connaroides* and *Clerodendron inerme* leaves totally achieved class lll (60.1-80% repellency) and class V (80.1-100% repellency) respectively after 24 hr. observation. The order of repellent activity was *Callosobruchus chinensis* < *Tribolium castaneum* <*Rhyzopertha dominica*. *The* concentrate ofmethanol-extract of *Clerodendron inerme* leaves was found to be more effective than *Trichilia connaroides* according to One Way ANOVA ($P<0.05$; & Student *t*-test). These plant extracts can be exploited as promising stored product insect control agents.

Keywords: Pytochemicals, Repellency, *Rhyzopertha dominica, Tribolium castaneum, Callosobruchus chinensis, Trichilia connaroides, Clerodendron inerme*

34 – The utilization of saturated atmospheres from *Syzygium aromaticum* and *Mentha pullegium* essential oils against rice fungi

Abstract type: **Oral presentation**

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Abstract: Storage of rice is a specific ecosystem, conditioned by several factors that are difficult to control, like temperature, relative humidity, water content, oxygen availability. This is especially true in underdeveloped countries where technological innovations such as refrigeration and controlled atmospheres represent huge investments.
Storage under deficient conditions can originate insect or fungi attack, inducing organoleptic changes (taste, flavour and appearance), nutritional losses or even mycotoxin contamination. This situation causes significant economic losses and serious health problems. Currently the use of synthetic pesticides is restrained by regulation and political pressure due to carcinogenic and teratogenic effects, and to high residual acute toxicity. It is also important to consider their long degradation times and environmental pollution issues and collateral effects on consumers. Due to such reasons, populations have become more interested on natural food conservatives. The use of essential oils from aromatic plants may be a practical alternative to the use of synthetic pesticides in preventing deterioration caused by fungi on stored rice. So in this study it was evaluated the potentiality of *Syzygium aromaticum* and *Mentha pullegium* essential oils to promote saturated atmospheres capable to protect the rice against *Aspergillus candidus*, *A. niger*, *Fusarium culmorum* and *Penicillium islandicum*.

This work was funded by FEDER through the Operational Competitiveness Programme – COMPETE - and by national funds through the Foundation for Science and Technology - FCT - in the framework of the project PTDC/AGR-ALI/119270/2010).

Keywords: *Syzygium aromaticum*, *Mentha pullegium*, rice fungi, saturated atmospheres

35 – Comparative insecticidal efficacy in the Sudano-Guinean versus Sudano-Sahelian agro-ecological zones of Cameroon of FossilShield and NeemPro against *Sitophilus zeamais* on maize in storage

Abstract type: **Oral presentation**

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Abstract: The effectiveness of the diatomaceous earth, FossilShield and the neem-based product, NeemPro in protecting stored maize against the infestation of the maize weevil, Sitophilus zeamais, in the laboratory was assessed in the colder and more humid Sudano-Guinean (Ngaoundere) and the hotter and drier Sudano-Sahelian (Maroua) agro-ecological zones of Cameroon. Maize grains were admixed with the two insecticides at four dosage levels for the determination of adult mortality and inhibition of progeny production. The two insecticide powders caused significant and increasing mortality to S. zeamais, relating to the contents and exposure periods in the two agro-ecological zones. The weevil was more susceptible to FossilShield than NeemPro, regardless of the agro-ecological zone. Mortality caused by both insecticide powders was higher in Maroua compared to Ngaoundere. Complete mortality of S. zeamais was achieved by FossilShield at Maroua at the dosage level of 1.5 g/kg, but at Ngaoundere at the dosage level of 2 g/kg, 7 days after exposure. 3-d LC_{50} values at Maroua were 0.39 g/kg for FossilShield and 0.99 g/kg for NeemPro and at Ngaoundere 1.9 g/kg for FossilShield and 23.72 g/kg for NeemPro. At Maroua, the two tested insecticide powders completely inhibited the production of progeny in the weevil at all the dosage levels. The highest tested contents of FossilShield (2 g/kg) and NeemPro (6 g/kg) inhibited the production of progeny by 90.50% and 87.00%, respectively, at Ngaoundere. The results indicate that the use of FossilShield and NeemPro in stored product protection in Africa would be more effective in the Sahelian regions than in the more humid zones of the continent.

Keywords: *Sitophilus zeamais*, FossilShield, NeemPro, toxicity, progeny production

36 – Mating disruption of stored product *Pyralidae*: results from large-scale trials in Europe

Abstract type

Oral presentation

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Abstract: Mating disruption of stored product Pyralidae is based on the use of ZETA [(Z, E) 9, 12 tetradecadien 1-ol acetate]. In the current report, we present the data from series of trials that were carried out during the last five years in several parts of Europe, at different types of storage facilities and commodities, such as food processing facilities, feed and flour mills, retail stores, warehouses etc., using the ZETA-based formulation Dismate PE. Trials that have been conducted between 2010 and 2012 in Italy, Czech Republic and Greece indicated that this method can be used with success for the suppression of the Indian Meal moth, *Plodia interpunctella* (Huebner) (Lepidoptera: Pyralidae) and *Ephestia* spp., particularly the Mediterranean flour moth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae). In these tests, after three years of the continuous use of Dismate PE, trap captures in pheromone-baited traps were notably reduced. At the same time, moth oviposition and larval presence was significantly reduced in comparison with the years before the Dismate PE application. For instance, in trials in Greece, there was an approx. 5-fold decrease in the number of moth captures in ZETA-baited traps, after 3 years of continuous mating disruption. Similarly, studies in several food processing facilities in the UK suggested that the number of insecticidal applications for the control of Pyralidae was decreased as compared with the pre-application period. Our results clearly illustrate the feasibility of using mating disruption-based strategies for the control of stored-product Pyralidae, under a wide variety of conditions and facilities.

Keywords: Mating disruption, stored-product *Pyralidae*, pheromone baited traps.

37 – Small bin trial of pea extract mixed with pyrethrins to control stored-product insects

Abstract type: **Oral presentation** (possible withdrawal)

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Abstract: Protein-rich pea flour is toxic when consumed and repels stored-product insect pests (Fields 2006). The toxicity in the pea flour is due to a combination of a 37 amino acid peptide (PA1B) and soysaponin (Taylor et al. 2004, Fields et al. 2010). A pilot-plant-scale extraction of the active compounds was carried out on 500 kg of protein-rich pea flour (Taylor et al. 2012). A 3-month test with grain bulks of 350 kg showed that the pea flour (1000 ppm) reduced *Sitophilus oryzae* (rice weevil) and *Cryptolestes ferrugineus* (rusty grain beetle) but not *Tribolium castaneum* (red flour beetle) populations. Pea extract (500 and 1000 ppm) reduced *S. oryzae* but not *C. ferrugineus* or *T. castaneum* populations.
Given that the pea extract was not effective against all insects, the trials were repeated with pea extract (500 ppm), pyrethrins (1.5 ppm), synergized pyrethrins (1.5 ppm with piperonyl butoxide (PBO) at 15 ppm) and the mixtures of the pea extract and the two pyrethrin formulations. In addition to the three previous insects, *Rhyzopertha dominica* (lesser grain borer) was also released into the grain bulks. Pea extract controlled only *S. oryzae*, pyrethrins controlled only *R. dominica*, synergized pyrethrins controlled all insects, pea extract combined with pyrethrins controlled *S. oryzae* and *R. dominica*, and pea extract with synergized pyrethrins controlled all insects.

Keywords: Pea, peptide, PA1B, soysaponin, grain, insects

38 – Study of analysis, insecticidal and antimicrobial activity of the Essential Oils of *Ferula vesceritensis* and *Thymus munbyanus*

Abstract type: Poster

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Abstract: This work studied the chemical composition, insecticidal activity on *Sitophilus oryzae* and antimicrobial activity of essential oil (EO) extracted from *Ferula vesceritensi*s and *Thymus munbyanus*. Analysis of the EOs was established by GC-MS. The methodology of the biocidal activity testing (dose range: 0.063-0.503 $\mu L.cm^{-2}$) was the impregnated filter paper disk bioassay in a Petri dish or vapor phase release in a closed exposure chamber (0.503 $\mu L.mL^{-1}$, single dose). Antimicrobial test was carried out with dose ranging from 0.3 to 20 $\mu L.mL^{-1}$ EO in culture medium. The evaluation of the biocidal effect of oils is based on the LD_{50}, LD_{90}, LT_{50}, LT_{90}, and the values of the minimum inhibitory concentration (MIC) for antimicrobial test. The ferrule EO was composed of 45.2% of oxygenated sesquiterpenes and 28.8% other sesquiterpenes and thyme (EO) was composed of oxygenated monoterpenes with a content of 66.6%. The rod (ferrule EO) causes inhibition of microbial culture with fungal colony diameters that did not exceed 15 mm. The essential oil of thyme causes complete inhibition of growth in all other microorganisms tested at doses less than or equal to 2.5 $\mu L.mL^{-1}$. The activity of thyme EO was more effective than the activity of ferrule EO in the treatment against rice weevil or against target microorganisms. The richness of monoterpenes in thyme known to exhibit a good antimicrobial as thymol and carvacrol, which are the major compounds of thyme EO.

Keywords: *Thymus munbyanus*, *Ferula vesceritensis*, Essential oil, chemical composition, antimicrobial and insecticidal activity, *Sitophilus oryzae*

39 – Effectiveness of *Laurus nobilis* and *Mentha pullegium* essential oils against *Sitophilus zeamais* Motschulsky (Coleoptera: Dryophtoridae) on stored maize

Abstract type: Poster

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Abstract: Laboratory studies were carried out to evaluate the effects of some essential oils from *Laurus nobilis* and *Mentha pullegium* against unsexed adult insects aged from 1 to 7 days of *Sitophilus zeamais* on stored maize.
The concentrated essential oils at different volumes of 0,5 µl, 1,5 µl, 2,5 µl, 5,0 µl and 10 µl, were poured on filter papers with 2 cm Ø each corresponding respectively to 0,039 µl/cm^2, 0,119 µl/cm^2, 0,199 µl/cm^2, 0,398 µl/cm^2 and 0,796 µl/cm^2. For diluted oils, the fixed volume of 15 µl of different concentrations of 1:150v/v, 1:100 v/v, 1:75 v/v, 1:50 v/v and 1:10 v/v either in methanol or n-hexane were used to impregnate the filter papers.
Treatments with the concentrated oils were more effective particularly those from *M. pullegium*. All the concentrations used from *M. pullegium* provided 100 % adult mortality and no progeny production was achieved. *L. nobilis* has revealed 100% adult mortality at 0,796 µl/cm^2.
Regarding the treatments with diluted oils once again the oil from *M. pullegium* provided 100 % adult mortality at concentrations of 1:50 v/v and 1:10 v/v. *L. nobilis* was not effective at any of the concentrations used. There were no significant differences between the solvents used.

This work was funded by FEDER through the Operational Competitiveness Programme – COMPETE - and by national funds through the Foundation for Science and Technology - FCT - in the framework of the project PTDC/AGR-ALI/119270/2010).

Keywords: *Sitophilus zeamais*, botanical insecticides, essential oils, repellence, insect control agents.

40 – Identification of pure compounds in dried apricot and apple electrophysiologically active in *Plodia interpunctella* (Huebner)

Abstract type: Poster

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Abstract: Stored product insects are able to perceive a wide range of volatile organic compounds (VOCs) which orient them towards or away from the source. The principal organ of smell in insects is the antenna. The aim of this study was to use the antenna of *Plodia interpunctella* adults for the identification of electrophysiological active compounds in dried apple and apricot. Volatiles were collected using closed-loop-stripping analysis (CLSA) method and analyzed by gas chromatography (GC) coupled to two detectors, a mass spectrometry (MS) and an electroantennographic detector (EAD). The EAD consisted of *P. interpunctella* antenna placed between two electrodes from which an amplified signal is recorded by computer software. The results showed that eight VOCs from dried apple and ten from dried apricot were able to induce a response in the antenna. From dried apple, the following VOCs were identified: three alcohols (1-hexanol, 2-methyl-1-butanol and 1-pentanol), two aldehydes (hexanal and (Z)-2-heptenal), one ester (3-butyl octanoate), one terpene (3-carene) and one benzene derivative (styrene). From dried apricot, four alcohols (1-butanol, 1-pentanol, 1-hexanol, 3-methyl-1-butanol), two esters (ethyl benzoate and 3-methyl-1-butanol acetate), one acid (acetic acid), one ketone (3-hydroxy-2-butanone), one pyrazine derivative (trimethylpyrazine) and one benzenoid compound (benzyl alcohol) were able to elicit an EAD-response in the insect. Considering the fact that olfaction is mediated mainly by receptors on the antenna, a compound not eliciting an EAG-response can be excluded as an olfactory cue for the insect. Therefore, the aforementioned compounds will be tested for their behavioural effect (attractive or repellent) towards *P. interpunctella* adults.

Keywords: *Plodia interpunctella*, GC-MS/EAD, volatile organic compounds, dried apple, dried apricot

41 – Efficacy of *Lippia adoensis* essential oil against *Sitophilus zeamais* (Coleoptera: Curculionidae) as influenced by leaf age

Abstract type: Poster

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Abstract: *Lippia adoensis*' essential oils have already shown good insecticidal efficiency. Leaf composition varies with leaf age, but no report exists on the effect of leaf age on the efficacy of essential oils. We evaluated the effect of *L. adoensis'* leaf age on *Sitophilus zeamais*. After chemically analysing the essential oils, we evaluated the filter paper toxicity, the repellent and the persistence efficacy of *L. adoensis* in relation with leaves age. β-myrcene, dimethylstyrol, tagetone, piperitone oxide and delta cardinene were present in the essential oil from old leaves and absent in the other essential oil. α-terpineole and myrtenale were found in the essential oil from young leaves and absent in the other. The essential oil from young leaves killed more weevils than the one from elder leaves did but old leaves were more repellent (II ≤ Percent Repellency ≤ V) than young leaves (0 ≤ Percent Repellency ≤ I). With its persistency levels of 98.47% after 96 h, essential oil from old leaves was more persistent than that from young leaves (94.66% after 96 h). Essential oil from young leaves could be of value in stored product protection where *S. zeamais* is a problem. However essential oils from older leaves could provide more intense repellency.

Keywords: *Sitophilus zeamais*, essential oil, *Lippia adoensis*, toxic activity, repellency, persistence.

42 – Refrigerating conservation of apples and in vitro testing different essential oils to control storage rots pathogens

Abstract type: Poster

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Abstract: The best application techniques and methods of bio-preservation of fresh fruits are the ultimate solution to control multi-resistant microorganisms and to obtain healthy and sound fruits. The present study aimed at monitoring physical-chemical quality variation of apples ('Golden delicious'), during storage in a cooled room (4°C) and at evaluating the antifungal activity of essential oils (EO) through in vitro tests with *Eugenia caryophyllata*, *Thymus vulgaris* and Citrus limon, and this on three fungi species (*Penicillium digitatum*, *Botrytis cinerea* and *Alternaria* spp.) isolated from stored apples., In-vitro tests of fungal control were carried out after chemical analyses of EO and antifungal activity were checked during 6 months storage. The results showed after the 2nd month of storage, a loss of more than 15% dry matter loss due to fungal attacks. The dry matter decreases from (18.82 ± 0.17)% to (15.14 ± 1.755)%; a total mineral matter rate decreased of 2% was observed at the fourth week and remains stable up to the 12th week. Flavonoid concentration decreased from 67.22 mg/100g at 4th week to 30.28 mg/100g at 12th week, according to an increase of fungal infestation by the three species. The biocontrol test with EO showed a high antifungal activity against microorganisms tested: *P. digitatum* was less sensitive than *T. vulgaris* and *E. caryophyllata* EO, with MIC = 6.25% whereas *Alternaria* spp. and *B. cinerea* MIC were assessed at 3.125%. The three fungi were moderately sensitive to *T. vulgaris* EO with MIC = 12.5%. *Eugenia caryophyllata* essential oil which has relative density (1.043), relative humidity (1.14), refraction index (1.531/ 20 °C), pH (5.9), power rotation (-0.099) and an acidity (1.04), exhibited the best MIC at 6.5% against the three fungi. This EO which can be integrated into the program of stored food bio-control as an alternative to synthetic treatments.

Keywords: Cold conservation, golden delicious, essential oil, physicochemical quality, biofungicide.

43 – Chemical composition, antioxidant and insecticidal activities of essential oils and ethanolic extracts from Algerian *Rosmarinus eriocalyx* Jord. & Fourr. and *Lavandula stoechas* L.

Abstract type: Poster

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Abstract: Essential oils (EOs) from *Rosmarinus erioclalyx* Jord. & Fourr. and *Lavandula stoechas* L. grown in Algeria were obtained by hydrodistillation with a yield of 1.6 and 0.16 ml per 100 g of fresh weight for *R. eriocalyx* and *L. stoechas*, respectively. Their analysis by CG and CG/MS shown that fenchone was the major compound of lavender essential oil (11% v/v) with camphor (6.85%), while in rosemary oil camphor was the dominant compound (39.4%) followed by α-pinene (10.4%), and the sum of p-Cymene + Limonene (11%). The ethanolic extracts of the two plants had a yield of 19.29 and 30.59% for *L stoechas* and *R. eriocalyx*, respectively. Antioxidant activity was assessed through *in vitro* tests: diphenyl-picrylhydrazyle (DPPH), radical scavenging capacity assay, and butylated hydroxytoluene (BHT), antioxidant power. The DPPH test revealed that ethanolic extracts (rosemary IC_{50} = 11.59 ± 0.07 mg/l and lavender IC_{50}= 18.30 ± 0.31 mg/l) exhibited higher radical scavenging capacity than antioxidant ability (BHT test) (IC_{50}= 28.01 ± 0.66 mg/l), and these ethanolic extracts were much more active than EOs. Reducing power capacity correlated to BHT test results. Ethanol extracts show significantly higher reducing power activity than EOs. Sub-lethal doses, causes a significant reduction of female fecundity and of hatchability of laid eggs.

Keywords: *Rosmarinus eriocalyx*, *Lavandula stoechas*, essential oil, antioxidant power, insecticidal activity.

44 – Toxicity of *Newbouldia laevis* (Seem) against the Angoumois grain moth, *Sitotroga cerealella* (Olivier) in paddy rice

Abstract type: Poster

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Abstract: The toxicity of powders and oil extract of *Newbouldia laevis* (Seem) against *Sitotroga cerealella* (Olivier) in paddy rice was assessed at ambient temperature of 28°C (±2°C) and relative humidity of 75% (±5%). The activity of powder and oil extract of whole plant parts (leaf, stem and root) was studied at 0.0 g (control), 0.1 g, 0.2 g, 0.3 g, 0.4 g and 0.5 g, and 1, 2, 3, 4 and 5% oil concentration, respectively. All the plant powders caused high mortality of *S. cerealella* at all concentrations. All the powders significantly reduced oviposition and adult emergence of *S. cerealella* and differences were not significant. Seed damage and seed weight loss were reduced by powders. The leaf, stem bark and root bark extracts of *N. laevis* prevented adult emergence, seed damage and seed weight loss at low concentration. All extracts of *N. laevis* induced 100% mortality from the lower concentration. However, adult moth mortality increased with extract concentration and exposure time. The root bark extract was lethal within 72 h at 4% concentration; but its effect was not significantly different from that of leaf and stem bark extracts. All the extracts and powders were toxic to adult stage but the most potent was the root extract. Adult emergence was prevented by the extract of *N. laevis* and their effects were significantly different between treated and untreated control. The application of extracts did not adversely affect germination of treated seeds. In fumigant toxicity test, none of the extracts was active as a fumigant since none could cause more than 14% mortality of *S. cerealella* after 4 d exposure. There was no significant difference in the treated and untreated control. The extracts and powders from *N. laevis* are effective bio-insecticides against *S. cerealella* in stored paddy rice.

Keywords: *Newbouldia laevis,* Powder or extract, toxicity, *Sitotroga cerealella,* bioassay, emergence reduction.

Session 4

Non-chemical control of pests and pathogens at the post-harvest stages (physical, biological, bio-technical...)

Chairpersons: Cornel Adler and Matthias Schoeller

Oral communications: 10
Posters: 14

Timetable:
Thurday 4th July, 08h40 – 12h40

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45 – Non-chemical control in stored grain and other durables

Abstract type: **Oral presentation (keynote)**

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Abstract: As witnessed in the last three decades, new chemical compounds for pest control in post harvest protection have become increasingly scarce. Thus, in Germany phosphine gas, pirimiphos-methyl, and deltamethrin are the only synthetic compounds authorized for grain treatment at present. But with the lack of synthetic pesticides comes the chance for non-chemical methods to compete in terms of efficacy and cost-benefit. The grain storage may be treated with pyrethrine fogs. Carbon dioxide is authorized for treatment at ambient or high pressure. Diatomaceous earth (DE) derived from fossil diatoms can also be applied in grain or empty storages. Anoxia combined with increased temperatures is now commercially used for pest control in tobacco. Pheromones have already been used for trapping, and sexual pheromones of moth have been tested for mating disruption with variable levels of success. New sensitive acoustic devices could also help to applying biological control at an early stage. At present 10 parasitoids are commercially available for biological stored product pest control in Germany. *Holepyris sylvanidis* may be number 11 soon.
Heat treatments are common for empty room disinfestation, e.g. in flour mills. Freezing at the other end of the temperature scale is utilized to disinfest valuable products such as nuts, dried fruits, breakfast cereals, teas or medical herbs.

Keywords: Pyrethrine, diatomaceous earth, cooling, drying, anoxia, pheromone, mating disruption, phytochemical, biological control, heat treatment, freezing

46 – Mortality of *Carpophilus hemipterus* eggs and larvae under the influence of thermal disinfestation

Abstract type: **Oral presentation**

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Abstract: The dry date cultivars grown in Israel pests may become infested in the orchard. Where pest management is insufficient, dates are brought to the warehouses with some *Nitidulidae* beetles and *Phycitinae* moths infestation. Therefore, to prevent further damage during storage within the warehouses and to remove the insects from the dates, insect control should be carried out by disinfesting the dates as they reach the packing stations. Thermal disinfestation technology has been successfully implemented by the transfer of hot air through a channel where dates are placed on trays. In earlier laboratory and commercial thermal disinfestation trials the effectiveness in disinfesting dates from larvae and adults was demonstrated. Exposure of dates to 50°C for 3 h exposure was shown to be the most effective treatment for removing the insects from the dates and to control them. The present investigation was carried out during the development of the thermal disinfestation technology and addressed to examine the effectiveness of heat on eggs and larvae stage of *Carpophilus hemipterus*. In laboratory studies, the influence of 50°C on the levels of mortality of *C. hemipterus* eggs was examined over a 3-h exposure period at relative humidity of 20% to simulate commercial disinfestation treatments. Complete egg mortality was achieved after 3 h exposure. Since dates are disinfested at various moisture contents, the effect of humidity on the effectiveness of the treatment was questioned. Therefore, on a separate laboratory experiment, survival of the larva stage of same species exposed to 50°C at 15, 65 and 95 % relative humidity for 5, 30, 60, 90 and 120 min was examined. Complete mortality was achieved in all relative humidities at a period above 60 min. There was no dependence of mortality on the relative humidity level within the larva's micro-environment.

Keywords: Dried fruits, nitidulid beetles, heat, thermal disinfestation, *Carpophilus hemipterus*, eggs, larvae mortality, date pests control, methyl bromide alternatives

47 – Supercooling capacity of the endoparasitoid *Venturia canescens* (Hymenoptera: Ichneumonidae)

Abstract type: **Oral presentation**

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Abstract: *Venturia canescens* Gravenhorst (Hymenoptera: Ichneumonidae) is a parthenogenetic koinobiont endoparasitoid which develops in the larvae of several pyralid moths and is considered as a model organism because of its rapid mass rearing and its body size. Laboratory studies were conducted, by using larvae of the Mediterranean flour moth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) as a host, in order to assess the effect of age, food, availability of host and acclimation on the cold tolerance of *V. canescens* by determining the supercooling capacity. Young adults of *V. canescens* displayed significantly lower supercooling points (21.7 ± 0.6^{o}C) compared to old ones (15.2 ± 0.2^{o}C), irrespective of the availability of host. In general, availability of host had a moderate effect on supercooling of *V. canescens*. On the other hand, food consumption had a noticeable influence on supercooling capacity, as it enhanced significantly the supercooling point of *V. canescens*. Acclimation to low temperatures could considerably increase the supercooling capacity of *V. canescens* adults. Increase of duration of exposure to acclimation temperature resulted to lower supercooling points. Considering the overall data, adults of *V. canescens* displayed an enhanced ability to supercool, which was lower than that of its host, *E. kuenhiella*. This information would be useful in determining the potential of using *V. canescens* as a biological control agent in IPM programs, taking into consideration the adverse effects of temperature on its survival.

Keywords: *Venturia canescens*, *Ephestia kuehniella*, supercooling point, age, host, food, acclimation temperature

48 – The use of the parasitoid *Anisopteromalus calandrae* for the control of the weevils *Sitophilus zeamais* and *Rhyzopertha dominica* in rice

Abstract type: **Oral presentation**

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Abstract: *Sitophilus zeamais* and *Rhyzopertha dominica* are the most concerning pests of stored rice in the Mediterranean coast of Spain. They can survive the polishing process and consequently, adults may be present in the final product. Therefore, alternative methods for its control are necessary during the long storage period. Biocontrol agents are essential components for the implementation of Integrated Pest Management Programs. Hence, the aim of this study was to evaluate the control ability of the parasitoid *Anisopteromalus calandrae* on *S. zeamais* and *R. dominica* in rice under laboratory conditions. Effectiveness of control was measured by releasing three different pest: parasitoid ratios (1:0.5; 1:1; 1:2) in containers with 2 kilos of rice previously infested with 20 females of pest. The experiment lasted 3 months at 28°C of temperature. In all trials a high number of parasitoid progeny were obtained. The parasitoid decreased weevil population more than 70% and in consequence reduced more than 65% the level of grain damaged by these important storage product pests.

Keywords: Biological Control, Stored Product Pests, Dosage rates, Grain.

49 – Legume entomotoxic type 1 albumins: Promising candidates for the protection of stored cereals

Abstract type: **Oral presentation**

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Abstract: Because of the increasing concern of consumers and public policy about environmental and health issues due to the use of chemical pesticides, the search for safer molecules and control strategies is currently of great importance. Type 1b albumins are plant peptides that are naturally present in legume seeds. The entomotoxic activity of one of their representatives, PA1b (Pea Albumin 1, subunit b) against cereal weevils (*Sitophilus* sp.) was discovered 15 years ago (Delobel et al., 1998). Pa1b is an amphiphilic 37-amino acid peptide isolated from pea seeds (*Pisum sativum*), and belongs to the knottin family (http://knottin.cbs.cnrs.fr). This structural family is a group of small disulfide-rich miniproteins characterized by their stability, rigidity and resistance to proteolysis. The toxicity of PA1b via ingestion was evaluated for many insect species and the molecule proved to have a diversified host spectrum, such as cereal weevils (*Sitophilus* spp.), the mosquitoes *Culex pipiens* and *Aedes aegyptii*, and some aphid species (Gressent et al., 2007). To date, no vertebrate per os toxicity or allergenicity was reported for this peptide. Purified from a widely available plant resource without losing its bio-activity, PA1b has great potential for use on an industrial scale and/or for use in organic farming. The potential of this peptide to limit pest damage has stimulated research on its host range, its mechanism of action, its structure, its evolutionary history and its structure-function relationships. We therefore think that in the current crop protection context, focused on biocontrol, PA1b is a promising bioactive source to control pests of stored cereals. We will show how recent results on its cellular mode of action, and its evolution in the *Fabaceae*, have even improved the potential interest of this peptide toxin family.

Keywords: PA1b, insect, bioinsecticide, Legumes.

50 – Efficacy of biofumigation in stored product pest management: a case study with *Callosobruchus maculatus* F. (Coleoptera: Bruchidae)

Abstract type: **Oral presentation**

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Abstract: As most of the current research methods in stored product insect control are techno economically unsupportable for farmers, this paper presents an alternative method, which can be very easily adopted. It concerns a study on the efficacy of fumigation using the smoke of two rhizomes of *Acorus calamus* L., *Curcuma longa* L. and leaves of *Hyptis suaveolens* L., on all life stages of *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae). A fumigation chamber was made out of clay pots connected by a PVC pipe. Bags containing 2kg of seeds infested with eggs, larvae, pupae and adults were placed (in separate bags) inside the large pot and 5, 10 and 25 g of each plant powder was manually sprayed over the red hot ember every time. A mechanical blower was used to direct the smoke into the large pot. Comparison of different types of biological fumigations was done using ANOVA and Tukey analysis. The time of exposure plays a major role in the mortality percentage of test organisms. The 72h exposure to all botanical smokes, showed a high mortality (around 98%) whereas in 24h exposure the mortality percentage was very low (around 30%). Thus, it was concluded that plant smoke biofumigation is a suitable alternative to chemical fumigation and an efficient method in the management of stored product pests.

Keywords: *Callosobruchus maculatus*, control, biofumigation, *Acorus calamus*, *Curcuma longa*, *Hyptis suaveolens*.

51 – Development of climatic mapping and self-diagnosis software to enhance stored-grain cooling aeration system performance

Abstract type: **Oral presentation**

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Abstract: Presence of live insects in stocks represents a serious obstacle to grain marketing. Today, cooling aeration with ambient air is currently used in France to preserve grain quality and to limit insect pest proliferation during storage. To be fully effective, cooling aeration requires a good fit between cooling power of equipment and size and content of grain bins. Local climate at the geographical location of grain storage site may also influence grain cooling efficiency. The French Institute for cereal grain quality, ARVALIS – Institut du végétal, investigated about the ways to optimize cooling aeration operations in taking into account the meteorological data available at a given storage site. From climatic data recorded on a 20-year period according to different climatic zones in France, the capabilities to achieve cooling aeration process at three aeration periods (from mid-summer to end-winter) targeting successive temperature levels at 20°C, 12°C, and 5°C, were determined. It was produced a series of pedagogic maps, predicting regional constraints to drive properly cooling aeration. Following this study, innovative software for self-diagnosis was developed in partnership with FranceAgriMer for grain store managers. From the measurement of air pressure and air flow in the pipe between the air fan and grain bin, and temperature of external air and of pressurized air in the pipe behind the fan, the software allows the calculation of the required number of aeration hours required at each step of the cooling aeration process. The result can be compared to available hour number issued from data of meteorological mapping. The software validates or not the design of the ventilation system. This self-diagnostic software was developed as a free tool and available for grain store managers wishing to optimize grain cooling and to improve the efficiency of existing equipment.

Keywords: cereal grain, storage, ambient air cooling aeration, climate zoning, optimal cooling performance.

52 – Efficacy of diatomaceous earth against the rice weevil *Sitophilus oryzae* L. after a preventive treatment of wheat

Abstract type: **Oral presentation**

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Abstract: Since 2009, diatomaceous earth (DE) is authorized at the EU level as natural insecticide to control insects and mites in grain stores and also for the treatment of empty stores. It is also registered in different EU countries. Treatments with DE SilicoSec® were carried out in order to prevent wheat infestation by the rice weevil *Sitophilus oryzae*. Two dosages were tested with an application rate of 1 and 2 g of DE / kg of grain and the efficacy was compared to a contact insecticide treatment with pirimiphos-methyl, used in France at 4 mg/kg. For each test series, 50 kg of non-infested wheat were treated in a concrete mixer with diatomaceous earth (2 dosages) and pirimiphos-methyl by spraying. Treated wheat was divided in two parts, 25 kg were stored at 15°C and 25 kg were stored at 25°C. For each test series, three samples of 1 kilogram of wheat where sampled 24 h, two weeks, 1, 2 and 3 months after treatment in order to assess the efficacy of the treatment and its insecticidal persistence. After each post-treatment period 200 adult rice weevils were introduced into 1.5 L glass jars filled with 1 kg of treated wheat with DE and pirimiphos-methyl. The same operation was repeated with non-treated wheat for the control. The observation of insecticidal efficacy of diatomaceous earth was done 14 d after the introduction of insects. After the first test series (24 h after treatments), samples of wheat were stored at 25°C and 65% R.H. in order to assess the emergence reduction of insects in these conditions and to compare the results between DE, pirimiphos-methyl and control. Mortality was 100% for all treatments with pirimiphos-methyl. Corrected mortality was above 95% at 25°C for all treatments with DE. Corrected mortality was below 22% at 15°C for each test series with 1 g/kg and below 69% for samples treated with 2 g/kg. The temperature seems to be the main factor which affects the efficacy of DE in these conditions even after 3 months of storage. The emergence reduction of insects was around 99% for all samples treated with pirimiphos-methyl, between 63 to 76% for wheat treated at 1 g/kg and between 81 to 94% for wheat treated at 2 g/kg.

Keywords: *Sitophilus oryzae*, diatomaceous earth, wheat, pirimiphos-methyl, SilicoSec.

54 – Efficacy of some microbial control agents and inorganic insecticides against red flour beetle *Tribolium castaneum* and confused flour beetle, *Tribolium confusum* (Coleoptera: Tenebrionidae)

Abstract type: **Oral presentation**

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Abstract: The efficacy of three fungal pathogens: *Paecilomyes fumosoroseus; Nomuraea rileyi* and *Verticillium lecanii* alone and with the combination with Natural diatomaceous earth (DE) and silicagel-O-500 and silica-O-750 evaluated against red flour pests *Tribolium castaneum* and confused flour beetle, *Tribolium confusum*. Results showed that modified diatoms with Calcium hydroxide (Ca-DE) and modified diatoms with Sodium hydroxide (Na-DE) were the highlight treatments against the two tested insects and achieved the highest mortality percentages. *T. castaneum* achieved the highest tolerant to tested DEs. Cab-O-Sil-750 gave highest mortality against *T. castaneum* reached to 89, 50 and 12% at concentrations 1, 0.5 and 0.25, respectively. The fungus *P. fumosoroseus* was the most effective alone against *T. castaneum* $LC_{50,}$ recorded 140 sore/ml. . Ca-DE and Na-DE treatments strongly enhanced the potency of the tested fungi *P. fumosoroseus* and *N. rileyi*. Results showed that *T. castaneum* was susceptible to *N. rileyi*. Larvae of *T. castaneum* were more tolerant to *V. lecanii* alone. In most cases, DE combinations with tested fungi had synergistic effects, while in *T. castaneum* modified diatoms with aluminium hydroxide (Al-DE) decreased the efficacy of *V. lecanii*. Both silica gel and diatoms protected grain better. The egg production was highly suppressed by combination of Ca-DE followed by Na-DE with tested fungi in comparison to untreated control. The combination of Ca-DE/*P. fumosoroseus* strongly suppressed the number of deposited eggs of *T. castaneum* (87.5±9.6 eggs/female), in comparison to untreated control (277.0±5.9 eggs/female). The most effective DEs modification were Ca-DE and Na-DE had insecticidal, repellent and ovicidal effects against tested *T. castaneum* and they had synergistic effects on the potency of tested fungi.

Keywords: *Paecilomyes fumosoroseus*; *Nomuraea rileyi*, *Verticillium lecanii*, *T. castaneum*, *T. confusum*, Cab-O-Sil-750 , Cab-O-Sil-500, Diatomaceous earth.

56 – Effectiveness of essential oils of *Eucalyptus camaldulensis* and *Cymbopogon citratus* in protecting stored rice against *Sitophilus oryzae* and *Sitotroga cerealella*

Abstract type: Poster

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Abstract: The increase in sub-Saharan African rice production and the consequent resurgence of storage pests such as *Sitophilus oryzae* and *Sitotroga cerealella* require a response to preserve the quality and quantity of stored crops. Chemical control methods are widely used on-farm for storage issue, but it is necessary to explore new measures to limit the risks of pesticides to producers and consumers' health. The objective of this study was to develop alternative technologies based on the treatment of storage bags with the essential oils of *Eucalyptus camaldulensis* and *Cymbopogon citratus* to protect stored rice against these key pests. Two methods were used: impregnation of jute bags and treatment of cotton bags. Jute bags were soaked in oils diluted in alcohol at various concentrations (3%, 4% and 5%). Cotton bags were treated either with a single oil (dose: 0.25 ml), or with the two oils (dose: 0.125 ml). Twenty-four hours after application of the oils, 100 g of rice paddy were placed in each bag, and then each was artificially infested with 10 pairs of adults of *S. oryzae* and *S. cerealella*. After 90 days of storage, we assessed the populations of the two pest species and the damage inflicted on the stored rice. We also assessed the economic profitability of the various treatments. Impregnation of jute bags and treatment of cotton bags with essential oils of *C. citratus* and *E. camaldulensis* effectively protected the stored rice against *S. oryzae* and *S. cerealella*. Moreover, the mixture of the two products was the most effective treatment against these species. However, because of the high cost of essential oils, their use would only be economically viable for the prevention of high infestations of these pests or for the treatment of seeds, where profitability can be assured in the medium or long term.

Keywords: Alternative measures, storage pests, protection, plant extract, rice weevil, Angoumois grain moth

57 – Reproductive strategy and biocontrol potential of *Dinarmus basalis* (Rondani), a koinobiont parasitoid of stored grain pests

Abstract type: Poster

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Abstract: Bruchids (Coleoptera: Bruchidae) cause heavy loss to stored legumes during monsoon and reasonably less throughout the year. *Callosobruchus maculatus* and *C. chinensis* serious pests of stored legumes, *Phaseolus mungo, P. aureus* and *Vigna sinensis* and many more edible legumes showed complete development and repeated generations in the absence of parasitoid. But reproductive strategies and biocontrol potential of *Dinarmus basalis* (Rondani) (Hymenoptera: Pteromalidae), a koinobiont parasitoid of many stored product pests disrupted the development of both pest, *C. maculatus* and *C. chinensis* in between. Early developing stages of parasitoid utilized the late developing stages of host insect for its growth and development. Female parasitoid precisely searched the developing stages of host insects inside the seeds and utilized the ovipositor initially for drilling and then placing the eggs on or close to the larval body. The most preferred and susceptible stages for oviposition and development were fourth instar larvae and prepupae of both the host species. The larval pupal development of parasitoid was 7.8 ±1.4 and 17.2±2.4 on *C. chinensis* and 6.8±0.8 and 13.4±1.4 days on *C. maculatus* and total development period was 29.7±2.3 and 27.3±1.3 days respectively. Parasitoid larvae completed their development at the cost of host larvae and pupae and kill them during metamorphosing into adults. The tendency of parasitoids to use the host stages for its own development could be exploited at a large scale for the biological control of bruchids and other stored product pests.

Keywords: Bruchids, stored grain pests, *Dinarmus basalis*, reproductive strategies, biocontrol

58 – Laboratory test bench for the study of high-temperature-short-time disinfestation of cereal grain housing granary or rice weevil pre-emergent stages and of incidence on wheat and durum quality

Abstract type: Poster

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Abstract: A laboratory test-bench was built up to simulate high-temperature-short-time (HTST) exposure of infested grain samples by hidden stages of *Sitophilus granarius* or *S. oryzae* in a fluidized bed in order to model temperature-exposure time relationship. The reduction of emergence of the two weevil species (*S. granarius* in bread making wheat and *S. oryzae* in durum wheat) was determined after different exposure times in the fluidized bed exposure chamber crossed by 2 $m.s^{-1}$ airflow at inlet air temperatures of 60, 90, 120 and 150°C. The influence of a grain moisture content from 14 to 19% w.b. on lethal time 50% (LT_{50}) and lethal time 99% (probit 8 or LT_{100}) was also observed. The main microbiological and technological characteristics checked on grain samples after heat treatment were measured. Higher the moisture content longer the exposure time required for the same mortality rate to be achieved. The "temperature-exposure time products" assessed at LT_{50} and LT_{100} were modeled as asymptotic negative regression curves. LT_{100} was observed in less than 10 s exposure time for temperature at air inlet of 120 and 150°C, whatever the moisture content level. The reduction of fungal colonies was more important with long exposure time at moderately high temperature (90°C) than with short exposure time at very high temperature (150°C) (giving similar levels of insect mortality rate). For bread-making wheat, it was not observed significant changes in alveogramme rheological test parameters processed with white flour extracted from heat-treated wheat samples, provided that air temperature and initial grain moisture content are at moderately high level (less than 150°C and 15% m.c.). The HTST treatment of cereal grain is an efficient and rapid method of control of weevil internal feeder stages and may be developed at practical scale for organic cereals or high-added-value use for special healthy cereal food disinfestation.

Keywords: *Sitophilus granrius, Sitophilus oryzae,* high-temperature-short-time treatment, wheat grain sample, fluidized-bed, quality characteristics changes.

59 – Application of Biological Control Agents and Pheromone Traps For Controlling *Ephestia* spp. in Date Warehouses of Two Provinces in Iraq

Abstract type: Poster

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Abstract: As a result of high infestation of Dates by *Ephestia* spp. during its storage period which was for about 3-6 months before manufacturing and marketing it , Iraq used to apply Methyl bromide as fumigant agent to stop its infestation with *Ephestia* spp ,but because this fumigant agent proved to be carcinogen and ozone depleting agent , a decision was taken to stop using it internationally and nationally. This decision made Iraqi scientist to search for another methods to control *Ephestia* spp. or to decrease infestation to the lowest percentage. Therefore, Iraqi scientist recently concentrated on using IPM specifically biological control agents (Egg parasitoid, *Trichogramma evanescens* and larval parasitoid, *Bracon hebetor* in addition to the pheromone traps for this purpose. The research carried out into two date warehouses, one in Karbala province, while the other in the Babylon province which belong to the Iraqi company for manufacturing and marketing Dates. In these two date warehouses, the biological agents mentioned above were released periodically in addition to hanging pheromone traps. The results revealed that the percentage of preserving date in these two date warehouses were 97.5 and 98.1 % in comparison with 90.5 and 92.5 % into the control dates warehouses in which biological agents and pheromone traps did not used. Furthermore, to prove that this method for controlling *Ephestia* spp. in date warehouse was succeeded, we examined date from another date warehouse containing about 3250 tons of date packed in polyethylene bags and treated with methyl bromide to protect it from *Ephestia* spp. infestation. Unfortunately the percentage of preserving dates was only 91.7%. Finally our results showed that the mean number of *Ephestia* spp. captured by pheromone traps in the control warehouse which treated with methyl bromide was 18 times more than that captured into warehouses treated with biological agents mentioned above and pheromone traps.

Keywords: *Ephestia* spp. date warehouses, pheromones traps, capture limitation, biocontrol species, *Bracon hebetor*

60 – Insecticidal effect of ozone against different life stages of *Plodia interpunctella*, *Tribolium confusum*, *Cryprolestes ferrugineus* and *Oryzaephilus surinamensis*

Abstract type: Poster

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Abstract: Laboratory experiments were carried out in order to assess the insecticidal efficacy of ozone, against all life stages of four major stored-product beetle species, the Indian Meal moth, *Plodia interpunctella* (Huebner) (Lepidoptera: Pyralidae), the confused flour beetle, *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae), the rusty grain beetle, *Cryptolestes ferrugineus* (Stephens) (Coleoptera: Laemophloeidae) and the saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.) (Coleoptera: Silvanidae). All species were tested in jars, by using ozone at three different concentrations, 55, 115 and 210 ppm. The exposure intervals tested were 2, 4, 6 and 8 h. Generally, at the two highest dose rates, all mobile stages were dead after 6 h of exposure, with *T. confusum* adults being the most tolerant. On the other hand, pupae and especially eggs were less susceptible to ozone, given that mortality did not exceed 85 and 55 % for pupae and eggs, respectively, regardless of the dose and the exposure interval. The results of the present work indicate that ozone efficacy is highly affected by the target species and the life stage, while eggs were by far the least susceptible.

Keywords: Ozone, insecticidal efficacy, life stages, Lepidoptera, Coleoptera

61 – Investigations on the microsporidian pathogen of *Plodia interpunctella* (Lepidoptera: Pyralidae) in Turkey

Abstract type: Poster

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Abstract: The Indian-meal moth, *Plodia interpunctella* (Lepidoptera: Pyralidae), is one of the most widely distributed and economically important pests infesting stored products in Turkey. In the present study we aimed to investigate microsporidium pathogens of this insect in Turkey for possible biological control strategies. A microsporidian pathogen of *P.interpunctella* is described based on light microscopy, ultrastructural characteristics and gene analysis for a better understanding of the taxonomy and characteristic features of *P. interpunctella*'s natural enemies which can be used in biological control.

Keywords: *Plodia interpunctella*, microsporidium, biocontrol, stored food product

62 – Insecticidal activity of homologous protein peas (*Pisum sativum* L.)

Abstract type: Poster

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Abstract: PA1b (pea albumin 1, subunit b) is a 37-amino acid cysteine-rich plant defense protein isolated from pea seeds (*Pisum sativum* L.). It induces short-term mortality in several pests, among which the cereal weevils *Sitophilus* sp, that are a major nuisance for stored cereals, all over the world. As such, PA1b is the first genuine protein phytotoxin specifically toxic to insects, which makes it a promising tool for seed weevil damage control.The effect of the protein PA1b pea (*Pisum sativum*), chickpea (*Cicer arietinum*), bean (*Phaseolus vulgaris*), lentil (*Lens esculenta*) and bean (*Vicia fabae*), was evaluated at concentrations of 10, 20, 40, 60 and 80%. Legume seeds are toxic to pests in stored grain. The effect of the protein PA1b pea (*Pisum sativum*), chickpea (*Cicer arietinum*), bean (*Phaseolus vulgaris*), lentil (*Lens esculenta*) and bean (*Vicia fabae*), was evaluated at concentrations of 10, 20, 40, 60 and 80%. We note that all legumes tested are toxic to the species *Sitophilus granarius* L. and a total mortality of the insect after 14 days. On 3rd day, there is in general 1-2 dead on wheat up to 15 days or the experiment was stopped. On peas, there is a mortality exceeding 10% at a concentration of 80% of PA1b. From 7 days, there are no survivors. For concentrations of 40% and 60%, mortality rates were 73.3% and 93.3% respectively; but, the rates are low, not exceeding the threshold of 20% for concentrations of 20% and 10%. Some legume species cause total mortality of the insect as well as 60% to 80%. This is the case of the lens, beans and bean. Others are less toxic as chickpea which causes lower mortality of about 3 and 23% respectively.

Keywords: PA1b, legumes, bio insecticide, control, granary weevil.

63 – Stored-product insect natural enemies in wheat industry in Sicily

Abstract type: Poster

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Abstract: The cultivation of wheat in Sicily (Italy) has its origins in ancient times and today it turns out to be the one that invests the largest areas in the island. Connected to this cultivation, a flourishing industry of primary and secondary processing has been developed and is particularly competitive in the global market thanks to the qualitative features of sicilian durum wheat. In the last decade research activities were undertaken in order to implement quality by studying infesting arthropods and by developing integrated control methods. In this context, during the monitoring activities of the stored grain pests carried out over the past decade in sevral grain industries and warehouses in Sicily, the following natural enemies were collected: *Withius piger* (Simon) (Pseudoscorpionida; Whiitidae), *Xylocoris flavipes* (Reuter) (Hemiptera; Anthocoridae), *Anisopteromalus calandrae* (Howard) (Hymenoptera; Pteromalidae), *Habrobracon hebetor* Say (Hymenoptera; Braconidae), *Theocolax elegans* (Westwood) (Hymenoptera; Pteromalidae), *Venturia canescens* (Gravenhorst) (Hymenoptera; Ichneumonidae), *Cephalonomia* sp. (Hymenoptera; Bethylidae). More extensive researches are currently in progress for some of these species. Here we discuss their potential use in the framework of the IPM programs.

Keywords: stored grain, predators, parasitoids, Italy.

64 – Testing the insecticidal efficacy of individual and combined use of four different natural substances against granary weevil (*Sitophilus granarius*) under laboratory conditions

Abstract type: Poster

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Abstract: Laboratory experiment was carried out to evaluate the impact of different natural substances on the mortality of the granary weevil (*Sitophilus granarius*) adults. We tested the insecticidal properties of diatomaceous earth (commercial formulation SilicoSec®), quartz sand of local origin, Neem leaf powder (offered in a local market as fertilizer and plant strengthener), common beech wood ash, combination of SilicoSec® and wood ash, combination of Neem leaf powder and wood ash, combination of quartz sand and wood ash, combination of all 4 substances tested. Natural substances in a form of powder were mixed with grain in different dose rates. Wheat grains were treated with 450 and 900 ppm of SilicoSec® and quartz sand as self-based formulation, wood ash (5 weight (w)% and 2.5 w%) as self-based formulation, Neem leaf dust (1.25 w% and 2.5 w%). Individual treatments were evaluated as mixtures of SilicoSec (450 ppm) and wood ash (2.5 w%), Neem leaf powder (2.5 w%) and wood ash (2.5 w%); quartz sand (450 ppm) and wood ash (2.5 w%); SilicoSec® (225 ppm), wood ash (2.5 w%), Neem leaf powder (0.625 w%) and quartz sand (225 ppm). Control treatment was presented as untreated grain. Specific treatment was composed from 500±0.01 g of wheat grain and concentration of natural substance and it was replicated three times. Mortality of adults was evaluated seventh, fourteenth and twenty-first day after exposure. Insecticidal efficacy was tested at three different temperatures (20, 25, and 30°C) and two different relative humidity levels (55 and 75%). Significantly the highest mortality of adults was evaluated in treatment treated with formulation consisting of wood ash and SilicoSec® (66.38±2.64%), meanwhile wood ash (2.5 w%) provoked 63.35±2.74 % mortality. In general, mortality after 21 days reached 48.52±0.01% and it was also higher at lower humidity level (46.02±1.66%). Interactions between different factors of experiment will be presented, and suggestions for the practical use of the most effective substance will be given.

Keywords: Granary weevil, physical control, diatomaceous earth, quartz sand, neem leaf powder, common beech ash, mortality, efficacy.

65 – Effect of fluctuating temperarures on development of the koinobont endoparasitoid *Venturia canescens* (Hymenoptera: Icneumonidae)

Abstract type: Poster

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Abstract: *Venturia canescens* Gravenhorst (Hymenoptera: Ichneumonidae) is a solitary, koinobiont endoparasitoid of several pyralid moth larvae that are major pests of stored products. Laboratory studies were conducted to determine the effect of fluctuating temperatures on development and biological parameters of *V. canescens*. Parasitized fourth-instar larvae of the Mediterranean flour moth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae), were reared individually in incubators at different temperature regimes (20-30^{o}C with a mean of 22.5^{o}C, 25-27.5^{o}C with a mean of 25^{o}C and 25-31.5^{o}C with a mean of 28^{o}C) until emergence and death of *V. canescens* adults. Developmental time from parasitism to adult eclosion, adult longevity and survival were recorded at each temperature regime. Overall, developmental time decreased with increasing mean temperature of fluctuating temperature regimes. The lowest developmental time was observed at 28^{o}C (25.4 days) while the highest at 22.5°C (32.9 days). Adult longevity was also affected by fluctuating temperature, as it was significantly reduced at the highest mean temperature (7.6 days at 28^{o}C) compared to the lowest one (13.4 days at 22.5^{o}C). Survival was relatively low at all the tested temperatures, however it was significantly higher at mean temperature of 25^{o}C (37%), compared to 22.5 and 28^{o}C (21 and 28%, respectively). These results provide us with useful information on the biocontrol efficiency of *V. canescens* against pyralid moths in natural conditions, since fluctuating temperatures may provide a more accurate assessment of insect developmental biology than constant temperatures.

Keywords: *Venturia canescens*, *Ephestia kuehniella*, fluctuating temperatures, developmental time, adult longevity, survival.

66 – First application in France of heat disinfestation of a large wheat mill

Abstract type: Poster

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Abstract: Thermal disinfestations of flour mill structures and equipment were traditionally used before the 1960's, but they have been replaced by methyl bromide fumigation until the international ban of methyl bromide in 2005. During the last decade, heat disinfestation of flour mills was developed in Northern America and in some European countries from the 2000's workshops of heat disinfestation of wheat mills were carried out. In France, the first industrial application of this technology was attempted in 2010 for the disinfestation of a large wheat mill and was carried out by Agronet Company in collaboration with INRA Research Laboratory in Bordeaux. The heating of the flour mill was performed from electric heat generators of Thermonox® technology (Germany). The electric heaters are forced heat air ventilators enabling to reach the target temperature of 50 to 55°C in about 10-12 h in all parts of the mill. Then, temperature is maintained at this level during 24 to 36 h and optimised from the indications of temperature sensors in order to obtain complete mortality of insects, whatever their development stage. Encaged insects (*Tribolium castaneum* and *Rhyzopertha dominica*) placed in the mill during mill heating were killed at more than 97%. Very few survivals were only observed on the floor at the ground level of the mill. The reproductive capacity of individuals surviving thermal exposure was severely reduced. This first industrial application of heat disinfestation process to a large wheat mill confirmed the results of laboratory studies performed earlier at INRA Laboratory. The economic evaluation of the heat treatment in the conditions described above revealed that it is competitive compared to fumigation with similar requirements in the preparation of the building before treatment. This technology seems very promising for periodic eradication of insect colonies in cereal processing industries without use of pesticide.

Keywords: Wheat mill, electric heat generator, Thermonox® technology, heat disinfestation, industrial scale, stored-product insect, complete mortality.

67 – Potential of *Anisopetomalus calandrae* and *Lariophagus distinguendus* (Hymenoptera: Pteromalidae) as biocontrol agents of *Callosobruchus maculatus* (Coleopetera: Bruchidae)

Abstract type: Poster

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Abstract: In Algeria, the cowpea produced or imported are highly susceptible to insects attacks particularly of the bruchids *C.maculatus*. In storage *C.maculatus* is currently parasitized by two parasitoids *Anisopeomalus calandrae* and *Lariophagus distinguendus*. The aims of this study were to evaluate the impact of the two parasitoids used alone or simultaneously and at different density on the reduction of emergence of *C. maculatus* bruchids adults. The effect of intra and interspecific competition between parasitoids was also studied. The results show that *A. calandrae* was much more efficient at reducing of emergence of *C. maculatus* than was *L. distinguendus*. Competition reduced emergence of both *A. calandrae* and *L. distinguendus;* however *A. calandrae* was clearly the dominant species when bruchids were exposed to equal number of both species of parasitoids.

Keywords: Biological control, *Callosobruchus maculatus*, *Anisopteromalus calandrae*, *Lariophagus distinguendus*, competition.

68 – Biological and molecular analysis of an isolated Granulovirus *Tecia solanivora* collected in Páramo Mucuchíes of Merida, Venezuela

Abstract type: Poster

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Abstract: *Tecia solanivora* (Lepidoptera: Gelechiidae), a major pest of potato [Solanum tuberosum L. (Solanaceae)] of Central America and the north of South America, was introduced in Venezuela through infested seed imported, from where progressively invaded Colombia and Ecuador to settle in areas colonized by *Phthorimaea operculella* (Lepidoptera: Gelechiidae), other taxonomically related insect pest. Both insect species coexist in the same localities in different proportions. There are no biological control methods suitable for *T. solanivora*, and the use of native granulovirus (Baculoviridae: Betabaculovirus) would provide a solution. Since 1993, the National Agricultural Research Institute (INIA) of Venezuela, has used an isolated uncharacterized collected from infected larvae of *T. solanivora* in the locality of Mucuchíes Paramo, Merida, with the aim of biological control of pests in field and warehouse. This work, done in the context of an institutional collaboration between France and Venezuela, is to analyze biological and molecularly granulovirus Mucuhíes'isolated, collected from *T. solanivora* and multiplied on *P. operculella*. The study of polymorphic fragments with restriction endonucleases (REN), and using as reference the sequencing isolated Tunisia (*GV-1346*), allowed identified as *P. operculella* Granulovirus-Venezuela and was appointed as PhopGV-Venezuela. Biologically, was evaluated "per os" insecticidal activity by the method of nebulization and killed its alternative host (a colony of P. operculella without latent infection in a laboratory multiplied French Institute National de la Recherche Agricole, INRA), with an LD_{50} = 32 occlusion bodies (OBs) mm^{-2}. This behavior makes it similar to other granulovirus biologically isolated from T. solanivora, (PhopGV-Ecuador, PhopGV-Colombia, PhopGV-Costa Rica), whose LD_{50} are between 20 and 30 (OBs) mm^{-2}. These same isolates are always much more efficient when the isolates are tested on their host of origin, so it is recommended to test the biological effect of PhopGV-Venezuela on colonies of *T. solanivora* in Mucuchíes Paramo conditions.

Keywords: Granulovirus, biological control, nebulization *per os*, *Tecia solanivora*, alternative hosts.

69 – Natural occurrence of entomopathogenic fungi isolated from stored grain insect species in Punjab, Pakistan

Abstract type: Poster

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Abstract: The detailed survey of different storage facilitates in Punjab (Pakistan) was conducted to explore the occurrence and diversity of entomopathogenic fungi from stored grain insects collected from various storage structures. Total 25,720 insect of different species were collected by sieving whom 195 isolates of different fungal species were recovered including the major entomopathogenic fungi like *Beauveria bassiana* (Balsamo) Vuillemin (Hypocreales: Cordycipitaceae), *Metarhizium anisopliae* (Metschnikoff) Sorokin (Deuteromycotina: Hyphomycetes), *Paecilomyces lilacinus* (Thorn) Samson (Trichocomaceae: Eurotiales) and *Lecanicillium attenuatum*. The cadavers of red floor beetle *Tribolium castaneum* Herbst. (Coleoptera: Tenebrionidae) (0.26%) were greatly infected with the fungi followed by the rice weevil *Sitophilus oryzae* L. (Coleoptera: Curculionidae) (0.16%), the lesser grain borer *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae) (0.10%), the rusty grain beetle *Cryptolestes ferrugineus* Stephens (Coleoptera: Cucujidae) and the cowpea weevil *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) (0.08%), however, the least were found in the khapra beetle *Trogoderma granarium* Everts (Coleoptera: Dermestidae) (0.07%). The findings of the current surveys clearly indicated that the entomopathogenic fungi are widely distributed in the insect cadavers which may later be used in successful IPM programs.

Keywords: Occurrence, isolation, entomopathogenic fungi, *Sitophilus oryzae*, *Rhyzopertha dominica*, *Cryptolestes ferrugineus, Callosobruchus maculatus, Trogoderma granarium*.

Session 5

Chemical control in stored product IPM programs

Chairpersons: Shlomo Navarro and Yann Ciesla

Oral communications: 11
Posters: 9

Timetable:
Wednesday 3rd July, 08h40 – 12h20
Thursday 4th July, 14h – 15h20

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70 - Chemical Control in Stored Products

Abstract type: **Oral presentation (keynote 1)**

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Abstract: Insect pest management in raw stored grain and in grain-based finished products presents many challenges for the 21st century, especially when viewed on an international scale. The complexity of storage structures, economic aspects of utilizing chemical controls in the different sectors encompassing stored products, regulatory and environmental considerations, a low tolerance for insect damage in finished products, and expectations of consumers are just a few examples that pose challenges for research. Selected key issues will be presented and discussed in relation to research needs for the future and how scientists involved in stored product research can address those needs.

Keywords: Insecticides, control, management, research.

71 - Relative importance of fumigation in integrated management of stored-grain insect pests in some EU countries (France and Germany)

Abstract type: **Oral presentation (keynote 2)**

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Abstract: Fumigation with phosphine remains still one of the key methods in controlling pests in stored grain. Also carbon dioxide and nitrogen with some residual oxygen serve this purpose to a minor extent. Various other chemicals and methods complete the whole spectrum of integrated pest management where fumigation often presents the last option after other alternatives have failed or do not present feasible options. Grain especially in bulk as stored in silo bins or granaries over several months or even some years is target for some specialised species of insect and mite pests. Prevention, detection and control of these synanthropic pests are difficult and hardly complete. Fumigation offers an economic possibility of thorough disinfestation without moving the grain. Phosphine as grain fumigant is threatened by resistance of progeny of sublethally treated insects. A quick test for resistance has been developed by Reichmuth to offer practitioners the opportunity to determine the degree of tolerance towards phosphine of occurring insects prior to fumigation. Proper adaptation of the dosage according to this degree of tolerance or resistance still allows complete control the pests.
The situation with phosphine in France and Germany is presented. In France, despite registration of the fumigant phosphine, contact insecticides like deltamethrin, pirimiphos methyl... are regularly preferred as protectants. This situation is mainly explained by the lack of sealing silos, the cost, the lack of staff, the period of detention of goods during the exposure time and sometimes to avoid later infestation of prophylactically treated grain. In Germany, contact insecticides must only be applied after infestation in accordance with the German regulation. Since the movement of the grain after detection of insect infestation is costly, fumigation of the stored grain preferably with phosphine is the method of choice. Registrations exist of tablets, pellets, bags, blankets, strips and plates as well as of pure magnesium phosphide and cylinder gas (phosphine in nitrogen).

Keywords: Phosphine, phosphides, frisin, insect pest control, resistance, quick test, grain, fumigant, France, Germany.

72 - Phosphine fumigation of sunflower seeds: efficacy on insect pests and phosphine residues in seeds

Abstract type: **Oral presentation**

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Abstract: A study was conducted on the phosphine fumigation on sunflower seeds, in order to control insect infestation, in collaboration with the National Laboratory of Stored Foodstuffs (French Ministry of Agriculture). It was performed on two kinds of fumigations:
- Fumigation during storage that eliminates all stages of insects with a PH_3 standard dose 1.5 g/m^3.
- Fumigation just before bin downloading, including low-dose shock action removes only adults (PH_3 dose between 0.045 and 0.09 g/m^3) for foodstuffs for sale to be processed (effective control persisting during two weeks).
In order that the residual concentration of phosphine fell below the maximum residue limit in seeds (10 µg/kg), the waiting time required was variable according to the conditions of temperature and duration of the fumigation. Thus, in the case of fumigation during storage at 1.5 ppm g/m^3, it takes between 3 and 30 days for complete phosphine desorption. For the fumigation just before outoading at 0.045 to 0.09 g/m^3, no phosphine residues can be detected after 24 hours, whatever the temperature.
For a good efficiency of phosphine gas, the temperature of the seeds should be at least 10°C. These two types of fumigation showed very good control of insects found in sunflower seeds. They may be integrated in IPM (Integrated Pest Management) programs for oilseed protection against possible infestation by some insect pest species.

Keywords: Sunflower seeds, storage, insect pests, phosphine fumigation, IPM program.

73 - Physical and chemical control agent thresholds for action on storage insects

Abstract type: **Oral presentation**

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Abstract: Many factors are involved in the successful application of a control measure, whether using a chemical pesticide or whether altering the physical environment by manipulation of temperature humidity or oxygen level. Setting the dosage for a contact insecticide, fumigant or low oxygen level needs to take into account firstly the period of time insects will be exposed while factors such as temperature and humidity are also of critical importance. For any treatment to work, an adequate presence of the control agent needs to be achieved and maintained where the target pest species are actually living. A spectrum of concentration threshold levels for full efficacy exists among individuals of each species and stage, some responding much earlier than others as concentrations are lowered. Threshold temperature spectra for the upper and lower limits of survival also exist, in close relationship with humidity, again individuals differing in their response.
Besides having some knowledge of the thresholds for survival, pest control operators also need to consider temperature thresholds for mobility and flight. Even light levels can have high importance. These aspects and their interrelations are discussed.

Keywords: Fumigants, insecticides, modified atmospheres, temperature, humidity, light.

74 - Phosphine Generator SGF-M2 and fumigation technologies with its use

Abstract type: **Oral presentation**

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Abstract: The target of our research was to create an autonomous physico-chemical system, which at the result of internal reactions could have performed the self-regulated process of phosphine gas elaboration without any special electronic control system assistance. As a result of a long-term basic and applied research a high technology and thus a simple device called the Active Cell Phosphine Gas Generator (SGF-M2) has been developed. The SGF-M2 is a lightweight standalone physical-chemical system producing the phosphine gas without any external power source or computer control of chemical and thermal processes. No special training or skills for the operators using the SGF-M2 are required. The properties of SGF-M2 allow its use in any facilities where required to carry out fumigation, even if the ambient temperature is below 0°C.
Fumigation technologies with SGF-M2 use are suitable for all object types. Technologies of insect eradication based on use of SGF-M2 allow fumigation of large volumes of grains and/or grain products either during storage or transportation.
Fumigation of grain silos with use of SGF-M2 does not require grain transfer or movement between the silo bins as a fumigant gas (phosphine + carbon dioxide mixture) movement technology called "*the fumigation wave method*" is being used. The *fumigation wave* method means the vertical movement of high gas concentration area being generated by SGF-2M and drawn through the grain mass by convectional air streams present inside the silo bin. Repeated *fumigation waves* eradicate insects layerwise, thus reducing the phosphine gas expenditure in comparison with tablet form preparations use. Use of the necessary number of SGF-M2 generators allows the fumigant gas application to all silo bins simultaneously. The time of fumigant gas generation by each SGF-M2 is 2 hours.
The use of SGF-M2 generators in the railway cars allows the most quick, safe and effective fumigation of transported goods. Fumigation technologies with SGF-M2 use in hopper cars allow direct application of the fumigant gas to the product avoiding temperature, humidity and residue issues typical for tablet form preparations use. The time of fumigant gas generation by each SGF-M2 is 2 hours. Fumigation technologies with SGF-M2 use for other transport units like freight containers, river barges or ship's holds are similar to hopper cars fumigation.

Keywords: SGF-M2, phosphine gas, transit fumigation technology, “the fumigation wave method”, grain fumigation without transfer

75 - Improved Speedbox as an effective instrument for phosphine fumigation

Abstract type: **Oral presentation**

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Abstract: Phosphine is mainly in use today for stored product insect pest control, after the phase out of methyl bromide in developed countries due to its ozone depletion effects. However, some limitations, such as low temperatures and relatively long exposure time, limit the use of phosphine. In order to overcome these difficulties, a special devise, called "Speedbox" has been developed by Detia Degesch GmbH Germany. Currently, the improved model of Speedbox was evaluated for Phosphine fumigation against stored product insects. The experiments were conducted in a fumigation room (15 m^3 - pilot), in commercial warehouse and in commercial containers. Internal coleopterans *Sitophilus oryzae* L, *Rhyzopertha dominica* F. and *Callosobruchus maculatus* F. and external coleopterans *Oryzaephilus surinamensis* L, *Trogoderma granarium* Everts, *Tribolium castaneum* Herbst and Lepidoptera *Plodia interpunctella* Hub. and *Ephestia cautella* Walker were used as test insects. All developmental stages of these species were tested. The used phosphine concentrations were 2-6 g of gas per m^3. Exposure time was 1 to 4 days. The phosphine concentration was monitored by Bedfont device model 415. Three Phosphine gas-sampling points were located at the top, middle and bottom of the fumigation room while one point was placed among the bags containing wheat. The temperatures of intergranular air and of the room space, as well as outdoor air relatively humidity were also recorded. At 4 g/m^3, the phosphine concentrations of 370 ppm, 1100 ppm and 2000 ppm (a maximum of the monitor range) were reached just after one, 3 and 9 hours from the beginning of the fumigation respectively. At 6 g/m^3, the concentrations of 1000 ppm and 2000 ppm were reached just after 3 and 6 hours respectively. The total mortality of all tested insects and stages was recorded. In the commercial stack and container fumigations similar results were obtained. The use of improved model of Speedbox allows reaching higher by 20-30% phosphine concentrations, getting effective concentrations in a shorter time compared with the basic model and especially with the application of tablets and thus to decrease the exposure time of the fumigation. The Speedbox also allows to achieve an even distribution of the gas in the treated space and to enable effective fumigation at low temperatures. The use of the Speedbox opens novel possibilities for Phosphine fumigation also as a quarantine treatment.

Keywords: Fumigation, phosphine, Speedbox, stored product insects

76 - Influence of egg morphology on ovicidal efficacy of fumigants

Abstract type: **Oral presentation**

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Abstract: There is great variability in the way eggs of different stored-product insect pests respond to fumigation treatments. Doses of sulfuryl fluoride and propylene oxide required to kill *Carpophilus hemipterus* (L.) (Coleoptera: Nitidulidae) eggs are higher than those required to kill *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae), *Ephestia elutella* (Hübner) (Lepidoptera: Pyralidae), and *Amyelois transitella* (Walker) (Lepidoptera: Pyralidae) eggs. No published explanation for this variability exists. The external morphology of insect eggs has been extensively studied using the scanning electron microscope (SEM). However, these studies have focused on elucidating external morphology of insect eggs in order to develop phylogenetic relationships and to facilitate tracing origin of infestations in domestic and international trade. No studies have addressed the relationship between respiratory structures on the chorion surface that facilitate gaseous exchange and relative tolerance of insect eggs to fumigants. Therefore, the objective of our study was to use a SEM to compare the abundance, distribution, and location of egg respiratory structures of *C. hemipterus* with those of *L. serricorne*, *E. elutella*, and *A. transitella* in order to determine how respiratory structures of stored-product insect eggs may be related to their tolerance to fumigants. We found that *C. hemipterus* eggs have only two aeropyles at the anterior pole, and no micropyle(s). *E. elutella* had many aeropyles and a single micropyle per egg whereas each *A. transitella* and *L. serricorne* egg had many aeropyles and several micropyles. In *C. hemipterus* eggs with only 2 aeropyles, the route for fumigant entry may predominantly be diffusion through the chorion whereas in *L. serricorne*, *E. elutella*, and *A. transitella* entry is mostly through aeropyles and micropyle(s). Fumigant entry into eggs by diffusion through the chorion may be comparatively slower compared to entry through aeropyles and micropyle(s). Our findings provide a possible explanation for why *C. hemipterus* eggs are more tolerant to fumigants than *L. serricorne*, *E. elutella*, and *A. transitella* eggs.

Keywords: Stored product, *Carpophilus hemipterus*, *Lasioderma serricorne*, *Ephestia elutella*, *Amyelois transitella*.

77 - Effect of Deltamethrin and Spinosad on phosphine resistant strains in comparison with laboratory strains of four stored product pest species

Abstract type: **Oral presentation**

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Abstract: Scope of the study was information on alternative treatment against the most reported phosphine resistant species, *Cryptolestes ferrugineus* (Stephens, 1831), *Rhizopertha dominica* (Fabricius, 1792), *Sitophilus oryzae* (Linnaeus, 1763), and *Lasioderma serricorne* (Fabricius, 1792). In Germany deltamethrin (DM) containing pesticides are registered for commodity and empty room treatment since 2011. Spinosad (SP) has been reported as promising active substance for grain protection. Tests were performed with commercially available products K-Obiol® EC 25 and Spintor®. Wheat was impregnated with solutions containing insecticide at the label recommended dose of 0.25 mg DM/kg or 1 ppm SP respectively. Adults of laboratory and phosphine resistant strains from the insect stock of Julius Kühn-Institut were used for bioassays. Adults were placed on insecticide treated wheat at 25°C and 62-65% R.H. Mortality was checked after 24 h, 48 h, 7 and 14 d.
Results after short exposure 24 h and 48 h indicate mortalities below 30% in most cases. *R. dominica* generally showed highest susceptibility to the insecticides: After 14 d 100% mortality was achieved on DM treated substrate and about 95-98% mortality on SP treated substrate for both strains. *L. serricorne* was not notably affected by exposure to SP within its comparatively short lifetime. Differences between laboratory and resistant strains were a slightly higher mortality for resistant strains of *C. ferrugineus*, *S. oryzae* and *R. dominica* due to SP exposure. After 14 d *C. ferrugineus* phosphine resistant strain showed a higher mortality (43%) compared to the laboratory strain (9%). Exposure to DM had nearly no effect to *L. serricorne* phosphine resistant strain. Results indicate that deltamethrin and spinosad have potential in control of phosphine resistant strains. However, this depends on the species. As found by chance the coexistent resistance to phosphine and high tolerance to deltamethrin in a strain of *L. serricorne* needs further consideration.

Keywords: *Sitophilus oryzae*, *Rhizopertha dominica*, *Cryptolestes ferrugineus*, *Lasioderma serricorne*, deltamethrin, spinosad, phosphine resistance, deltamethrin resistance.

78 - Improving phosphine fumigation by sealing and using a closed loop system

Abstract type: **Oral presentation**

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Abstract: Failure to kill all grain-infesting insects when fumigating a storage structure occurs for several reasons: leaks in the facility, poor gas distribution, emergence of surviving insects following a poor treatment, and insect resistance. Fumigation can be improved by using a closed loop fumigation (CLF) system where the base ducts are pressurized to force the gas mixture upward through the grain mass which provides better gas distribution through the grain. Before using CLF, the structure must be well sealed. Materials used for sealing include closed-cell foam, silicone, gray tape, 6 mil plastic attached with adhesive spray, and elastomeric roof coating. Areas to seal on metal bins include aeration fan motor connections, fan inlets, fan transitions, roof eaves, sidewall seams, bin base joints, side and roof entry doors, roof vents, and CLF piping. On concrete silos, also seal downspouts, inner and outer connecting vents, and manhole covers. A correctly installed CLF system will use less fumigant, save on labor costs after initial installation, and cause less worker exposure which will lead to less health costs. In a test at a concrete facility that was divided into two sections where one side received conventional treatment and the other side had a CLF system, phosphine levels reached over 2000 ppm on the CLF side and only a maximum of 100 ppm on the conventionally treated side. Sealing and using a CLF system will save you money and result in better control of insect pests.

Keywords: Sealing, phosphine, closed loop fumigation, insect control.

79 - Residual toxicity of spinetoram on various surfaces to adult *Acanthoscelides obtectus* Say (Coleoptera: Bruchidae)

Abstract type: **Oral presentation**

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Abstract: Spinetoram is a new spinosyn insecticide with faster speed of action in comparison with spinosad. Although the efficacy of spinetoram against numerous field insect pest species has been tested, there is little data available on the effectiveness of spinetoram against stored-product insects. In present study, residual toxicity of spinetoram on various surfaces to adult of bean weevil, *Acanthoscelides obtectus* Say, was evaluated. Aqueous spinetoram suspension with concentrations of 2.5, 5, 7.5, 10, 15, 25 and 50 ppm was sprayed with an airbrush to surfaces of concrete, ceramic floor tile and laminate flooring. Control surfaces were sprayed with distilled water. Approximately 1 h after distilled water or spinetoram application, 25 adults of *A. obtectus* were confined to each untreated and spinetoram-treated surface. Knockdown and mortality of adults were recorded after 1, 3, 5 and 7 d of spinetoram exposure at 26 ± 1 ºC and 65±5 % RH. Knockdown and mortality of adults significantly increased with increasing spinetoram concentrations and exposure periods. At all spinetoram concentrations, low adult mortalities ranging from 0 to 27 % were found on all treated-surfaces after 1 d of spinetoram exposure. Higher spinetoram concentrations (15, 25 and 50 ppm) resulted in complete mortalities at all treated-surfaces after 7 d of exposure. Generally, efficiency of spinetoram was lower on surface of laminate flooring than that on surfaces of concrete and ceramic floor tile. These results indicated that spinetoram is not fast acting insecticide and requires least three days at high concentrations (15, 25 and 50 ppm) to reach complete mortality of *A. obtectus* adults.

Keywords: Spinetoram, *Acanthocelides obtectus*, residual toxicity, treated-surface.

80 - Phosphine resistance in the Indian meal moth infesting stored dates in Tunisia

Abstract type: **Oral presentation**

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Abstract: In Tunisia, dates are an important and valuable export commodity with 16% of the total value of agricultural exports. Nevertheless, high infestations by pyralid moth pests, mainly the Indian meal moth, *Plodia interpunctella* (Hübner), are causing significant economic losses during storage. This insect is reported as major pest of stored dates in Tunisia. Field strains of *P. interpunctella*, were collected from date collect centers and storage facilities in south Tunisia (Tozeur and Kebili regions) and the eggs were tested for resistance to phosphine. Two discriminating doses 45 and 75 g/m3 of phosphine (QuickPhos, United Phosphorus, Ltd, India), were tested at 25°C.
Results of the treatments indicated resistance in 6 of the 7 strains of *P. interpunctella* tested. Frequencies of phosphine resistance in this insect were relatively low and depended on the strains. Insects from Tozeur region were all resistant to phosphine treatments (resistance rates varied between 2.33% and 13.33%). Moreover, 2 of the 3 strains from Kebili were resistant with low rates compared to the 4 strains from Tozeur. Thus, our results showed that resistant to phosphine in the region of Kebili did not contribute to control failures. This work reports first investigation on phosphine resistance against *P. interpunctella* in Tunisia. Our study highlighted the urgent need for reviewing current fumigation practices in Tunisia to ensure effective use of phosphine and avoid further selection of resistance.

Keywords: *Plodia interpunctella*, resistance, Phosphine, dates

81 - Efficacy of β-cyfluthrin and chlorpyrifos-methyl plus deltamethrin applied to concrete surfaces against field strains of three stored-product insect species

Abstract type: **Oral communication**

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Abstract: The insecticides β-cyfluthrin and chlorpyrifos-methyl plus deltamethrin are approved in the United States for empty bin treatments prior to storing newly-harvested stored wheat. The susceptibility of adults of 16 field strains of the red flour beetle, *Tribolium castaneum* (Herbst); seven strains of sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.); and two strains of the lesser grain borer, *Rhyzopertha dominica* (F.), collected mainly from farm-stored grain in Kansas, USA, to commercial formulations of the two insecticides at labeled rates was evaluated on concrete surfaces. Concrete-poured 9-cm diameter plastic Petri dishes were used to simulate the concrete floor of empty bins. Adults of laboratory strains of the three species were first exposed to insecticide-treated concrete surfaces for 1 to 24 h to standardize the exposure times for field strains. Based on the time required for ~100% mortality of laboratory strains, the adults of *T. castaneum* and *O. surinamensis* field strains were exposed to β-cyfluthrin for 24 h while *R. dominica* were exposed for 2 h. Adults of all species were exposed for 8 h to chlorpyrifos-methyl plus deltamethrin treated concrete. Chlorpyrifos-methyl plus deltamethrin did not control all *R. dominica* and most *O. surinamensis* field strains. β-cyfluthrin was extremely effective against *R. dominica* but ineffective against *T. castaneum* and *O. surinamensis* field strains as evidenced by low mortality and high progeny production. Exposing the two least susceptible field strains of *O. surinamensis* and three of *T. castaneum* to one to four times the high labeled rate of β-cyfluthrin resulted in only 36 to 90% mortality. Reduced susceptibility in field strains to β-cyfluthrin may be due to inherent formulation deficiency or low levels of tolerance or resistance.

Keywords: Stored-product insects, β-cyfluthrin, chlorpyrifos-methyl plus deltamethrin, field strains, efficacy assessment.

82 - A comparison of immediate and delayed efficacy of currently used chemical insecticides with bio-based or mineral alternative active substances for stored-grain-insect control

Abstract type: Poster

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Abstract: A comparative study was performed in treating 50-kg wheat batches either by currently used contact insecticides or by non-synthetic alternative active substances (a.s.) for control of stored-grain pests (*Sitophilus oryzae* and *Rhyzopertha dominica*). The first group of a.s. was: cypermethrin (CYP), chlorpyriphos-methyl (CM), deltamethrin (DM), natural pyrethrins (synergized or not), and pyrimiphos-methyl (PM); the second group of a.s. was: methoprene (with CM), diluted neem oil, spinosad (with or without CM), DE, and silicagel + Sodium bicarbonate. Two series of assays were performed: the first series was destined to the evaluation of immediate efficacy of a.s. on the target insects (curative treatment), and the 2nd series was destined to evaluate the duration of complete protection of treated grain against an external infestation (preventive treatment). The trials were performed in accordance to official method of testing grain insecticides (French AFPP-CEB Method N° 106).
With the two organo-phosphates (CM and PM), the efficacy of curative treatments was near 100% on *S. oryzae*, but less than 65% for *R. dominica*, 7 d after treatment. For the pyrethroids (CYP and DM), complete mortality of the two insects was obtained up to 8 weeks after treatment. Natural pyrethrins and spinosad (alone) effectively controlled *R. dominica*. In the case of preventive control assay, either organo-phosphates or pyrethroids appropriately controlled *S. oryzae* for 6 months. *R. dominica* adult mortality with organophosphates was ≤ 58% immediately after treatment. However, the survivals were not able to reproduce (observed on the two species). Among alternative non-synthetic a.s., only spinosad (dose 1.0 $mg.kg^{-1}$) and synergized pyrethrins exhibited a significant efficacy, the former when associated with CM at half registered maximum dose (1.625 $mg.kg^{-1}$), spinosad alone at 1.5 $mg.kg^{-1}$ being active on R. dominica, only. These results should facilitate the selection of appropriate a.s. for the control of identified grain-insect-pest species.

Keywords: Wheat grain batch, insecticide application trial, active substances comparison, curative treatment, preventive treatment, insecticidal activity persistence

83 - Feeding deterrent activity of new alpha-asarone congeners designed using a molecular modeling towards insect storage pests

Abstract type: Poster

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Abstract: The stored grain may be destroyed or contaminated by storage pests. Therefore use of insecticides has become an economic necessity. One of proposed directions of research is to use new derivatives of alpha-asarone as antifeedants. Asarone is a compound naturally occurrence as a *cis* and *trans* isomers, in oil derived from *Asarum europaeum* L., *Acorus calamus* rhizoma and *Gauteria gaumerii*.
It was shown that alpha and beta asarone are growth inhibitors and antifeedants for the larvae of *Peridroma saucia* Hubner. Both isomers (*cis* and *trans*) have different modes of action and biological properties (Koul et al., 1990). In our early work (Łozowicka and Kaczyński, 2013) the antifeedant activity of a 45 synthesized alpha-asarone derivatives, possessing allyl, carboxy and pyridine moiety, di- and tri-methoxy groups in benzene ring, was tested against selected stored products pests Coleoptera: *Sitophilus granarius* L. (Curculionidae), *Tribolium confusum* Duv. (Tenebrionideae), and *Trogoderma granarium* Ev. (Dermestridae). Then Quantitative Structure Activity Relationship (QSAR) analysis was applied to all abovementioned derivatives using a combination of various physicochemical, steric, electronic, structural, molecular and chromatographic descriptors (Łozowicka et al., 2012). A principal component analysis procedure was used to model the relationships between lipophilicity and the antifeedant activity of the asarone derivatives. 3D QSAR modeling for alpha-asarone derivatives using the comparative molecular surface analysis allowed us to reveal a correlation between the activity of these compounds and the electrostatic potential at the molecular surface.
The aim of this work is to present the results of antifeedant activity of 8 new alpha-asarone synthesized derivatives (dimethoxy alkenylbenzenes with pyridine and allyl group), which were designed in using molecular modeling. In the group of new derivatives of alpha-asarone all compounds displaying strong deterrent properties against the wheat weevil beetles, larvae of the kaphra beetle and larvae and adults of the confused flour beetles, which have activity comparable to the best known natural antifeedant – azadirachtin. These compounds could be used to control insect pests by behavioural manipulation and they are considered to have potential for improving the protection of stored products particularly grain against Coleoptera. The application of antifeedants, often in combination with other methods within integrated pest management (IPM) strategies, has proven to be a good way to control insect pests. This work was supported by the Polish National Science Centre – N N310 781940.

Keywords: Deterrent activity, alpha-asarone derivatives, *Sitophilus granarius*, *Tribolium confusum*, *Trogoderma granarium*.

84 - Weevil x Insecticide: Does 'Personality' Matter?

Abstract type: Poster

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Abstract: An individual behavior is the expression of its integrated physiology in response to external and internal stimuli turning insect behavior into a potential determinant of insecticide exposure. Behavioral traits may therefore influence insecticide efficacy against insects compromising the validity of standard bioassays of insecticide activity, which are fundamentality based on lethality alone. By extension, insect 'personality' (i.e., an individual's integrated set of behavioral tendencies inferred from multiple empirical measures) may also be an important determinant of insecticide exposure and activity, which has yet to be considered since the behavioral studies involving insects and insecticides focus on populations rather than individuals. Even among studies of animal 'personality' the relative contribution of individual and population variation is usually neglected. Here we assessed behavioral traits (within the following categories: activity, boldness/shyness and exploration/avoidance) of individuals from 15 populations of the maize weevil (*Sitophilus zeamais*), a stored grain insect pest of worldwide importance with ever-growing problems of insecticide resistance, and correlated the behavioral responses with the activity of the pyrethroid insecticide deltamethrin. This was carried out at both the population and individual levels. There was significant variation in weevil 'personality' among individuals and populations, but variation among individuals within populations account for most of the observed variation (92.57%). This result emphasizes the importance of individual variation in behavioral and 'personality' studies. When the behavioral traits assessed were correlated with median lethal time (LT_{50}) at the population level and with the individual surviving time under insecticide exposure, activity traits, particularly distance walked (walking velocity also played a minor role when individuals were considered), exhibited significant effect on surviving time. Therefore, behavioral traits are important components of insecticide efficacy and individual variation should be considered in such studies. Among the weevil 'personality' traits assessed, individual activity and particularly its distance walked significantly increased insecticide efficacy.

Keywords: *Sitophilus zeamais*, insecticide toxicity, insecticide sub-lethal effects, stored grain pests, individuality, risk-taking.

85 - Phosphine Resistance in *Cryptolestes ferrugineus* (Coleoptera: Laemophloidea) From Stored Wheat in Oklahoma

Abstract type: Poster

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Abstract: Phosphine gas, or hydrogen phosphide (PH_3), is the most common insecticide applied to durable stored products worldwide and is routinely used in the U.S. for treatment of bulk-stored cereal grains and other durable stored products. Research from the late 1980s revealed low frequencies of resistance to various residual grain protectant insecticides and to phosphine in grain insect species collected in Oklahoma. Recent research conducted using populations of stored-product insects collected from Oklahoma commercial grain storage facilities showed that one *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) population was 119-fold more resistant than the susceptible strain and a population of *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae) that was over 1,500-fold more resistant. The present work, which employed the same previously established protocols for phosphine toxicity as in earlier studies, evaluated adults of several different populations of *Cryptolestes ferruginues* (Stephens) (Coleoptera: Laemophloidea), collected from broad geographic locations in Oklahoma. Results of this evaluation will be presented and their implications discussed.

Keywords: Hydrogen phosphide, stored product, resistance frequency, resistance level

86 - Insecticidal effect of chlorantraniliprole against major stored product insect pests in different grain commodities

Abstract type: Poster

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Abstract: Laboratory bioassays were conducted to assess chlorantraniliprole as a potential grain protectant against *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) larvae, *Liposcelis bostrychophila* Badonnel (Psocoptera: Liposcelididae) adults, *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) adults, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) adults and *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae) adults and larvae. Factors such as dose (0.01, 0.1, 1 and 10 mg chlorantraniliprole / kg of grain), exposure interval (7 days and 14 days), formulation (chlorantraniliprole WG and chlorantraniliprole SC) and commodity (barley, maize, oats, peeled rice, whole rice and wheat) were evaluated upon their impact on the insecticidal activity of chlorantraniliprole. Progeny production was assessed after 45 days of exposure in the case of *L. bostrychophila* adults and 60 days of exposure in the case of *R. dominica*, *S. oryzae* and *T. confusum* adults. For *L. bostrychophila* adults, after 7 days of exposure mortality was lower in maize and whole rice in comparison to the other commodities. The increase of dose generally increased mortality. Similar trends were also noted after 14 days of exposure. Offspring emergence was higher in maize and whole rice in comparison to the other commodities. For *E. kuehniella* larvae, after 7 days of exposure significant differences were noted among the tested commodities. The increase of dose only slightly increased mortality in all commodities. After 14 days of exposure mortality was further increased, but did not reach 100%. For *R. dominica* adults, after 7 days of exposure the increase of dose increased mortality significantly. After 14 days of exposure, mortality in barley, maize, whole rice and wheat exceeded 92% at 10 mg chlorantraniliprole / kg of grain. Offspring emergence was decreased, but it was not achieved 100% progeny suppression. For *S. oryzae* adults, after 7 days of exposure mortality was generally low at dose rates ≤1 mg chlorantraniliprole / kg of grain. After 14 days of exposure, 100% mortality was noted in whole rice. For *T. confusum* adults, after 7 days of exposure mortality was low. After 14 days exposure, mortality increased proportionately for all commodities. Most progeny production was noted in oats. For *T. confusum* larvae, after 7 days of exposure, mortality was generally higher in comparison to adults. After 14 days of exposure, mortality in maize was high. Generally, both formulations performed alike for all the tested insects.

Keywords: Chlorantraniliprole, stored product insect pests, grain treatment, control level

87 - Insecticidal efficacy of thiamethoxam against *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae) adults on concrete

Abstract type: Poster

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Abstract: The insecticidal effect of thiamethoxam, which belongs to the class of neonicotinoids, was tested on concrete at the rates of 0 (untreated controls), 0.025 mg (AI)/cm^2, 0.05 mg (AI)/cm^2 0.1 mg (AI)/cm^2 for control of *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae) adults. Two series of dishes were used; one in continuous darkness and one in continuous light (45,225 lux). The insects were exposed in the treated and untreated concrete surfaces for 1, 2 and 3 d. Upon completion of exposure, all live adults from each dish and from both series of dishes (darkness and light) were transferred to untreated concrete in new dishes with 0.5 g of flour. Then, the adults in the new dishes were transferred again back either to dark or to light and their delayed mortality was estimated after 7 d of exposure. This experiment was repeated for eight weeks in the same treated dishes or untreated controls. Relatively small differences between *T. confusum* adults that stayed in dark and of those in light were detected. Generally, mortality of *T. confusum* adults was progressively reduced during the eight weeks of the experiment in both darkness and light. The delayed mortality was low after the second week, and until the end of the experimental period. The *T. confusum* adults became immobilized after 1 d of exposure interval. The results of the present work indicate that thiamethoxan is effective against *T. confusum*, but this effectiveness is highly affected by the dose rate, the exposure interval and the time interval after the application.

Keywords: *Tribolium confusum*, thiamethoxam, concrete, surface treatment

88 - Determination of Hexamethylenetetramine in Foods by Gas chromatography-Mass spectrometry

Abstract type: Poster

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Abstract: Hexamethylenetetramine (HMT) is a preservative permitted in EU, which reduces the formation of gas by the *Clostridium* genus which causes the cracking of cheese. An analytical method using gas chromatography-mass spectrometry (GC/MS) was developed for HMT in foods. HMT was spiked in several foods such as cheese, glass noodle and processed bean product. HMT was extracted with methanol from the spiked samples and determined by GC/MS with capillary column (MXT-1, 30mx0.25 mm, 0.5 μm). The precursor ion for MS analysis of HMT was m/z=140 ion and the corresponding daughter ion was m/z=42 ion for identification of HMT. The recovery, linearity, limit of detection and limit of quantification were satisfactory. This method would be successfully applied to several food samples.

Keywords: Hexamethylenetetramine, gas chromatography-mass spectrometry, food samples

Session 6

IPSP decision support tools and integrated approach

Chairpersons: Bhadriraju Subramanyam and Francis Fleurat-Lessard

Oral communications: 3

Posters: 0

Timetable:

Thursday 4th July, 15h50 – 17h00

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89 – Aspects related to decision support tools and IPM in food chain

Abstract type: **Oral presentation (keynote)**

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Abstract: There are a wide range of tools available for pest management in stored product protection and in the food industry, but often the effectiveness of these approaches and how best to integrate them into a coherent and effective Integrated Pest Management (IPM) programme are not well understood. Many questions remain about the use of these tools, from the very practical issues such as how many traps are needed and which types work best, to fundamental issues concerning the relationship between trap captures and pest population density, distribution and level of product infestation. Limited acceptance of IPM in food facilities is partially explained by a combination of: low costs of responsive pest control interventions; difficulty in sampling properly, combined with unreliable sampling data; and calculations of action thresholds being too simplistic. In operational practice precise treatment thresholds and economic injury levels have not been developed, and standards and rejection criteria are inconsistent and difficult to apply. As a result, treatments based on an economic threshold are not typically performed and control strategies are often applied preventively, even when using tactics that do not have any residual effect. In current practice, many locations still rely on calendar-based pesticide (also fumigation) applications and have little understanding of the basis of pest management. Unfortunately many of studies reported have been under laboratory conditions or in simulated warehouses, so there is limited information on integration under field conditions. Fully utilization of the IPM approach will require more effort than other types of control programs, but the IPM approach can provide more reliable pest management decisions.

Keywords: IPM, pests, stored products, food industry, decision support tools, practical application

90 – Technical and economic analysis of pest management practices for stored wheat in 14 grain elevators in France

Abstract type: **Oral presentation**

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Abstract: Technical audits were achieved in 14 grain elevators in order to record pest management practices and to evaluate the cost of insect control management practices. Stored grain elevators that were selected for this study were representative of the different ways of insect pest prevention and control system in France. The selection of storage sites was based on the results of a previous study led on 95 elevators that identified 6 key-factors correlated with pest infestation: type of storage bin (vertical silo or 'flat' store), preventive sanitation of empty storage structures, grain cleaning, grain aeration, insecticide treatment on grain, grain temperature monitoring equipment. By combining these 6 factors, 7 modalities of pest management have been described. For each modality, two grain elevators that theoretically apply each modality have been sampled among the 95 elevators surveyed in Leblanc et al. surveys in 2010 and 2011. The evaluation carried out after the visit of the selected storage facilities revealed that pest management was mainly based on chemical treatment whatever the kind of insect management system was applied. Although all the visited elevators were equipped with ambient-air aeration systems, the airflow rate and the cooling time were often found inadequate to efficiently cool all stored grain bins. Grain cleaning cannot be made systematically at reception because harvested grain lots needing cleaning are delivered at a much higher rate than the grain cleaner can receive. Pest management costs were assessed in the range 0.15 €/t to 1.40 €/t, according to the 7 modalities. The major variation factor was the type of pesticide used. The economic loss related to price penalties in the case of quality defect at the supply of domestic or export grain markets for cereals are not considered as a driving factor for insect pest management policy adaptation by grain-elevator managers.

Keywords: Stored wheat, grain elevator, inspection audit, pest control strategies, economic cost analysis, key-factor in pest control.

91 – Influence of grain storage practices or kind of structure and pesticide use on insect presence in wheat bulks after a long-term storage: a multi-dimensional analysis

Abstract type: **Oral presentation**

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Abstract: A survey of stored-wheat bulks in France was carried out during two years in spring season 2010 and 2011 to improve the knowledge about the relationships between grain storage practices, preventive sanitation, grain insecticidal treatment, stored-grain temperature management, and presence of insect species in grain samples. 95 wheat storage sites were surveyed each year (after 8-9 month storage). Besides the quantitative analysis of grain samples for insect presence and residues content, a questionnaire was submitted to grain-store managers to record their storage practices, the characteristics of their equipment for grain quality preservation, and the preventive and corrective means they use for insect control. The data from these two groups of variables were processed in a multidimensional statistical analysis to reveal significant correlations between grain management practices for sanitary quality maintenance and the level of presence of insects in wheat samples.
It was observed a strong relation between the kind of storage structure and the frequency of insect presence in wheat samples. Flat storage of large grain bulks was showed the most risky storage structure vs. vertical storage in metal or concrete bins. A relation was observed between insect presence frequency in samples and stored grain temperature level and also, with the lack of temperature measurement equipment installed inside grain bins linked to cooling aeration systems. Preventive sanitation before grain harvest period, i.e. systematic cleaning and insecticide spraying of unfilled bins, was related to 50% reduction of insect presence frequency in corresponding grain samples. The preventive chemical treatment of harvested grain before long-term storage was not related to a limitation of insect presence frequency in samples taken after a 8-9-month storage period. The results of this representative survey give objective arguments for the implementation of good IPM practices and risk prevention for grain sanitary quality preservation during long-term storage periods.

Keywords: Grain bulk sampling, grain storage site, national survey, insect presence frequency, insecticide residues content, storage practices, multidimensional data processing.

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