出國報告（出國類別：其他）

活動名稱

第二屆生物防治國際會議 ICBC 2 (線上會議)

2nd International Congress of Biological Control (ICBC 2) Virtual Meeting

服務機關：行政院農業委員會 農業藥物毒物試驗所
姓名職稱： 張瑞璋 所長
黃莉欣 副研究員
梁瑩如 助理研究員
派赴國家：臺灣，中華民國
出國期間：**110** 年 **4** 月 **26** 日 至 **110** 年 **4** 月 **30** 日
報告日期：**110** 年 **07** 月 **25** 日

線上國際會議研習報告

申請人姓名 (中/英文)	張瑞璋 Ruey-Jang Chang 黃莉欣 Li-Hsin Huang 梁瑩如 Ying-Ru Liang	職稱	所長 Director General 副研究員 Associate Researcher 助理研究員 Assistant Researcher
活動期間 (西元年/月/日)	April 26 – April 30, 2021	研習地點 (中/英文)	台灣，中華民國
研習名稱	(中文) 第二屆生物防治國際會議 ICBC 2 (線上會議) (英文) 2nd International Congress of Biological Control (ICBC 2) Virtual Meeting		

摘要（200-300 字）

本次參加視訊會議人員共 3 人，於 110 年 4 月 26 日至 110 年 4 月 30 日在臺灣參加線上會議及發表相關研究成果。由於受到 COVID-19 疫情嚴峻之影響，全球的疫苗接種將需要冗長時間，使得第二屆生物防治國際會議 (ICBC2) 大會舉辦者：國際生物防治組織 (International Organization for Biological Control，IOBC) 和 國際應用生物科學中心 (Centre for Agriculture and Bioscience International，CABI)於2021年1月底宣布，放棄原先 ”實體與線上的混合會議 (hybrid meeting)” 的構想，改採 100% 視訊會議之方式舉行。本次會議主題涵蓋包括： (1) 跳脫學科框架並在全球農產品系統下提升生物防治策略、(2) 天敵的基因改良、(3) 氣候變遷下生物防治的挑戰與前景、(4) 在非洲小農生產系統下生物防治策略、(5) 非天然生物防治資材的監管及其發展與挑戰、(6) 以新穎分子技術強化生物防治與IPM的執行、(7) 新穎性木黴菌的應用、(8) 用於保護仙人掌作物和外來入侵仙人掌科植物上害物的生物防治法、(9) 生物防治的應用在現場與外場對話的必要性、(10) 用於農業和畜牧業生物防治的植物源藥劑、(11) 生物防治之風險分析與決策新方法、(12) 應用古典生物防治法防治新興與既有節肢害蟲、(13) 次世代 DNA 定序時代中的生物防治策略、(14)生物防治劑應用其生態的交互作用、(15) 令人興奮的挑戰: 掠食者 Zoophytophagous、(16) 天敵語言：訊息化學在生物防治的應用、(17) 天敵間的交互作用及其對生物防治的影響、(18) 多營養階層的交互作用及其對生物防治的天敵之寄主選擇影響、(19) 拉丁美洲生物防治的增殖和保育：在果樹和蔬菜作物的應用經驗、(20) 承諾：以生物防治維護地球的健康、(21) 應用食蚜蠅進行生物防治和授粉、(22) 南-南合作以管理入侵害蟲的策略、(23) 自由論壇 a 和 b-海報論文區、(24) 蟎類生物防治：下一步是什麼？(25) 全球生物防治現況、有效性、經濟性和大眾關注議題的成功案例、(26) 數量與質量：生物防治劑的需求增加與挑戰等26個主題。分

別在5天會議期間進行。農業藥物毒物試驗所有2篇研究摘要發表於本次線上會議。本次國際研討會設定的主題相當廣泛，由於時區關係，部分主題無法進入會議時段聆聽，或因於重疊的時間內而無法參加，甚為可惜；然會議上豐富的專題演講，仍為此次會議帶來不同的腦力激盪，如使用植物萃取物來進行防治之優缺點、法規防治所需面臨的問題、氣候變遷對於生物防治策略之影響與生物防治決策系統等，均與我們國內生物防治應用相關，激發我們深入思考應用與發展方向，多元的主題內容能略略彌補前述時區與時段重疊的不足。

目次

目的

透過參加國際研討會，瞭解國際間在生物防治議題上的最新趨勢與發展，並與其他國家相同領域的研究人員交換研究心得與交流。

議程:

Day 1

TW Time	Zurich Time	Activity	Contents
18:00 - 18:30	12:00 – 12:30	歡迎詞與專題演講	**Welcome to the 2nd International Congress of Biological Control –** opening welcome addresses by Martin Hill, Professor & President IOBC Global, Rhodes University, Grahamstown, South Africa and by Ulli Kuhlmann, Executive Director & Local Organizer ICBC2, CABI, Delémont, Switzerland followed by a keynote address by George Heimpel, Professor & Past President IOBC Global, St Paul, University of Minnesota, USA
Panel 1: What is being done to improve the uptake of biological control? A multi-stakeholder perspective - Ulli Kuhlmann, CABI, Delémont, Switzerland & Jennifer Lewis, International Biocontrol Manufacturer Association, Brussels, Belgium			
19:00 - 21:00	13:00 – 15:00	小組研討會 (Pleanary Panel/Symposium)	**Panel 1: What is being done to improve the uptake of biological control? A multi-stakeholder perspective –** opening keynote addresses by Jonathan Shoham (Senior Consultant Analyst, IHS Markit) and Alessandra Moccia (Director Regulatory Affairs of Suterra) with the following panellists: David Cary (Board Member of PAN Europe), Washington Otieno (Programme Executive Plantwise at CABI), Max Schulman (Chair of the Agri-Food Chain Roundtable on PPPs, COPA COGECA) and Felix Wäckers (Director R&D, Biobest Group)
21:00 - 21:15	15:00 - 15:15	Break	
21:15 - 23:00	15:15 – 17:00	**Poster Session - Meet the Poster Presenters**	

04:00 - 06:00	22:00 – 00:00	**Poster Session - Meet the Poster Presenters**

Day 2

Session 1: Busting disciplinary silos to advance biological control within global agri-food systems - Yanhui Lu, IPP-CAAS, Beijing, China; Kris Wyckhuys, Chrysalis Consulting, Hanoi, Vietnam & Mauricio Gonzalez-Chang, Universidad Austral de Chile, Valdivia, Chile			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Yanhui Lu, Kris Wyckhuys & Mauricio Gonzalez-Chang**
19:10	13:10	01-O01	**Gabor Pozsgai**: *Interaction networks between aphids and their fungal pathogens: Insight into host-pathogen specificity and crop systems dependency*
19:30	13:30	01-O02	**Mauricio González-Chang:** *Understanding the pathways from biodiversity to agro-ecological outcomes: a new, interactive approach*
19:50	13:50	01-O03	**Kris Wyckhuys**: *Bridging social and natural sciences to assess uptake, public awareness and economic impact of biological control*
20:10	14:10	01-O04	**Qian Li**: *A tale of two guilds: interplay between insect pollinators and natural enemies in cotton-pear agro-landscapes*
20:30	14:30	01-O05	**HaiJun Xiao**: *Effective natural pest control provide by diverse landscapes in small-scale subtropical rice agroecosystems*
20:50	14:50	Final statement	**Yanhui Lu, Kris Wyckhuys & Mauricio Gonzalez-Chang**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 2: Genetic improvement of natural enemies: an urgent breakthrough in the progress of biological control - *Alberto Urbaneja, Instituto Valenciano de Investigaciones Agrarias, Moncada, Spain & Pablo Bielza, Universidad Politécnica de Cartagena, Cartagena, Spain*			
19:00	13:00	Introduction	**Alberto Urbaneja & Pablo Bielza**
19:10	13:10	02-O01	**Pablo Bielza**: *Genetic improvement of Orius laevigatus for better field performance in protected crops*

19:30	13:30	02-O02	**Leo W. Beukeboom**: *Polyploid effects on parasitoid biocontrol*
19:50	13:50	02-O03	**Duarte Toubarro**: *Tools provided by RNAseq for the improvement of the entomopathogenic nematode H. bacteriophora*
20:10	14:10	02-O04	**Maria Zwyssig**: *Experimental evolution to study the adaptation of plant-beneficial pseudomonads to insects*
20:30	14:30	02-O05	**Alberto Urbaneja**: *Genetic improvement of Nesidiocoris tenuis Reuter (Hemiptera: Miridae): evaluation of selected isofemale lines*
20:50	14:50	Final statement	**Alberto Urbaneja & Pablo Bielza**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 3: Biological control under changing climates: challenges and prospects - *Frank Chidawanyika, University of the Free State, Bloemfontein, South Africa & Casper Nyamukondiwa, Botswana International University of Science and Technology, Palapye, Botswana*			
19:00	13:00	Introduction	**Frank Chidawanyika, Casper Nyamukondiwa & Chris Weldon**
19:10	13:10	03-O01	**Yan Sun**: *Rapid evolution of a plant invader in response to biological control and global warming*
19:30	13:30	03-O02	**Reyard Mutamiswa**: *Spatio-temporal potential distribution of Chilo partellus and its endoparasitoid, Cotesia flavipes under current and future climatic conditions in southern Africa: implications for biological control*
19:50	13:50	03-O03	**Belinda Luke**: *BioSuccess - an app to help determine the effects of climate change on the efficacy of a biopesticide*
20:10	14:10	03-O04	**Frank Chidawanyika**: *Thermal tolerance of the biological control agent Neolema abbreviata and its potential geographic distribution together with its host Tradescantia fluminensis in South Africa*
20:30	14:30	03-O05	**Jonathan Casey**: *Climate-smart pest management: nature-based solutions for the climate and environme*
20:50	14:50	Final statement	**Frank Chidawanyika, Casper Nyamukondiwa & Chris Weldon**

21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 4: Biological control in African smallholder production systems - *Thomas Dubois, The International Centre of Insect Physiology and Ecology (ICIPE), Nairobi, Kenia & Samira A. Mohamed, ICIPE, Nairobi, Kenia*			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Thomas Dubois & Samira A. Mohamed**
19:10	13:10	04-O01	**Sevgan Subramanian**: *Biological control of key lepidopteran pests of cereals in Africa – achievement and way forward*
19:30	13:30	04-O02	**Costas Zachariades**: *Biological control of Chromolaena odorata in Africa: current status*
19:50	13:50	04-O03	**Malick Ba**: *Biological control of the millet head miner in the Sahel: lessons learned and way forward*
20:10	14:10	04-O04	**Pride Mudavanhu**: *Alien invasive acacia management: a biocontrol success story from South Africa*
20:30	14:30	04-O05	**Afure Ejomah**: *History of classical biological control in Nigeria: the story so far*
20:50	14:50	Final statement	**Thomas Dubois & Samira A. Mohamed**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 5: Regulatory oversight of non-native biological control agents: Developments and challenges - *Matthew Everatt, Defra, Sand Hutton, York, UK*			
22:00	16:00	Introduction	**Matthew Everatt**
22:10	16:10	05-O01	**Matthew Everatt**
22:30	16:30	05-O02	**Johannette Klapwijk**: *Challenges in the trade of invertebrate biocontrol agents*
22:50	16:50	05-O03	**Marion K. Seier**: *Navigating regulatory procedures for weed biological control using non-native agents in the UK*
23:10	17:10	05-O04	**Yelitza Colmenarez**: *Regulatory challenges for the exchange and use of biological resources in Latin*

			America
23:30	17:30	05-O05	**Jana Collatz**: A*ssessment of parasitoid overwintering in Switzerland*
23:50	17:50	Final statement	**Matthew Everatt**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 6: Novel molecular tools for IPM and biological control - *Steve Naranjo, USDA-ARS, Maricopa, Arizona, USA & Jörg Romeis, Agroscope, Zurich, Switzerland*			
22:00	16:00	Introduction	**Steve Naranjo & Jörg Romeis**
22:10	16:10	06-O01	**Anthony Shelton**: *Genetically engineered, self-limiting Diamondback Moth, Plutella xylostella, for enhanced IPM and biological control*
22:30	16:30	06-O02	**Jörg Romeis**: *Potential and risk of controlling invasive pests using gene drives*
22:50	16:50	06-O03	**Ana M Vélez**: *Enhancing biological control and IPM through specific RNAi-based pest control technologies*
23:10	17:10	06-O04	**Matthias Erb**: *Engineering nematodes to resist plant toxins improves their capacity to control a root pest*
23:30	17:30	06-O05	**Raymond St. Leger**: *Using GM pathogens to control mosuito-borne diseases*
23:50	17:50	Final statement	**Steve Naranjo & Jörg Romeis**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 7: Trichoderma beyond just cell wall degrading enzymes - Enrique Monte, University of Salamanca; Salamanca, Spain & María E. Morán-Diez, University of Salamanca, Salamanca, Spain			
22:00	16:00	Introduction	**Enrique Monte & María E. Morán-Diez**
22:10	16:10	07-O01	**Francesco Vinale**: *Trichoderma metabolites for crop protection*
22:30	16:30	07-O02	**Susanne Zeilinger**: *Environmental and endogenous cues as well as strain- and developmental stage-specific responses affect biology and mycoparasitism of the biocontrol agent Trichoderma atroviride*
22:50	16:50	07-O03	**Maria Pappas**: *Trichoderma-mediated tomato resistance against herbivorous pests*

23:10	17:10	07-O04	**Matthias Erb**: *Engineering nematodes to resist plant toxins improves their capacity to control a root pest*
23:30	17:30	07-O05	**María Eugenia Morán-Diez**: *Trichoderma biocontrol effects are heritable and subjected to epigenetic control through miRNAs*
23:50	17:50	Final statement	**Enrique Monte & María E. Morán-Diez**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 8: Biological control for the protection of cactus crops and the control of invasive alien Cactaceae - *Iain Paterson, Rhodes University, Makhanda, South Africa & Laura Varone, Fundación para el Estudio de Especies Invasivas, Hurlingham, Buenos Aires, Argentina*			
22:00	16:00	Introduction	**Iain Paterson & Laura Varone**
22:10	16:10	08-O01	**Clarke van Steenderen**: *Cochineal identification: how molecular techniques can distinguish between biological control agents and agricultural pest*
22:30	16:30	08-O02	**Meelad Yousef Yousef**: *The Prickly pear from an invasive plant to a threatened heritage: a study to control the false carmine cochineal in Cadiz Province (Spain)*
22:50	16:50	08-O03	**Laura Varone**: *A trip down the long and winding road of Cactoblastis cactorum research*
23:10	17:10	08-O04	**María Belén Aguirre**: *Advances in the identification and description of the Hypogeococcus pungens species complex (Pseudococcidae), mealybugs from South America*
23:30	17:30	08-O05	**Iain Paterson**: *Pest cactus and cactus pests: potential conflict between biocontrol of cochineal and biocontrol of cactus*
23:50	17:50	Final statement	**Iain Paterson & Laura Varone**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	

Day 3

Session 9: In-field and off-field requirements for biological control – a dialogue - Jana Collatz,

Agroscope, Zurich, Switzerland & Aurélie Ferrer, Agrapole, ISARA, Lyon, France			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Jana Collatz & Aurélie Ferrer**
19:10	13:10	09-O01	**Adrien Rusch**: *Biological pest control services in agricultural landscapes*
19:30	13:30	09-O02	**Philippe Jeanneret**: A*n agroecology and system approach to reduce pesticide use in arable crops*
19:50	13:50	09-O03	**Aurélie Ferrer**: *Optimization of farmer's agricultural practices to enhance conservation biological control*
20:10	14:10	09-O04	**Badrulhadza Amzah**: *Rice field habitat manipulation: Malaysia's experience in conservation biological control efforts*
20:30	14:30	09-O05	**Lucy Alford**: *Could winter flowering cover crops promote competition between parasitoids, hyperparasitoids and winter-active pollinators?*
20:50	14:50	Final statement	**Jana Collatz & Aurélie Ferrer**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 10: Botanicals for biocontrol in agriculture and animal husbandry - Annegret Schmitt, Julius Kühn-Institute, Darmstadt, Germany & Lucius Tamm, FiBL - Forschungsinstitut für biologischen Landbau, Frick, Switzerland			
19:00	13:00	Introduction	**Annegret Schmitt & Lucius Tamm**
19:10	13:10	10-O01	**Lucius Tamm**: *Registration of botanicals – current bottlenecks and future needs*
19:30	13:30	10-O02	**Valeria Fattoruso**: *Sustainable alternatives to gradually phase out mineral oil for pests control*
19:50	13:50	10-O03	**Spiridoula Athanasiadou**: *Botanicals for helminth control in small ruminants*
20:10	14:10	10-O04	**Sri Ita Tarigan**: *Insecticidial and antifeedant effects of liquid smoke of cocoa-coconut-rice waste against coffee stem borrer (Hypothenemus hampei)*
20:30	14:30	10-O05	**Liora Shaltiel-Harpaz**: *Novel botanical insecticides based on essential oils and clay – Thrips tabaci as a model*
20:50	14:50	Final statement	**Annegret Schmitt & Lucius Tamm**

21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 11: New approaches to risk analysis and decision making in biocontrol - Greg Lefoe, Agriculture Victoria State Government, Bundoora, Australia & Jackie Steel, Agriculture Victoria State Government, Bundoora, Australia, Australia			
19:00	13:00	Introduction	**Greg Lefoe & Jackie Steel**
19:10	13:10	11-O01	**Catarina Afonso**: *A comparative analysis of regulatory frameworks and procedures for the import and release of invertebrate biological control agents: Cleruchoides noackae as a case study*
19:30	13:30	11-O02	**Chris Malumphy**: *Regulatory oversight for the release*
19:50	13:50	11-O03	**Donald C. Weber**: *Unintentional biological control introductions: The phenomenon and its implications*
20:10	14:10	11-O04	**Brian Garms**: *The Australian approach to assessing risk of biological control agents – translating science into consistent policy decisions*
20:30	14:30	11-O05	**Greg Lefoe**: *Systematic cultivar selection for weed biological control risk assessment*
20:50	14:50	Final statement	**Greg Lefoe & Jackie Steel**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 12: Classical biological control of new and old arthropod pests - Alejandro Tena, IVIA, Valencia, Spain & Antonio Biondi, University of Catania, Catania, Italy			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Alejandro Tena & Antonio Biondi**
19:10	13:10	12-O01	**M. Lukas Seehausen**: *Suitability of the Asian parasitoid Ganaspis brasiliensis for classical biological control of Drosophila suzukii*
19:30	13:30	12-O02	**Jesica Pérez-Rodríguez**: *Classical biological control of the HLB vector Trioza erytreae in Europe*
19:50	13:50	12-O03	**Marc Kenis**: *Can the immense success of the classical biological control of the cassava mealybug be repeated against the fall armyworm?*

20:10	14:10	12-O04	**Antonia Soto**: *Use of classical biological control for the management of Delottococcus aberiae De Lotto (Hemiptera: Pseudococcidae) in Spanish* citrus crops
20:30	14:30	12-O05	**Dimitrios Avtzis**: *Invasion of the giant pine scale in Australia and prospects for classical biological control using silver fli* es
20:50	14:50	Final statement	**Alejandro Tena & Antonio Biondi**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 13: Biological control in the next-generation DNA sequencing era - Debora Pires Paula, Embrapa, Brasília, Brazil			
22:00	16:00	Introduction	**Debora Pires Paula**
22:10	16:10	13-O01	**Leo W. Beukeboom**: *How can genetics and genomics improve biological control?*
22:30	16:30	13-O02	**Mariska Beekman**: *Nanopore sequencing enables fast detection of protective endosymbionts in greenhouse aphids*
22:50	16:50	13-O03	**Maria Julia Carbone**: *Drought influences fungal community dynamics in the grapevine rhizosphere and root microbiome*
23:10	17:10	13-O04	**Chiara Pedrazzini**: *Influence of spatial and temporal separation on population structure of the European cockchafer and its main fungal pathogen*
23:30	17:30	13-O05	**Debora Pires Paula**: *What is new in gut content analysis of arthropod biological control agents*
23:50	17:50	Final statement	**Debora Pires Paula**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 14: Ecological interactions among biocontrol agents - Paul Ode, Colorado State University, Fort Collins, Colorado, USA & Paul Abram, Agriculture and Agri-Food Canada, Agassiz, BC, Canada			
22:00	16:00	Introduction	**Paul Ode & Paul Abram**
22:10	16:10	14-O01	**Melodie Ollivier**: *Metabarcoding and ecological interaction networks for selecting candidate biological*

			control agents
22:30	16:30	14-O02	**Carol Frost**: *Herbivore abundance and species-level network characteristics can predict their apparent competitive effects on other herbivores*
22:50	16:50	14-O03	**Alejandro Tena**: *Effects of ants on pests and their biological control agents: from a meta-analysis to a study case*
23:10	17:10	14-O04	**John Lill**: *Evidence for both facilitation and interference competition within a guild of insect herbivores in a natural forest system*
23:30	17:30	14-O05	**Paul Ode**: *Mechanisims of competitive displacement between two Cotesia parasitoids of cabbage white butterflies*
23:50	17:50	Final statement	**Paul Ode & Paul Abram**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 15: Zoophytophagous predators: still an exciting challenge to exploit - Meritxell Perez-Hedo, Instituto Valenciano de Investigaciones Agrarias, Moncada, Spain & Maria Pappas, Democritus University of Thrace, Orestiada, Greece			
22:00	16:00	Introduction	**Meritxell Perez-Hedo & Maria Pappas**
22:10	16:10	15-O01	**Alberto Urbaneja**: *Eliciting tomato plant defenses by exposure to HIPVs: a sustainable approach to manage agricultural pests*
22:30	16:30	15-O02	**Susanne Zeilinger**: *Environmental and endogenous cues as well as strain- and developmental stage-specific responses affect biology and mycoparasitism of the biocontrol agent Trichoderma atroviride*
22:50	16:50	15-O03	**Amy Roda**: *Biological control potential and drawbacks of three zoophytophagous mirid predators against Bemisia tabaci in the United States*
23:10	17:10	15-O04	**Sarra Bouagga**: *Pest managment in horticultural crops based on the use of zoophytophagous predators*
23:30	17:30	15-O05	**Lucia Zappala**: *Interactions among plants, essential oils and the omnivorous mirid Nesidiocoris tenuis*
23:50	17:50	Final statement	**George Broufas**: *Plant-mediated effects of beneficial soil microbes on zoophytophagous predators*

00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 16: Semiochemistry applied to biological control: using the language of natural enemies - Joe M. Kaser, USDA-ARS, Newark, USA & Donald C. Weber, USDA-ARS, Beltsville, MD, USA			
22:00	16:00	Introduction	**Joe M. Kaser & Donald C. Weber**
22:10	16:10	16-O01	**Ted Turlings**: *Exploiting the chemical ecology of plant-insect interactions to enhance the efficacy of biological control agents*
22:30	16:30	16-O02	**Alexander Gaffke**: *Improving the performance of above and below ground biological control agents through behavioral modification with semiochemicals*
22:50	16:50	16-O03	**Sara Hermann**: *Stress across space and time: Leveraging the ecology of fear to influence arthropod populations*
23:10	17:10	16-O04	**Marjolein Kruidhof**: *Learning: a neglected process in biological control for increasing the semiochemical-based host-finding of natural enemies*
23:30	17:30	16-O05	**Daniel Mutyambai**: S*oil conditioning by novel maize cropping system induces plant volatiles attractive to parasitic wasps*
23:50	17:50	Final statement	**Joe M. Kaser & Donald C. Weber**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 17: Interactions among natural enemies and their effects on biological control - David Andow, University of Minnesota, St. Paul, MN, USA; Debora Pires Paula, Embrapa, Brasilia, Brazil & Enric Frago, CIRAD/UMR CBGP, Montferrier, France			
03:00	21:00	Introduction	**David Andow, Debora Pires Paula & Enric Frago**
03:10	21:10	17-O01	**Enric Frago**: *The effect of natural enemy diversity on herbivore suppression and community stability*
03:30	21:30	17-O02	**Linda L. Kinkel**: *Diffuse interactions: competition, coevolution, and disease suppression in soil*
03:50	21:50	17-O03	**Guadalupe Peralta**: *Species interaction networks: tools for biological control*
04:10	22:10	17-O04	**Lola Serée**: *Do birds disrupt biological control on*

			oilseed rape herbivores by modifying arthropod trophic networks?
04:30	22:30	17-O05	**David A. Andow:** *Biological control with Harmonia axyridis in Brazil: lack of invasiveness*
04:50	22:50	Final statement	**David Andow, Debora Pires Paula & Enric Frago**
05:00	23:00	Break	
05:15	23:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
06:00	23:00	End Session/Panel	
Session 18: Multi-trophic interactions and effects on biocontrol agent host selection - Mike Cripps, AgResearch, Lincoln, New Zealand & Michael Rostás, University of Göttingen, Göttingen, Germany			
03:00	21:00	Introduction	**Mike Cripps & Michael Rostás**
03:10	21:10	18-O01	**Enrique Quesada Moraga**: *Effects of multi-trophic interactions mediated by entomopathogenic fungi endophytically colonized plants on the biocontrol of chewing and sucking pests*
03:30	21:30	18-O02	**Stefano Colazza**: *Multi-trophic interactions: new insight from plant insect microbes in conservation biological control*
03:50	21:50	18-O03	**Arnaud Ameline**: *Plant virus infection influences bottom-up regulation of a plant-aphid-parasitoid system*
04:10	22:10	18-O04	**Michael Rostás**: *Virus-mediated effects on tri-trophic interactions between Myzus persicae and Aphidius ervi in sugar beet*
04:30	22:30	18-O05	**Betty Benrey**:*The performance of an ectoparasitoid is affected by the combination of host caterpillars and the plants they feed on in a traditional Milpa cultivation system*
04:50	22:50	Final statement	**Mike Cripps & Michael Rostás**
05:00	23:00	Break	
05:15	23:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
06:00	23:00	End Session/Panel	
Session 19: Augmentative and conservation biological control in Latin America: experiences for fruit and vegetable crops - Maria R. Manzano, Universidad Nacional de Colombia sede Palmira, Carrera, Palmira, Colombia; Nancy Greco, Universidad Nacional de La Plata, La Plata, Argentina & Bruno Zachrisson, Instituto de Investigación Agropecuaria de Panamá, Panamá			
03:00	21:00	Introduction	**Maria R. Manzano, Nancy Greco & Bruno**

			Zachrisson
03:10	21:10	19-O01	**Bruno Zachrisson**: *Biological control in Panama: challenges and projections*
03:30	21:30	19-O02	**Lessando Gontijo**: *Diversifying distinct plant traits is still desirable in genotypically diverse cultivar mixtures: a case study for conservation biological control in brassicas in Brazil*
03:50	21:50	19-O03	**Nancy Greco**: *Trophic interactions and dispersal of two omnivorous predators in strawberry: a case study for augmentative and conservation biological control in Argentina*
04:10	22:10	19-O04	**Margarita Rocca**: *Trophic interactions between coccinellid species: a case study of the biological control of aphids in sweet pepper in Argentina*
04:30	22:30	19-O05	**Maria R. Manzano**: *Analysis of tritrophic interactions as an approach for conserving biological control agents: A case study in chili pepper in Colombia*
04:50	22:50	Final statement	**Maria R. Manzano, Nancy Greco & Bruno Zachrisson**
05:00	23:00	Break	
05:15	23:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
06:00	23:00	End Session/Panel	

Day 4

Session 20: Delivering on a promise: biological control for Planetary Health - Kris Wyckhuys, Chrysalis Consulting, Hanoi, Vietnam, Sacha Roudine & Joan van Baaren, University Rennes I, Rennes, France			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Kris Wyckhuys, Sacha Roudine & Joan van Baaren**
19:10	13:10	20-O01	**Sacha Roudine**: *Vector-borne plant virus controlled by natural enemies in agro-ecosystems*
19:30	13:30	20-O02	**Pepijn Schreinemachers**: *The genie is out of the bottle: the challenge of pesticide misuse in Asia's vegetable sector*
19:50	13:50	20-O03	**Kris Wyckhuys, Sacha Roudine & Joan van Baaren**
20:10	14:10	20-O04	**Alain Ratnadass**: *Biological control for alleviation of viral zoonotic risks in a One Health perspective*

20:30	14:30	20-O05	**Gianfranco Anfora**: *Samurai wasps to mitigate pesticide-related human health hazards in fruit crops in Italy*
20:50	14:50	Final statement	**Kris Wyckhuys, Sacha Roudine & Joan van Baaren**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 21: Concurrent pest control and pollination by aphidophagous hoverflies - Apostolos Pekas, Biobest Group, Westerlo, Belgium; Tanya Latty, University of Sydney, Camperdown, Australia & Karl Wotton, University of Exeter, Penryn, UK			
19:00	13:00	Introduction	**Apostolos Pekas, Tanya Latty & Karl Wotton**
19:10	13:10	21-O01	**Neus Rodriguez-Gasol**: *The ecology of predatory hoverflies as ecosystem-service providers in agricultural systems*
19:30	13:30	21-O02	**Karl Wotton**: *Mass seasonal migrations of hoverflies provide extensive pollination and crop protection services*
19:50	13:50	21-O03	**Elodie Chapurlat**: *Optimization of flower strips for the delivery of ecosystem services by syrphids*
20:10	14:10	21-O04	**Apostolos Pekas**: *Concurrent pest control and pollination by aphidophagous hoverflies*
20:30	14:30	21-O05	**Tanya Latty**: *Syrphids in the city: the role of Syrphids in Australian urban and peri-urban agricultural systems*
20:50	14:50	Final statement	**Apostolos Pekas, Tanya Latty & Karl Wotton**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 22: Management of invasive pest by South-South cooperation - Gopalsamy Sivakumar, National Bureau of Agricultural Insect Resources, ICAR, Bengaluru, Karnataka, India; Malvika Chaudhary, CABI, New Delhi, India & Yelitza, CABI c/o UNESP - Fazenda Experimental Lageado Rua José Barbosa de Barros, Botucatu, Brazil			
19:00	13:00	Introduction	**Gopalsamy Sivakumar, Malvika Chaudhary & Yelitza Colmenarez**
19:10	13:10	22-O01	**Gopalsamy Sivakumar**: *Current research on entomopathogens of recent invasive insect pests in India*

19:30	13:30	22-O02	**Aloisio Coelho Jr**: *New approach and improvement on Telenomus remus (Nixon, 1937) studies aiming Spopdoptera (Guenée, 1852) bioloogical control*
19:50	13:50	22-O03	**Thomas Jaekel**: *Role of policy and regulation*
20:10	14:10	22-O04	**Yelitza C. Colmenarez**: *The importance of technology transfer and collaboration platforms for the implementation of biological control* programmes in Latin America and Asia
20:30	14:30	22-O05	**Shachi Gurumayum**: *Managing Fall Armyworm with Fawligen, a baculovirus-based biological control, with experiences from Africa and South* Asia
20:50	14:50	Final statement	**Gopalsamy Sivakumar, Malvika Chaudhary & Yelitza Colmenarez**
21:00	15:00	Break	
21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 23a: Free theme contributions – Martin Hill, Rhodes University, Grahamstown, South Africa & Ulli Kuhlmann, CABI, Delémont, Switzerland			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Martin Hill & Ulli Kuhlmann**
19:10	13:10	23a-O01	**Ellen Cottingham**: *Virally vectored immunocontraception for the population control of feral cats in Australia*
19:30	13:30	23a-O02	**Patricia Folgarait**: *Conidiobolus lunulus, an Entomophthoral species attacking leafcutter ants*
19:50	13:50	23a-O03	**Tsung-Chi Chen**: *Development of recombinant vaccines to protect cucurbit crops from distinct insect-borne viruses*
20:10	14:10	23a-O04	**Rose Buitenhuis**: *Critical evaluation of three nabid predators for their potential as new biocontrol agents in North America*
20:30	14:30	23a-O05	**Emma Jenner:** *The CABI BioProtection Portal: a free online information resource for advisory services and growers*
20:50	14:50	Final statement	**Martin Hill & Ulli Kuhlmann**
21:00	15:00	Break	

21:15	15:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
22:00	16:00	End Session/Panel	
Session 24: Acarine biological control: what are the next steps? - Marcus Duarte, Biobest Group, Westerlo, Belgium & Dominiek Vangansbeke, Biobest Group, Westerlo, Belgium			
22:00	16:00	Introduction	**Marcus Duarte & Dominiek Vangansbeke**
22:10	16:10	24-O01	**Saioa Legarrea**: *Can we remove glandular trichomes from tomato to improve biocontrol without also promoting the plant's susceptibility to pests?*
22:30	16:30	24-O02	**Lore Vervaet**: *Potential of iolinid predatory mites for the control of tomato russet mite, Aculops lycopersici, in protected tomato cultivation*
22:50	16:50	24-O03	**Felix Wäckers**: *Pronematus ubiquitus: small mite, big impact.*
23:10	17:10	24-O04	**Sophie Le Hesran**: *Effects of drought on the predatory mite Phytoseiulus persimilis*
23:30	17:30	24-O05	**Emilie Demard**: *Seasonal abundance and species distribution of phytoseiid mites (Acari: Phytoseiidae) from different citrus production systems in Florida*
23:50	17:50	Final statement	**Marcus Duarte & Dominiek Vangansbeke**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 25: State of affairs and future of biological control worldwide - Peter Mason, Agriculture and Agri-Food Canada, Ottawa, ON, Canada & Donald C. Weber, USDA-ARS, Beltsville, MD, USA			
22:00	16:00	Introduction	**Peter Mason & Donald C. Weber**
22:10	16:10	25-O01	**Peter Mason**: *Importation/classical biological control in 2021: a global view and recent successes*
22:30	16:30	25-O02	**Beatrice Wambui Muriithi**: *Economic benefits of biological control to local economies*
22:50	16:50	25-O03	**Haley Catton**: *Public perceptions of the benefits of biological control*
23:10	17:10	25-O04	**Heidi Widmer**: *Tutavir as a biocontrol solution for integrated T. absoluta management from South America, over Europe to South Africa*
23:30	17:30	25-O05	**Jagadeesh Patil**: *The efficacy of selected indigenous entomopathogenic nematodes against Fall Armyworm,*

			Spodoptera frugiperda, in maize
23:50	17:50	Final statement	**Peter Mason & Donald C. Weber**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 26: Quantity and quality: Responding to the challenge of increased demand of biocontrol agents - Maria Luisa Dindo, University of Bologna, Bologna, Italy & Rose Buitenhuis, Vineland Research and Innovation Centre, Ontario, Canada			
22:00	16:00	Introduction	**Maria Luisa Dindo & Rose Buitenhuis**
22:10	16:10	26-O01	**José Roberto Postali Parra**: *Parasitoid mass rearing for augmentative biological control in open fields*
22:30	16:30	26-O02	**Eunhye Ham**: *Biological control effect of "Natural Enemy in First" method by growers: potential applications in pest management without monitoring*
22:50	16:50	26-O03	**Daniela Lupi**: *The rearing system of Sclerodermus brevicornis, a potential biocontrol agent of flat faced Longhorn beetle: perspective and* difficulties
23:10	17:10	26-O04	**Ikju Park**: *Advances and challenges on mass-rearing a univoltine weed biocontrol agent in a laboratory*
23:30	17:30	26-O05	**Emily Kraus**: *Solutions to common issues with cultivating aquatic weed hosts and biocontrol agents*
23:50	17:50	Final statement	**Maria Luisa Dindo & Rose Buitenhuis**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	
Session 23b: Free theme contributions – Martin Hill, Rhodes University, Grahamstown, South Africa & Ulli Kuhlmann, CABI, Delémont, Switzerland			
22:00	16:00	Introduction	**Martin Hill & Ulli Kuhlmann**
22:10	16:10	23b-O01	**Steve Naranjo**: *Development and implementation of biological control informed thresholds for IPM*
22:30	16:30	23b-O02	**Tim Haye**: *Do ecological and fundamenal host range of Trissolcus japonicus match in Europe?*
22:50	16:50	23b-O03	**Jacob Corcoran**: *The insect olfactory system: a target for next-generation biological control technologies*
23:10	17:10	23b-O04	**Patrick Fallet**: *A successful field trial using a*

			gel-based formulation of entomopathogenic nematodes against the fall armyworm
23:30	17:30	23b-O05	**Thomas E. Saunders**: *Exploring host-specificity through chemical ecology to gain insights into the ecological host ranges of three Trissolcus Ashmead (Hymenoptera: Scelionidae) parasitoids in New Zealand*
23:50	17:50	Final statement	**Martin Hill & Ulli Kuhlmann**
00:00	18:00	Break	
00:15	18:15	Meet Speakers	**Meet Session Speakers in Debate Lounge**
01:00	19:00	End Session/Panel	

Day 5

Panel 2: Developing decision support systems to foster the use of biocontrol agents against plant diseases in the field - Philippe C. Nicot, INRAE, Montfavet, France & Marc Bardin, INRAE, Montfavet, France			
TW Time	Zurich Time	Activity	Contents
19:00	13:00	Introduction	**Panel 2: Developing decision support systems to foster the use of biocontrol agents against plant diseases in the field** - *opening keynote address by Thomas Pressecq (PhD Student - INRAE Avignon) with the following panellists Guillaume Delanoue (Winegrower and Engineer at the French Wine and Vine Institute), Bélinda Gaillet (Vegetable Grower), Karine Mouret-Grosbeau (IBMA Global Board Member and Treasurer), Philippe Rothgerber (General Director of CBC Biogard SAS), Philippe Nicot (INRAE Research Scientist & IOBC-WPRS President) & Marc Bardin (INRAE Research Director)*
19:10 - 20:30	13:10 – 14:30	小組研討會 (Panel Discussion)	
		Final statement	
21:00 - 21:15	15:00 - 15:15	Break	
21:15 - 23:00	15:15 – 17:00	Poster Session - Meet the Poster Presenters	
Panel 3: Creating synergies among the biological control approaches to promote 'One Health' - Urs Schaffner, CABI, Delémont, Switzerland & Nicholas Mills, University of California at Berkeley,			

Berkeley, California			
22:00	16:00	Introduction	**Panel 3: Creating synergies among the biological control approaches to promote 'One Health'** - *moderated by George Heimpel (Professor at University of Minnesota & Past IOBC President) with the following keynote addresses by Nick Mills (Professor at University of California at Berkeley), Urs Schaffner (CABI Section Head Ecosystem Management), Matt Thomas (Director York Environmental Sustainability Institute) and Kris Wyckhuys (Chrysalis Consulting Vietnam) follwed by a panel discussion*
22:10 - 23:50	16:10 – 17:50	小組研討會 (Panel Discussion)	
		Final statement	
00:00	18:00	Break	
Closing event of the 2nd International Congress of Biological Control			
		Break/Closing Event	**Closing event of the 2nd International Congress of Biological Control** - *moderated by Martin Hill (Professor and Director of the Centre for Biological Control & President of IOBC Global), Rhodes University, Grahamstown, South*
	18:15 – 18:45	Closing Event	
		End	

國際生物防治組織 (International Organization for Biological Control (IOBC)) 為了推廣對環境安全友善的病蟲害防治方法，將國際生物防治大會 (International Congress of Biological Control) 列為旗艦的活動。2018 年於北京辦理第一屆大會，同年於印度邦加羅爾 (Bengaluru) 舉行第一屆國際生物防治研討會，並依此為基礎規劃辦理第二屆國際生物防治研討會，將第二屆國際生物防治研討會 (Second International Congress of Biological Control (ICBC2) 定位為提供多學科及跨學科生物防治研究和應用的平台。本次研討會為從事生物防治為目標的科學家和業者提供一個交流的平台，包括動植物蟲害、病害、雜草和入侵脊椎動物等，凡是以生物控制的相關基礎科學或改進方法的研究，均可以投稿發表與交流。

2021 年國際生物防治研討會由國際應用生物科學中心(Centre for

Agriculture and Bioscience International，CABI) 與 IOBC 共同舉辦，原訂 2021 年 4 月 26 日至 4 月 30 日在瑞士達佛斯(Davos, Switzerland)舉行，因 COVID-19 疫情關係，於 2021 年 2 月 1 日宣布如期舉辦，但改為線上研討會。雖然線上研討會有明顯的缺點，如無法面對面溝通與具有時差的問題，但仍具有部分優勢，例如節省旅行、餐會和住宿費用以及不必處理簽證問題。

為順應國際趨勢降低農藥使用風險及提升農產品安全，行政院農業委員會於 2017 年推動化學農藥十年減半政策，透過推動作物有害生物綜合管理模式、擴大環境友善資材補貼、輔導農友建立精準合理用藥的觀念與技能、強化高風險農藥管理、加速汰除劇毒農藥等相關措施，預計在 2027 年達成全國化學農藥使用量減半之目標。本所也致力於友善資材的研發及其應用與推廣，逢此機會參與本研討會，除瞭解目前國外相關的研究與進展及應用，也藉此機會分享研究初步的成果，期能與與會的學者進行交流，獲取新知識，也是參加本研討會的主要目的。本次研討會中本所提出 2 篇摘要發表，分別為「Antifungal ability of *Bacillus subtilis* and silicon dioxide against *Rhizoctonia solani* and their effects on reducing stem blight of water spinash (*Ipomoea aquatic*) in greenhouse」及「Microbial seed coating formulation primes cucumber defense response against *Pythium aphanidematum*」。

參加「第二屆國際生物防治研討會」內容紀要

一、本次研討會因採線上會議，以瑞士的時間為中心，為配合全球各地時間，依議題於不同時區辦理，有些有興趣的議題因時區安排的關係，於臺灣時間的半夜或清晨召開，致無法全程參與，僅能就適合的時間選擇有興趣的議題參與聽講。

二、本次研討會分為 3 個討論小組，共計有 26 個主題：

1. Panel 1: What is being done to improve the uptake of biological control? A multi-stakeholder perspective

   (1) Busting disciplinary silos to advance biological control within global agri-food systems

   (2) Genetic improvement of natural enemies: an urgent breakthrough in the progress of biological control

   (3) Biological Control under changing climates: challenges and prospects

   (4) Biological control in African smallholder production systems

   (5) Regulatory oversight of non-native biological control agents: Developments and challenges

   (6) Novel molecular tools for IPM and Biological Control

   (7) Trichoderma beyond just cell wall degrading enzymes

   (8) Biological control for the protection of cactus crops and the control of invasive alien Cactaceae

   (9) In-field and off-field requirements for biological control - a dialogue

   (10) Botanicals for biocontrol in agriculture and animal husbandry

   (11) New approaches to risk analysis and decision making in biocontrol

   (12) Classical biological control of new and old arthropod pests

   (13) Biological Control in the Next-Generation DNA Sequencing Era

   (14) Ecological interactions among biocontrol agents

(15) Zoophytophagous predators: still an exciting challenge to exploit

(16) Semiochemistry applied to biological control: using the language of natural enemies

(17) Interactions among natural enemies and their effects on biological control

(18) Multi-trophic interactions and effects on biocontrol agent host selection

(19) Augmentative and conservation biological control in Latin America: experiences for fruit and vegetable crops

(20) Delivering on a promise: biological control for Planetary Health

(21) Concurrent pest control and pollination by aphidophagous hoverflies

(22) Management of invasive pest by South-South Cooperation

(23) Free Session a and Free Session b

(24) Acarine biological control: what are the next steps?

(25) Worldwide recent successes in biological control, effectively, economics and public perception

(26) Quantity AND quality: Responding to the challenge of increased demand of biocontrol agents

2. Panel 2: Developing decision support systems to foster the use of biocontrol agents against plant diseases in the field

3. Panel 3: Creating synergies among the biological control approaches to

promote ‘One Health’

如同前述議程表所示臺灣時間，4 月 26 日研討會第 1 天，於瑞士時間中午 12:00-12:45 進行開幕式，如前述議程表所示，相當於臺灣時間晚上 18:00。臺灣時間晚上 19:00-22:00 進行 Panel 1 議題的小組討論及海報發表者交流時間。

一、4 月 27 日研討會第 2 日，瑞士時間下午 13:00-16:00，為第 1-8 主題的口頭論文發表。因時間限制僅選擇部分論文聽講，(1) Genetic improvement of *Orius laevigatus* for better field performance in protected crops：小黑花椿象 *Orius laevigatus* 對防治薊馬是有效的捕食性天敵，但仍有一些限制因素如農藥、食餌密度或極端氣候等阻礙其在田間的表現。Mendoza et al. 利用遺傳改良及提升小黑花椿象對殺蟲劑及環境的適應能力，不僅改進人工飼養的瓶頸，也增強小黑花椿象田間的應用性。(2) Experimental evolution to study the adaptation of plant-beneficial pseudomonads to insects：植物有益微生物 *Pseudomonas protegens* 及 *P. chlororaphis* 可促進根系的定植，同時對有些昆蟲具有抑制的潛力，有希望成為農業害蟲生物防治資材的候選者，本篇論文作者們利用 *P. protegens* CHA10 菌株進行試驗，重複餵食給小菜蛾 (*Plutella xylostella*) 幼蟲數週，分析基因組的變化及昆蟲對其適應力的觀察，以瞭解昆蟲-細菌及植物-細菌相互作用的關係，期能作為未來生物防治資材之一。(3) Genetic improvement of *Nesidiocoris tenuis* Reuter (Hemiptera: Miridae)：evaluation of selected isofemale lines：菸盲椿象 (*Nesidiocoris tenuis*) 在地中海地區被認為對菸草粉蝨 (*Bemisia tabaci*) 及番茄潛旋蛾 (*Tuta absoluta*) 具有高防治效果的捕食性天敵，然而當食餌密度極低時，菸盲椿象雜食性的習性會轉而取食為害番茄作物，透過番茄品種的篩選，找到具有抗菸盲椿象潛力的

2 個番茄品系，未來可作為商業品系應用於釋放菸盲椿象捕食性天敵的番茄園內。(4) BioSuccess - An app to help determine the effects of climate change on the efficacy of a biopesticide：全球都在倡議化學合成農藥減量使用的政策目標，生物農藥更受到重視與推廣，然而，氣候變遷可能造成環境溫度超出生物農藥的耐熱性而失效，也有可能因乾旱造成蟲生真菌無法發揮侵染的能力，BioSuccess 是一種應用軟體程式 (APP)，可提供給使用者作為生物農藥應用時機的決策參考，以提高防治效力，減少對化學合成農藥的依賴，同時也可以評估在特定環境下所使用的生物農藥是否可以在一定時間範圍內控制害物族群密度，達到防治的功效。BioSuccess 是透過 Copernicus Climate Data Store (CDS) 提供 C3S 氣候資料的溫度數據，再與昆蟲發育溫度及生物農藥功效進行分析所建立的生物模式，也就是為了提升生物農藥的有效性，施用時間必須與害蟲發育時間及當地環境和氣候條件吻合，BioSuccess 即在提供給使用者選擇適當的時機施用生物農藥，可收事半功效的防治成效。(5) Climate Smart Pest Management：Nature-based solutions for the climate and environment - the role of IPM and biocontrol products for safer, climate-friendly farming：氣候變遷可能造成物種分布的變化，使得害蟲爆發的預測更加困難，作者提出氣候智能的害物管理系統，整合氣候資訊服務及物候數據來改善生物防治產品有效的利用率，以提高農業生產力，並改善自然生態系統，降低農業生產的碳強度與改進預警系統。

二、此外在木黴菌的小組會議部分，提及木黴菌菌株被大量應用於世界各地的植物保護資材中，由於木黴菌具有對植物病原真菌、卵菌甚至線蟲具有生物防治的活性，許多木黴菌已經被商業化。在本次會議中報告部分菌株由遺傳分析，已由原來的型態轉化並定植作物根部，形成

內寄生 (endophyte)，使得木黴菌的正面效益更明顯，例如促進植物生長、誘導植物抵抗病原菌的攻擊和環境逆境、吸引害蟲天敵以及改善或維持土壤生產力。報告中亦提及木黴釋放揮發性物質 (VOC) 並幫助植物抵禦昆蟲攻擊及吸引寄生蜂、木黴菌從其他真菌中捕獲真菌病毒且可能將低毒力傳播給植物病原體、木黴菌在根圈的機會和競爭、木黴菌生物防治功效可藉由 miRNA 傳遞、木黴菌的代謝物或生物防治能力是基因組錯誤引起的嗎等相關議題。

三、4 月 28 日研討會第 3 日，瑞士時間下午 13:00-16:00，為第 9-19 主題的口頭論文發表。第 9 主題為生物防治應用的要件，包括「Biological pest control services in agricultural landscapes」、「An agroecology and system approach to reduce pesticide use in arable crops」、「Optimization of farmer's agricultural practices to enhance conservation biological control」、「Rice field habitat manipulation: Malaysia's experience in conservation biological control efforts」、「Could winter flowering cover crops promote competition between parasitoids, hyperparasitoids and winter-active pollinators?」等 5 篇論文。重點內容(1) 利用物種豐度、豐量、功能多樣性等指標分析不同捕食性天敵的功能作用，提升生物防治服務的水準；(2) IPM 的操作導入自然因子控制有害生物的預防做法，例如覆蓋作物、間作、輪作及生物防治等，從 2019 年起 6 年的推廣服務期能達農藥使用量減少 75%及最大損失 10%以內的目標；(3) 增加田區周圍的植物多樣性，以保育田間自然存在或釋放的天敵，建立害蟲與其天敵間的共存關係，例如作物輪作、覆蓋作物、減耕或免耕等措施，以優化調整農民既有的管理模式；(4) 以馬來西亞水稻田實施 IPM 為例說明其如何運用天敵的保育措施如於稻田周圍種植開花植物及與蔬菜作物間作或條作，來增加蜜源植物及寄生蜂

或捕食性節肢動物的數量，降低害蟲的族群密度，達到農藥減量的目標；(5) 由於氣候變遷，暖冬可能造成昆蟲滯育越冬的習性，全年發生，也影響其天敵的活動，故於冬季種植開花植物，以提供天敵如寄生蜂的食物來源與授粉昆蟲，增加田間有利的棲息條件與競爭力，本報告以在法國 Brittany 的水稻田為例進行研究，發現控制蚜蟲的寄生蜂與冬季活躍的傳粉媒介之間潛在競爭的關係。第 10 主題探討植物萃取物作為生物防治資材的應用評估，包括「Registration of botanicals – current bottlenecks and future needs」、「Sustainable alternatives to gradually phase out mineral oil for pests control」、「Botanicals for helminth control in small ruminants」、「Insecticidial and antifeedant effects of liquid smoke of cocoa-coconut-rice waste against Coffee stem borer (Hypothenemus hampei)」、「Novel botanical insecticides based on essential oils and clay-*Thrips tabaci* as a model」。本場次會議主要以植物源植保資材應用為主，作者 Tamma et al. 提到植物源植保資材因安全性高，未來被選用的機會很高，然而目前有關植物源產品如印楝樹 (*Azadirachta indica*)、藜蘆屬 (*Veratrum sp.*)、除蟲菊 (C*hrysanthemum cinerariaefolium*) 等植物的萃取物正式登記為商業植保資材的產品極少，然而其有效性、濃度、產品品質穩定度、毒理學、生態毒理學、原物料價格與生產量能等都有待建立基礎資料，也因此造成登記上的障礙，另外作者也提到這類產品售價不可以太高，才能大量推廣，保護農業生態系統。礦物油也是目前有機農業常用的植保資材之一，鑑於它們來自不可再生的石油來源，據報導對天敵有影響，對植物也有藥害的問題，因此礦物油目前在有機農業中也是具爭議的植保資材，也被討論中。Horizon 2020 project ”Replacement of Contentious Inputs in Organic Farming Systems (RELACS)” 提議評估植物精油替代礦物油的可行性，如甜橙精油 (EO, Prevam) 及蝶豆

(*Clitoria ternatea*) 萃取物 (CT, Serox)，從田間和半田間藥效試驗結果發現，對加州紅介殼蟲 (*Aonidiella aurantia*)、桔臀紋粉介殼蟲 (*Planococcus citri*)、柑桔刺粉蝨 (*Aleurocanthus spiniferus*) 著陸到寄主植物上的機會減低，也會干擾其產卵、取食等行為，也對煙草粉蝨進行測試，結果顯示 EO 及 CT 單獨或混合使用具有取代礦物油，作為有機農業植保資材的潛力。作者 Sri Ita Tarigan 為了以友善資材防治咖啡果小蠹 (*Hypothenemus hampei*) 利用農產品廢棄物包括可可豆殼、鋸末、椰子殼和稻殼製成液體煙霧來毒殺咖啡果小蠹，經 GCMS 化學分析，發現主要成分為 Benzenesulfonic acid 4-hydroxy and Acetic acid，以濃度 1%、1.5%、2%、2.5%進行測試，每處理每重複有 15 隻咖啡果小蠹成蟲，以陶斯松 (2 mL/L) 作為對照藥劑，記錄處理後 24、48、72、96、120 小時的死亡蟲數，以濃度 2.5% 的 49% 死亡率為最高，顯示來自椰子殼的煙液似乎可作為植物殺蟲劑，且其防治潛力高於其他殺蟲劑。Liora Shaltiel-Harpaz 等人的研究是將檸檬草 (*Cymbopogon flexuosus*) 和迷迭香 (*Rosmarinus officinalis*) 精油加入粘土和有機粘土配方研究精油的蒸發速率，發現添加粘土和有機粘土者可以緩釋精油的蒸發速率，對細香蔥 (*Allium Schoenoprasum*) 植物未有藥害的現象；另外以海泡石 (sepiolite) 為製劑配方，添加 2 種精油後可降低蔥薊馬 (*Thrips tabaci*) 的存活率約 10%，蔥薊馬對細香蔥的為害率約在 2%，低於對照組的 11%。結論為檸檬草和迷迭香油與海泡石新配方的精油可能可以作為防治蔥薊馬的替代殺蟲劑。也選聽 2 個以捕食性天敵-椿象的研究論文 (1)「Pest managment in horticultural crops based on the use of zoophytophagous predators」-在歐洲地區常用對粉蝨具有防治效果的捕食性椿象 2 種，菸盲椿象 (*Nesidiocoris tenuis*) 與 *Macrolophus pygmaeus*，此 2 種椿象為雜食性，也會取食為害植物，本研究發現其取食甜椒時會誘導甜椒釋放一

種揮發物 (HIPV) 可誘引可寄生粉蝨的恩蚜小蜂 (*Encarsia Formosa*)，然而卻可對西方花薊馬具忌避作用，降低 TSWV 在甜椒園的罹病率。(2)「Interactions among plants, essential oils and the omnivorous mirid *Nesidiocoris tenuis*」-本篇論文也是在探討菸盲椿象除了作為生物防治天敵外，如何選育對菸盲椿象具抗性的番茄品種，試驗期間也發現如果在番茄上噴施植物精油可以影響菸盲椿象的活動，對其產卵具負面影響。

四、 4 月 29 日研討會第 4 日，瑞士時間 13:00-16:00。選聽 session 22「Management of invasive pest by South-South Cooperation」中 2 篇論文(1)「Current research on entomopathogens of recent invasive insect pests in India」簡介微生物農藥玫煙色棒束孢菌 (*Isaria fumosorosea*), 黑殭菌 (*Metarhizium anisopliae*), 白殭菌 (*Beauveria bassiana*), 蠟蚧輪枝菌 (*Lecanicillium lecanii*), 蘇力菌 (*Bacillus thuringiensis*) 及蟲生線蟲對螺旋粉蝨 (*Aleurodicus rugioperculatus*)、木瓜秀粉介殼蟲 (*Paracoccus marginatus*)、番茄潛旋蛾 (*Tuta absoluta*)、秋行軍蟲 (*Spodoperda frugiperda*)、木薯綿粉介殼蟲 (*Phenacoccus manihoti*) 等害蟲的應用及防治效果。(2)「New approach and improvement on *Telenomus remus* Nixon, 1937 studies aiming *Spodoptera* Guenée, 1852 biological control」本論文在探討並建立黑漿卵蜂 (*Telenomus remus*) 大量飼養的方法，以釋放於田間防治夜蛾類 *Spodoptera* spp. 利於生物防治的應用。

五、4 月 30 日研討會第 5 日，瑞士時間 13:00-16:00。Panel 2 專題討論主題為「Developing decision support systems to foster the use of biocontrol agents against plant diseases in the field」 介紹所謂生物防治決策支援系統 (Biocontrol Decision Support Systems (DSSs))，希望透

過農場顧問、生物防治業者、學研單位及終端使用者農民一起建立一個生物防治適期的調查格式。16:00-18:00 第 3 組的專題討論「Creating synergies among the biological control approaches to promote 'One Health'」。於 18:15 進行閉幕式，由主席 Martin Hill 教授以視訊方式說明本次研討會的進行情況，也對 COVID-19 疫情影響大家到瑞士開會與交流的機會，也因為時區的不同，影響大家對有興趣聽講的題目的時間排程，這也是本次研討會有點遺憾之處。最後，主席請大家要保重身體，共渡疫情的難關，也期望下次會期，能再與大家見面交流。

心得

1. 本次會議較側重昆蟲害蟲防治，防治方法包括使用微生物、植物萃取物、天敵等，此外也討論法規防治 (session 5) 與氣候變遷等議題，都與我們目前實務上面臨的問題相關。由研討會可以了解到各個國家發展階段與解決問題的方法，是快速、務實且有效率的交流。然受限於時區與地域，未能完整選擇適當的議題，為本次會議最為可惜之處。

2. 在植物萃取物應用方面，植物萃取物可發展為新植物保護產品，並具有發展為動物用藥的潛力，而受到越來越多的關注，且亦極具潛力應用在有機農業和慣行農業中。在本次會議中，有使用礦物油防治農業害蟲的應用實例與方法，及報告不同作用模式的新穎植物萃取物，以減少植物病原體產生抗藥性。此外，以植物萃取物在有機畜牧業作為替代品取代抗生素。該時段討論包括以下會談：使用植物萃取物減少銅劑來防治植物病原真菌 (Annegret Schmitt，JKI，德國)、使用植物萃取物來降低害蟲防治用的礦物油使用量 (Ilaria Pertot，FEM，意大利)、

使用植物萃取物用於控制乳牛乳腺炎(Olivia Tavares, ITAB, France)、使用植物萃取物作為小型反芻動物驅蟲劑 (Spiridoula Athanasiadou, SRUC, UK)、植物萃取物之登記註冊-當前瓶頸和未來需求 (Lucius Tamm, FiBL, Switzerland) 等議題。

3. 本次研討會中有關害蟲的生物防治以椿象類發表較多，由於氣候變遷或極端氣候下，致力於篩選出更能適應氣候變化的小黑椿象，以強化田間的應用性。菸盲椿象除了可作為粉蝨及部分鱗翅目幼蟲的捕食天敵，其抑制效果相當不錯，但菸盲椿象除了取食害蟲外，也會棲息在新梢處刺吸取食，造成葉片出現受害痕，影響植株的生長，為了能有效利用菸盲椿象作為天敵，研究人員也嘗試篩選可抗菸盲椿象的作物如番茄，以利天敵的釋放，對要防治的食餌發揮最佳的防控效果。可見，國外除了重視生物防治的應用，也朝改善天敵的棲息環境，提升田間防治效果的目標進行各方向的研究，值得我們思考未來研究方向。

4. 在 IPM 操作上釋放天敵的時間點也就是害蟲密度需低於化學農藥施藥的基準，如何掌握釋放時機及保育天敵，在本次研討會中也有數篇提出分享，除了於田區周圍種植適合天敵棲息的植物場域外，也有提出一個新的思維「生物防治決策支援系統 (DSS)」，以農場農民為中心，透過與農場顧問及學研單位的合作，建立屬於個別客製化的生物防治適期的調查表與審定基準。IPM 即為一個害物防治的支援系統，過去多在談化學農藥的啓動時機，然而在本次會議中也針對「生物防治決策支援系統 (DSS)」以小組方式設定一個場景討論，此類 DSS 開發的問題。本所也正與業者開發智慧農藥 IPM 控制平台，是開發害物防治決策的支援系統，主要針對化學農藥及微生物農藥重點，未來若天敵應用層面更廣後，可以思考再導入生物防治決策支援系統，更加完備平台的應用。

5. 由於參加本次的研討會才得知有 BioSuccess 的 APP 工具，該軟體是為了因應極端氣候的變化，可能影響微生物農藥藥效的發揮而開發的一套應用軟體系統。為了農業的永續，達成農藥減半的目標，微生物農藥的應用尤其重要，若因極端氣候導致藥效降低，則不是農業操作者樂於見到的現象，BioSuccess 則是提供用以作為生物農藥應用時機的決策參考，以提高防治效力。

6. 本次研討會也有針對礦物油的替代品植物精油提出相關研究與防治效果初探。由於礦物油是石化產物的一種，雖然目前可用於有機農業，但若使用頻度太多了，有可能破壞生態環境，也朝植物精油進行開發與效果測試，例如甜橙精油及蝶豆萃取物混合後，不僅不會造成作物藥害問題，除了造性慢性毒效外，供試害蟲的活動及產卵能力均受到減少的負面效應，值得應用推廣。然而基於法規，目前登記藥效的精油很少，也有作者提出建議，應該針對植物源植保資材建立檢驗規格以穩定產品、有效性評估方法、毒理影響等，甚至對於法規部分，也應有對應的調整，最終作者也建議，植物源植保資材的費用太高，很難大面積的推廣，建議應該下降，以利農民的使用與推廣。

結論及建議

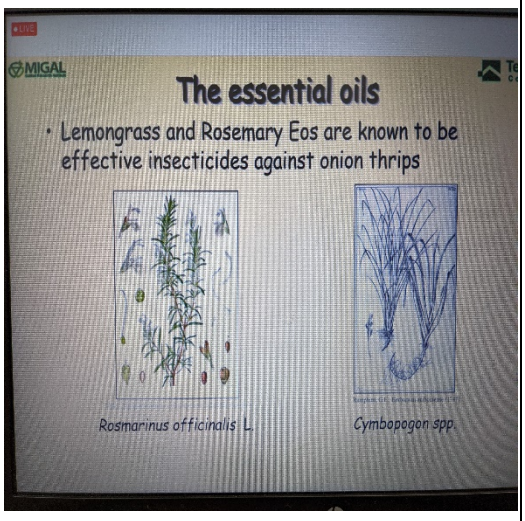
一、本次國際研討會設定的主題相當廣泛，由於時區關係，有些有興趣的主題無法進入會議時段聆聽，或因於重疊的時間內而無法參加，是有點遺憾。由於線上會議缺乏互動的機會，例如與會人員在 2 篇論文發表區留言提出問題，也留下電郵，但至會議結束至今，一直沒有收到回音，為此次參加美中不足之處。

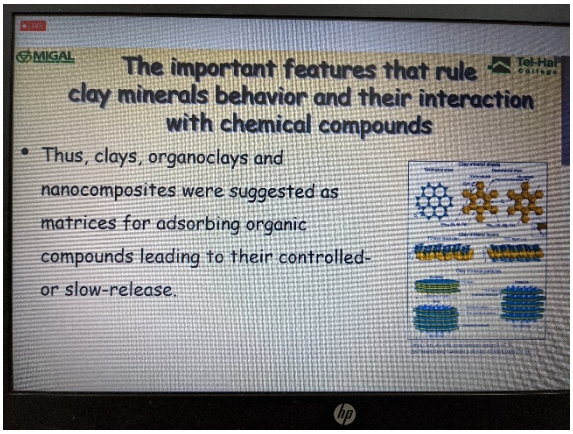
二、此次很多主題與害蟲的生物防治有關，與會人員偏重選擇應用面的題目

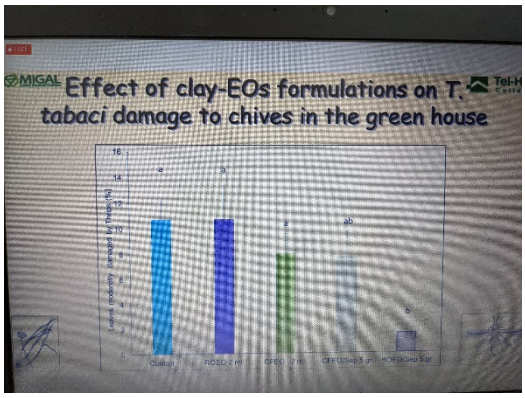
進入聆聽，尤其與 IPM 結合的主題優先聽講。其中有關 BioSuccess 應用軟體的簡介，與會人員得知國外已進步到將氣候因素利用 APP 工具，提供給農田管理人員在生物防治應用時釋放或微生物農藥施用時機的參考，實施 IPM 時除了透過監測與紀錄作為防治時機的決策支援系統外，現在又多了生物防治應用時機的決策系統。若非有參加本國際生物防治研討會的機會，尚不知道有 BioSuccess 這套應用軟體工具，對與會人員而言獲益很多。

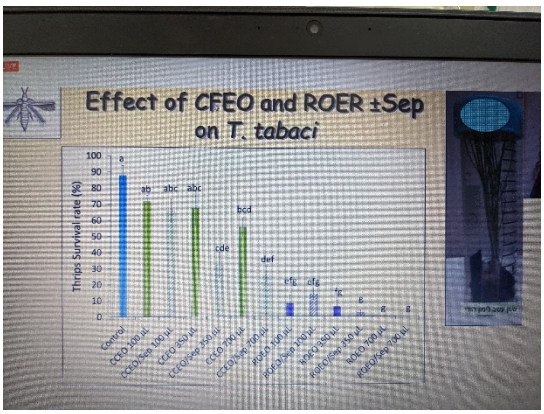
三、氣候變遷在本次會議主題中也是重要的議題，目前國內談論氣候變遷議題時，多想到害蟲族群的變動與分布更迭，然而本次研討會則從氣候條件及物候學上來探討害蟲與其天敵共存的關係，提供生物防治運用操作的支援系統及預警系統的建立或修正，也是未來在 IPM 實施時需再加強的基礎學識。特別是這幾年氣候環境對於我們的生活環境影響深遠，對於作物栽培更是重要課題，未來應加強涉略相關害蟲與天敵的動態影響，甚或與微生物相關研究探討與基礎資料，以作為國內建構 IPM 系統的依據。

附錄一、口頭簡報部分截圖佐證

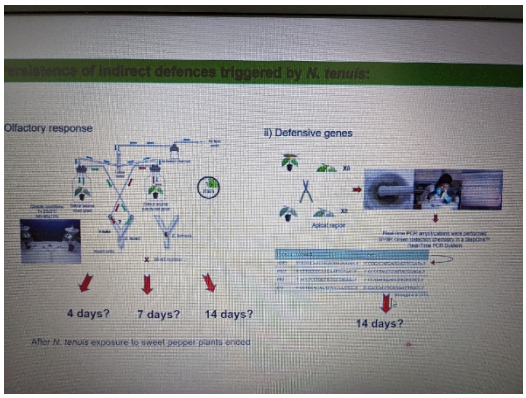


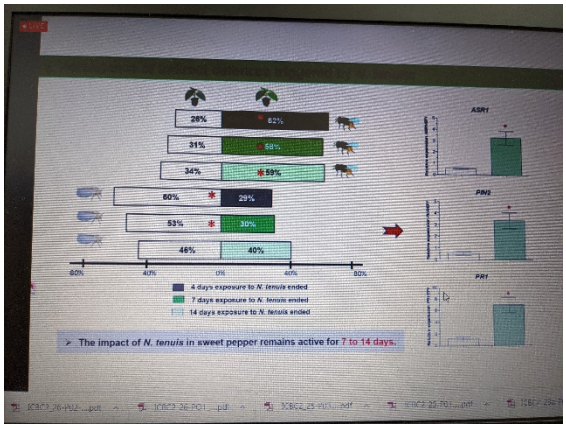






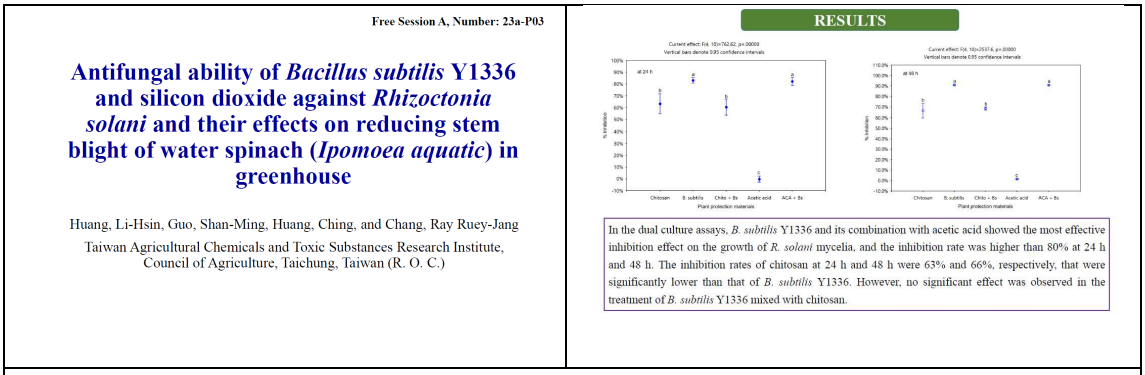
圖一、摘錄自 Session 10-O05 作者簡報部分內容





圖二、摘錄自 Session 15-O03 作者簡報部分內容

附錄二、節錄本所發表內容



Free Session A, Number: 23a-P03

Antifungal ability of *Bacillus subtilis* Y1336 and silicon dioxide against *Rhizoctonia solani* and their effects on reducing stem blight of water spinach (*Ipomoea aquatic*) in greenhouse

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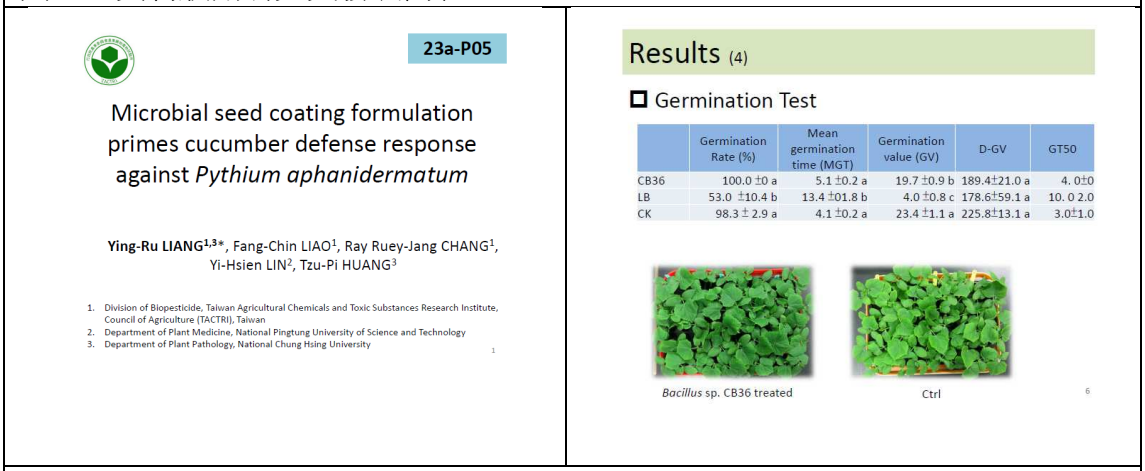
RESULTS

In the dual culture assays, *B. subtilis* Y1336 and its combination with acetic acid showed the most effective inhibition effect on the growth of *R. solani* mycelia, and the inhibition rate was higher than 80% at 24 h and 48 h. The inhibition rates of chitosan at 24 h and 48 h were 63% and 66%, respectively, that were significantly lower than that of *B. subtilis* Y1336. However, no significant effect was observed in the treatment of *B. subtilis* Y1336 mixed with chitosan.

圖三、黃莉欣副研究員發表內容



23a-P05

Microbial seed coating formulation primes cucumber defense response against *Pythium aphanidermatum*

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3. Department of Plant Pathology, National Chung Hsing University

Results (4)

Germination Test

	Germination Rate (%)	Mean germination time (MGT)	Germination value (GV)	D-GV	GT50
CB36	100.0 ±0 a	5.1 ±0.2 a	19.7 ±0.9 b	189.4±21.0 a	4. 0±0
LB	53.0 ±10.4 b	13.4 ±01.8 b	4.0 ±0.8 c	178.6±59.1 a	10. 0 2.0
CK	98.3 ± 2.9 a	4.1 ±0.2 a	23.4 ±1.1 a	225.8±13.1 a	3.0±1.0

Bacillus sp. CB36 treated

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圖四、梁瑩如助理研究員發表內容