Front. Agr. Sci. Eng. 2022, 9(1): 1–3 https://doi.org/10.15302/J-FASE-2021431

EDITORIAL

CROP PROTECTION OPENS UP NEW ERA OF SUSTAINABLE AND ENVIRONMENT-FRIENDLY AGRICULTURAL PEST MANAGEMENT

Guirong WANG[1,2], Yuanchao WANG[3], Guangfu YANG[4], Kongming WU (✉)[1]

1 State Key Laboratory for Biology of Plant Diseases and Insect Pests, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100193, China.
2 Guangdong Laboratory for Lingnan Modern Agriculture (Shenzhen Branch), Agricultural Genomics Institute at Shenzhen, Chinese Academy of Agricultural Sciences, Shenzhen 518172, China.
3 Plant Protection College, Nanjing Agricultural University, Nanjing 210095, China.
4 Key Laboratory of Pesticide & Chemical Biology, Ministry of Education, International Joint Research Center for Intelligent Biosensor Technology and Health, Central China Normal University, Wuhan 430079, China.

Received October 27, 2021.
Correspondence: wukongming@caas.cn

China is the largest agricultural producer in the world. Reducing yield losses caused by pests is an important issue and major challenge for China, especially when confronting global climate change, biological invasions and declining agricultural biodiversity of recent decades. Wang et al. (this issue) summarized the impacts of changing climate on two staple crops in China, wheat and rice (https://doi.org/10.15302/J-FASE-2021432). They reviewed the impacts of climate change on crops, crop pests and crop diseases. Basically, increased temperature would reduce crop yields and increase pest damage. Biological invasions have become a serious threat to the agriculture worldwide. Developing approaches for monitoring and controlling invasive pests, such as fall armyworm, has been recognized as high priority for China. The excessive use of highly toxic pesticides has caused considerable damage to the environment and biodiversity, which is also one of the many contributors to the increasing outbreaks of pests and diseases. In addition, understanding interaction between crop pests and plant diseases is another critical challenge for agriculture. About 80% plant viruses can be transmitted by crop pest vectors such as aphids, whiteflies and other hemipteran pests. Therefore, to solve the problem of crop pests and diseases, suitable green crop protection methods have been identified as a key components of sustainable development. This special issue of Frontiers of Agricultural Science and Engineering outlines potential sustainable and environment-friendly options for crop protection.

To prevent outbreaks of crop pests, an advanced monitoring and early warning system could be the first step in crop protection. The use of science and technology in monitoring and early warning of major crop pests provides better pest management and acts as a fundamental part of an integrated plant protection strategy to achieve the goal of sustainable development of agriculture. Wu et al. (this issue) summarized the fundamental information on pest monitoring and early warning in China by documenting the history of research and application, Chinese laws and regulations related to plant protection, and the National Monitoring and Early Warning System, with the purpose of presenting the Chinese model as an example of how to promote regional management of crop pests, especially cross border pests such as fall armyworm and locust, by international cooperation across pest-impacted countries (https://doi.org/10.15302/J-FASE-2021411). They provide an overview of long-term Chinese efforts in the fight against major pests and to present the country’s experience in crop pest monitoring and early warning technology to the world.

Field management is a traditional conservation agriculture technique on plant protection such as no-till cropping, crop rotation, intercropping and cover cropping. Shi et al. (this issue) found that soil solarization is an environment-friendly promising strategy that achieved complete mortality to the larvae of *Bradysia cellarum* (https://doi.org/10.15302/J-FASE-2021402). Crop rotation, intercropping and cover cropping of different crops or plants could help to reduce the outbreak of crop pests and diseases. Wang et al. (this issue) summarized the interactions and trade-offs between plants and entomophagous arthropods, and discussed a landscape management method by sowing flowering plants in agricultural fields (https://doi.org/10.15302/J-FASE-2021427). However, such methods are limited when crop pests have already become well established in crop fields.

Pesticides are widely used in the crop protection. The ideal pesticide should have high effectiveness in the control crop pests but low toxicity to non-target organisms. In this case, biopesticides including biochemical pesticides, microbial pesticides and plant-incorporated protectants are considered to be potential ideal pesticides for crop protection. Biochemical pesticides are the naturally occurring substances, they are derived from animals, plants and microorganisms. Microbial pesticides mainly rely on bacteria, fungi, virus or protozoans as the active agent. They are environment-friendly biopesticides with high effectiveness and species-specificity, and have been commercialized worldwide, for example, *Bacillus thuringiensis*. Plant-incorporated protectants are products that are genetically incorporated into plant tissues including chemicals, proteins or dsRNA for pest control or anti-microbial activity. Qu et al. (this issue) systematically introduced bioinsecticides for pest control and discussed current constraints that prevent bioinsecticides from being widely used and proposed the future research directions in this issue (https://doi.org/10.15302/J-FASE-2021404). Xu et al. (this issue) optimized synthesis process of an anti-plant-virus candidate drug NK0238, and evaluated the antivirus activity and environmental safety of this product (https://doi.org/10.15302/J-FASE-2021390). Zhu et al. (this issue) investigated a new family of natural cyclic lipodepsipeptides with potent activity against Gram-positive bacteria. By genetic manipulation of accessory genes in the WAP biosynthetic gene cluster, new WAP-8294As were produced in Lysobacter, which confirmed the possibility to expand the spectrum of the biocontrol compounds (https://doi.org/10.15302/J-FASE-2021410). In addition, structural biology studies on action targets provides important insights on molecular functions. Using a structure-based drug design strategy, Zheng et al. (this issue) prepared a battery of novel triketone-quinoxaline compounds, which could be potentially applied to design new herbicides targeting p-hydroxyphenylpyruvate dioxygenase (https://doi.org/10.15302/J-FASE-2021401).

With the development and application of new biotechnology in agriculture, opportunities for crop protection are great becoming more abundant, opening new approaches, such as genetic engineering, to improve the plant resistance against crop pests and diseases. It is now feasible to control pests by directly targeting genes that are essential for the development and survival of insects and pathogenic microorganisms, for example, the sterile insect technique based on gene-drive and RNA interference using dsRNA. In addition, it has been confirmed that some gene families are effective targets that indirectly contribute to crop pests and diseases protection by targeting the plant biochemical synthesis or virus transmitting pathways. In this case, identifying new genes associated with the interaction between crops, insects, microorganisms should be a key focus, both now and in the future. Huang et al. (this issue) summarized the recent research on the interaction between plant viruses and insect vectors, and discussed the potential control strategies to prevent the transmission of insect-vectored plant viruses using RNAi technology, gene editing technology and gene-driven technology (https://doi.org/10.15302/J-FASE-2021389).

We anticipate that the ideas and approaches highlighted in this issue will help broaden reader’s perspectives on every increasing prospect for a new era of sustainable and environment-friendly agricultural pest management.

Dr. Kongming Wu, Professor at the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, China. He currently holds the post of president, Chinese Academy of Agricultural Science. He received his PhD in agricultural insect and pest control from the Graduate School of Chinese Academy of Agricultural Sciences in 1994. He was selected as Academician, Chinese Academy of Engineering in 2011. His research focuses on biology and management strategies of cotton insect pests, including migratory biology, integrated pest management strategy of cotton insect pests, impacts of Bt transgenic cotton on evolution of pest status in agricultural ecosystem, and insect resistance management strategy of cotton bollworm/pink bollworm to Bt cotton. These strategies, in applying the principle of agro-ecology and moving towards the concept of a sustainable agriculture, have been widely used for insect pest management in Chinese agricultural system, which play very important roles in reducing the utilization of insecticides and improving economic output of cotton in China. He has published more than 200 academic articles in scientific journals including *Science*, *Nature*, *Nature Biotechnology*, *PNAS* and *Annual Review of Entomology*, etc.

Dr. Guirong Wang, Professor at the Agricultural Genomics Institute at Shenzhen, Chinese Academy of Agricultural Sciences, China. He received his PhD in agricultural insect and pest control from the Graduate School of Chinese Academy of Agricultural Sciences, China, in 2002. Subsequently, he joined the Institute of Plant Protection, Chinese Academy of Agricultural Sciences as an Assistant Professor. He was promoted an Associate Professor in 2005 and a Professor in 2010. During 2005–2010, he worked on insect olfaction at Vanderbilt University, USA, as a Senior Research Associate. He is currently engaged in the study of insect chemical ecology and functional genomics. His aim is not only to reveal the molecular mechanism of olfactory coding in agricultural pest insects, but also to develop novel environment-friendly green pesticides.

Dr. Yuanchao Wang, Professor in the Department of Plant Pathology, Nanjing Agricultural University. He received his PhD in Plant Pathology from Nanjing Agricultural University (NJAU) in 1996. After finished two and half years Postdoc research in Biotechnology Institute in Zhejiang University, he joined NJAU in 1999. He was promoted a Professor in 2005. Research in Yuanchao's laboratory mainly focuses on oomycete pathogens, including Phytophthora, that cause economically important plant diseases. He investigates the molecular basis of the plant-pathogen arms race by elucidating the function of pathogen virulence proteins called effectors, which directly manipulate plant immunity to facilitate disease development. Using effectors as molecular probes, his research provides mechanistic insight into microbial pathogenesis and plant immunity. This basic research sets the foundation for achieving broad-spectrum pathogen resistance in crops. Currently, his group studies the *Phytophthora sojae* and *Phakopsora pachyrhizi*, both causes the devastating disease in soybean crops.

Dr. Guangfu Yang, Professor at the Central China Normal University (CCNU), China. He received his PhD in pesticide science from Nankai University in 1997. Subsequently, he joined the Institute of Organic Synthesis of CCNU as a Lecturer and became a Professor in 2001. He has served as the Dean of College of Chemistry of CCNU (2001–2014), and as Assistant President of CCNU (2014–2017). He is the Director of the Key Laboratory of Pesticide & Chemical Biology (Ministry of Education) (2003–present) and the Director of the International Joint Research Center for Intelligent Biosensor Technology and Health (2018–present). He has been working in the field of pesticide discovery and its chemical biology for almost 30 years. He has invented six green pesticides, including benquitrione as the first selective herbicide used for the weed control in sorghum crops.